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In 2008 all ECB publications feature a motif taken from the €10 banknote.

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CONTENTS

Abstract

We analyse the interactions between public and private sector wages per employee in OECD countries. We motivate the analysis with a dynamic labour market equilibrium model with search and matching frictions to study the effects of public sector employment and wages on the labour market, particularly on private sector wages. Our empirical evidence shows that the growth of public sector wages and of public sector employment positively affects the growth of private sector wages. Moreover, total factor productivity, the unemployment rate, hours per worker, and inflation, are also important determinants of private sector wage growth. With respect to public sector wage growth, we find that, in addition to some market related variables, it is also influenced by fiscal conditions.

Keywords: public wages, private wages, employment.

JEL Classification: E24, E62, H50.

Non-technical summary

The relevance of public wages for total public spending has gradually increased in the past decades in several European countries. Apart from the importance that such budgetary item has for the development of public finances and for attaining budgetary objectives, public sector employment and wages play a key role on the labour market. Therefore, the main objective of this paper is to understand the interactions between private and public sector wages.

First, we motivate the analysis with a dynamic labour market equilibrium model with search and matching frictions to study the effects of public sector employment and wages on the labour market. As in other models that address this issue, we find that public sector wages and employment have some impact on private sector wages. In essence, public sector wages and employment impinge on private sector wage, via two channels. On one hand, they affect the outside option of the unemployed, either by increasing the value of being employed in the public sector (public sector wage) or by increasing the probability of being hired by the public sector (public sector employment). Therefore, they put pressure on the wage bargaining. On the other hand, both public wages and employment have to be financed by an increase in taxes, which will reduce the overall gain from the match and increase the wage paid by the firm. In the model, an increase of 1% in public sector wages induces an increase of 0.1% in private sector wage. An increase in public employment of 1 percentage point of the labour force increases private sector wages by 0.45%.

Second, we go on assessing the determinants of private sector wage growth. We develop our analysis for the OECD and European Union countries for the period between 1970 and 1998/2006 (depending on data availability). We carefully discuss the econometric issues involved, and how we deal with them, particularly the problem of endogeneity.

An additional purpose of the paper is to analyse as well what are the main determinants of public sector wages. For instance, public wages can also depend on the fiscal position. Moreover, public wages might be used as an instrument in terms of income policies, so they can depend on political factors such as the political alignment of the ruling party or election cycles.

In a nutshell, we empirically find that a number of variables affect private sector wage growth, for instance: changes in the unemployment rate (negative relationship), inflation rate, total factor productivity growth and hours per worker. Moreover, public sector wages and employment growth also affect private sector wage growth, which has important policy implications. In addition, regarding the public sector wages, statistically significant determinants are private sector wage growth, inflation, and changes in the unemployment rate (positive relationship). Public sector wages also react positively to the budget balance and negatively to government indebtedness, that is, to higher debt-to-GDP ratios.

1. Introduction

The relevance of public wages for total public spending has gradually increased in the past decades in several European countries. Apart from the importance that such budgetary item has for the development of public finances and for attaining budgetary objectives,[1] public sector employment and wages play a key role on the labour market. Therefore, the main objective of this paper is to understand the interactions between private and public sector wages.

First, we motivate the analysis with a dynamic labour market equilibrium model with search and matching frictions to study the effects of public sector employment and wages on the labour market. As in other models that address this issue,[2] we find that public sector wages and employment have some impact on private sector wages. In essence, public sector wages and employment impinge on private sector wage, via two channels. On the one hand, they affect the outside option of the unemployed, either by increasing the value of being employed in the public sector (public sector wage) or by increasing the probability of being hired by the public sector (public sector employment). Therefore, they put pressure on the wage bargaining. On the other hand, both public wages and employment have to be financed by an increase in taxes, which will reduce the overall gain from the match and increase the wage paid by the firm. In the model, an increase of 1% in public sector wages induces an increase of 0.1% in private sector wage. An increase in public employment of 1 percentage point of the labour force increases private sector wages by 0.45%.

Second, we go on assessing the determinants of private sector wage growth. We develop our analysis for the OECD and European Union countries for the period between

[1] According to the European Commission, the average share of public wages (compensation of employees) in general government total spending was around 23 per cent in 2007 for the European Union, that is, around 11 percent of GDP. Interestingly, the public wages-to-total government spending ratio was 28 per cent in 2006 in the US. See the Appendix for some illustrative country data.

[2] See, for instance, Holmlung and Lindén (1993), Algan et al. (2002) or Ardagna (2007).

1970 and 1998/2006 (depending on data availability). We carefully discuss the econometric issues involved, and how we deal with them, particularly the problem of endogeneity.

An additional purpose of the paper is to analyse as well, what are the main determinants of public sector wages. Although there is evidence of some pro-cyclicality of public wages (Lamo et al., 2007), their developments may be less aligned with those of private wages. For instance, public wages can also depend on the fiscal position. In fact, Poterba and Ruben (1995) and Gyourko and Tracy (1989) find that fiscal conditions affect wages of public employees at a local level. Moreover, public wages might be used as an instrument in terms of income policies, so they can depend on political factors such as the political alignment of the ruling party or election cycles. For instance, Matschke (2003) finds evidence of systematic public wage increases prior to a federal election in Germany.

In a nutshell, we empirically find that a number of variables affect private sector wage growth, for instance: changes in the unemployment rate (negative relationship), inflation rate, total factor productivity growth and hours per worker. Moreover, public sector wages and employment growth also affect private sector wage growth, which has important policy implications. In addition, regarding the public sector wages, statistically significant determinants are private sector wage growth, inflation, and changes in the unemployment rate (positive relationship). Public sector wages also react positively to the budget balance and negatively to government indebtedness, that is, to higher debt-to-GDP ratios.

The paper is organised as follows. In section two we present an analytical framework, relevant for the subsequent empirical analysis. In section three we present the empirical setting and in section four we report and discuss the results. Section five summarises the paper's main findings.

2. Analytical framework

2.1. The model

We set up a dynamic labour market equilibrium model, with public and private sectors and search and matching frictions, along the lines of Pissarides (1988). The general setting shares some features with Quadrini and Trigari (2007). Public variables are denoted with superscript $\{g\}$ while private sector variables are denoted by $\{p\}$. Households' utility takes the form

$$u(c_t, g_t) = c_t + \chi g_t \,, \tag{1}$$

where c_t is private consumption and g_t is the flow of services derived from public employment.

Part of the labour force is unemployed (u_t), while the remaining is either working in the public sector (L_t^g) or in the private sector (L_t^p),

$$1 = u_t + L_t^g + L_t^p \,. \tag{2}$$

Workers supply one unit of labour. If they are unemployed they search for jobs in both public and private sectors. s_t gives the share of time devoted searching for a public sector job. Firms post vacancies v_t^p. The number of matches is determined by two matching functions, one for each sector, and we allow for different matching coefficients η^p and η^g:

$$M_t^p = \bar{m}^p ((1-s_t)u_t)^{\eta^p} v_t^{p(1-\eta^p)} \,, \tag{3}$$

$$M_t^g = \bar{m}^g (s_t u_t)^{\eta^g} v_t^{g(1-\eta^g)} \,. \tag{4}$$

From the matching functions we can calculate the job finding rates (p_t^g and p_t^p) and the probabilities of vacancies being filled (q_t^p and q_t^g):

$$q_t^p = \frac{M_t^p}{v_t^p}, q_t^g = \frac{M_t^g}{v_t^g}, p_t^p = \frac{M_t^p}{u_t}, p_t^g = \frac{M_t^g}{u_t} \,. \tag{5}$$

Government

The government hires workers to provide some public services, following a simple linear function $g_t = L_t^g$. As in Quadrini and Trigari (2007), we assume that both public sector employment and wages are set exogenously. It is not our purpose to identify the optimal level of public employment and wages, but simply to understand the transmission mechanism of public sector wages and employment shocks.

$$L_t^g = \bar{L}^g, w_t^g = \bar{w}^g. \tag{6}$$

Although the government targets the level of public employment, it has to post a number of vacancies consistent with the following law of motion.

$$L_{t+1}^g = (1-\lambda^g)L_t^g + q_t^g v_t^g. \tag{7}$$

Every period a fraction λ^g of public jobs are destroyed so the government posts the number of public sector vacancies (v_t^g) needed to maintain the level of employment, given the current market conditions.

Finally, the government sets a labour income tax (τ_t) necessary to finance the government wage bill, the payment of unemployment benefits (z) and the cost of posting the vacancies (c^g),

$$\tau_t L_t^p w_t^p = (1-\tau_t)L_t^g w_t^g + zu_t + c^g v_t^g. \tag{8}$$

Firms

Firms produce a good with a production function that only depends on labour.

$$Y_t = AL_t^{p(1-\alpha)}. \tag{9}$$

The private sector labour follows the following law of motion

$$L_{t+1}^p = (1-\lambda^p)L_t^p + q_t^p v_t^p, \tag{10}$$

where λ^p is the private sector job separation rate. At any point in time the level of employment is predetermined and the firm can only control the number of vacancies it posts. The objective of the firms is therefore to maximize the present discounted value of profits subject to the law of motion of private employment,

$$Max\ E_t \sum_{k=0}^{\infty} \beta^k [AL_{t+k}^{p\ (1-\alpha)} - L_{t+k}^p w_{t+k}^p - c^p v_{t+k}^p], \tag{11}$$

where c^p is the cost of posting a vacancy. The solution to this problem is given by the following first order condition:

$$\frac{c^p}{q_t^p} = \beta E_t [A(1-\alpha) L_{t+1}^{p\ -\alpha} - w_{t+1}^p + (1-\lambda^p)\frac{c^p}{q_{t+1}^p}]. \tag{12}$$

The optimality condition of the firm states that the expected cost of hiring a worker must equal its expected return. The benefits of hiring an extra worker is the discounted value of the expected difference between its marginal productivity and its wage and the continuation value, knowing that with some probability λ^p the match can be destroyed.

Workers

The value to the household of each member depends on their current state: employed in the public or in the private sector or unemployed. The value of being in each state is given by the following expressions:

$$W_t^p = (1-\tau_t) w_t^p + \beta E_t [(1-\lambda^p) W_{t+1}^p + \lambda^p U_{t+1}], \tag{13}$$

$$W_t^g = (1-\tau_t) w_t^g + \beta E_t [(1-\lambda^g) W_{t+1}^g + \lambda^g U_{t+1}], \tag{14}$$

$$U_t^p = z + \beta E_t [p_t^p W_{t+1}^p + p_t^g W_{t+1}^g + (1-p_t^p - p_t^g) U_{t+1}]. \tag{15}$$

The value of unemployment depends on the level of unemployment benefits and on the probabilities of finding a job in the two sectors. As the unemployed control the search effort into each sector, they can affect both probabilities. Therefore, they will choose how to

split their search optimally, by maximizing the value of unemployment. The optimal search of public jobs is given implicitly by:

$$\frac{\eta^g M_t^g E_t[W_{t+1}^g - U_{t+1}]}{s_t} = \frac{\eta^p M_t^p E_t[W_{t+1}^p - U_{t+1}]}{1-s_t}. \qquad (16)$$

The optimal search of public sector jobs increases with the number of vacancies in the public sector and the value of a public job, which depends positively on the public sector wage and negatively on the separation probability. It is increasing in the importance of unemployment and in the government matching function, and decreasing in the same coefficient of the private sector matching function.

Wage bargaining

We consider that the private sector wage is the outcome of a Nash bargaining between workers and firms. The solution is given by

$$(1-b)(W_t^p - U_t) = bJ_t, \qquad (17)$$

where b is the bargaining power of the worker and J_t is the value of an average job for the firm, given by the following expression

$$J_t = \frac{Y_t}{L_t^p} - w_t^p + \beta(1-\lambda^p)J_{t+1}. \qquad (18)$$

2.2. Calibration and simulation

We calibrate the model to be, in general, representative on an OECD economy. Table 1 shows the baseline calibration. We consider public employment to be 15% of total labour force, which, given an average unemployment rate of 8% is equivalent to, roughly, 16% of total employment. The public sector wage is set such that in steady state the public sector

wage premium is equal to 5%. This value is in line with several empirical estimates (see Gregory and Borland, 1999, for an overview of the literature.

[Table 1]

The separation rate in the public sector is set to 3%, half the separation rate in the private sector (6%). This follows Gomes (2008) that finds evidence of this for UK. We also calibrate the two matching functions differently. As it is usual in the literature, we set η^p equal to 0.5. In contrast, η^g is set equal to 0.3, which implies that vacancies are relatively more important than the pool of unemployed in the public sector. We believe that this is a less extreme assumption than the one used by Quadrini & Trigari (2007). They consider that the unemployed queue for a public sector job which means that all public vacancies are filled.[3]

The other frictions parameters (c^i and $\overline{m}^i$) are set equal in both sectors. Overall, the calibration implies an unemployment rate of 8%, a job finding rate of 0.63 between the two sectors, and a probability of filling a vacancy in the private sector of 0.5 and of 0.8 in the public sector.

Following also the search and matching literature, the coefficient of the private wage bargaining is set to 0.5. Finally, the unemployment benefit is set to 0.3, which implies a replacement rate around 0.4, the discount factor is set to 0.99 and α to 0.3.

We can see in Figure 1 that the steady state level of private sector wages is positively affected by the level of public sector wages and public sector employment.[4]

[Figure 1]

In essence, public sector wages and employment impinge on private sector wage, via two channels. First, they affect the outside option of the unemployed, either by increasing the

[3] In practice, the way that we calibrate the matching function is not important. The government decision variable is the level of public employment and vacancies adjust to guarantee that the new hires compensate the separations.
[4] In the Appendix we report the behaviour of the other variables in the model.

value of being employed in the public sector (public sector wage) or by increasing the probability of being hired by the public sector (public sector employment). Therefore, they put pressure on the wage bargaining. Second, both public wages and employment have to be financed by an increase in taxes, which will reduce the overall gain from the match and increase the wage paid by the firm. On average, an increase of 1% in public sector wages induces an increase of 0.1% in private sector wage. An increase in public employment of 1% of the labour force increases private sector wage by 0.45%.

Effects of temporary shocks in public sector employment and wages

We will now consider shocks to the level of public sector wages and employment of the following type:

$$\ln(w_t^g) = \ln(\overline{w}^g) + \varepsilon_t,\ \varepsilon_t \sim AR(1), \tag{19}$$

$$\ln(L_t^g) = \ln(\overline{L}^g) + \mu_t,\ \mu_t \sim AR(1), \tag{20}$$

with an autoregressive coefficient of the error of 0.8.

Figure 2 shows the response of public and private sector wages to a public sector wage shock. We consider three cases with different levels of steady state public employment ($\overline{L}^g = 0.10$, $\overline{L}^g = 0.15$ and $\overline{L}^g = 0.20$). A temporary increase in public sector wage raises the level of the private sector wage, but the magnitude of the response is, however, lower than if the shock was permanent. A 1% increase in public sector wages increase private sector wages by between 0.03% and 0.05%, depending on the size of the public sector. The bigger the size of the government, the higher the effect of public sector wages on the labour market.

[Figure 2]

Figure 3 shows the response of private sector wages to a temporary increase of public sector employment of 6.67% (corresponding to an increase from 0.15 to 0.16). We also

consider three alternative scenarios for the level of public sector wages (with low public sector wages ($\overline{w}^g / \overline{w}^p = 1.00$), the baseline case ($\overline{w}^g / \overline{w}^p = 1.05$) and one with higher public sector wages ($\overline{w}^g / \overline{w}^p = 1.10$). The impact on private sector wage occurs at the time of hiring, and that is why the impact on the private sector wage is not very persistent. After two periods it is close to zero. Nevertheless the contemporaneous effect is quite strong. Private sector wages go up between 3% and 7%.

[Figure 3]

3. Empirical framework

In this section, we estimate the determinants of both private sector and public sector wages. Our underlying idea is to estimate two different wage functions which link private and public wages together, carefully addressing the problem of the endogeneity between the two.

Most papers that study the relation between the two wage variables usually focus on wages per employee in levels (see, for instance, Nunziata, 2005, Jacobson and Ohlsson, 1994 and Friberg, 2007). However, we prefer to model growth rates, to assess the behaviour of the two variables in the short-run. Since we have annual data, using growth rates eliminates the low frequency movements but preserves the movements at business cycle frequency, which we are more interested in uncovering (see Abraham and Haltiwanger, 1995).

In the long-run it is natural that the two variables are cointegrated with a slope coefficient of one, otherwise, one would observe a constant divergence of the wages of the two sectors. Notice that this does not exclude that there are differences in the levels of the wages, but essentially that these differences do not have a trend. In fact, we observe and we should expect either a public sector wage premium or a gap to exist, due to different skill composition of employment or barriers between the two sectors.

We study this issue in a panel framework for OECD and European Union country groups, covering essentially the period between 1970 and 2007, depending also on data availability.

3.1. Empirical specification for private sector wages

Our general baseline wage function for the developments in private sector salaries can be given by

$$wp_{it} = \beta_i + \delta_p wp_{it-1} + X_{it}^{p} + Z_{it}^{p} + \gamma_p E_{it-1} + \mu_{it}\,. \qquad (21)$$

In (21) the index i (i=1,…,N) denotes the country, the index t (t=1,…,T) indicates the period, β_i stands for the individual effects to be estimated for each country i, and it is assumed that the disturbances μ_{it} are independent across countries. wp_{it} is the growth rate of the nominal compensation per employee in the private sector. X_{it}^{p} is a vector of macroeconomic variables that might be endogenous to the private sector wage growth:

$$X_{it}^{p} = \theta_1 wg_{it} + \theta_2 p_{it} + \theta_3 l_{it} + \theta_4 h_{it} + \theta_5 tot_{it} + \theta_6 u_{it} + \theta_7 tw_{it} + \theta_8 eg_{it}\,. \qquad (22)$$

This vector X_{it}^{p} includes the growth rate of real compensation per employee in the public sector, wg_{it}, the growth rate of the consumer price index, p, the growth rate of labour productivity, l (or total factor productivity), the change in the unemployment rate, u, the growth rate of the per worker average hours worked, h, tot denotes the growth rate of the countries terms of trade, tw is the change in the tax wedge, while the growth rate of public employment, eg, which can also positively impinge on the growth rate of private sector wages, if higher labour demand in the public sector pressures private sector wages upward.

On the other hand, Z_{it}^{p} is a vector of institutional exogenous variables

$$Z_{it}^{g} = \pi_1 ud_{it} + \pi_2 bc_{it} + \pi_3 bd_{it} + \pi_4 brr_{it} + \pi_5 cbi_{it}\,, \qquad (23)$$

which includes the change in union density, *ud*, an index of bargaining coordination, *bc*, the change in benefit duration, *bd*, the change in the benefit replacement ratio, *brr* and previous work by Nunziata (2005) concluded that these institutional variables were important determinants of the level of wages. While union density should contribute to increase wages, the benefit replacement rate and duration all affect the outside option of the worker, and therefore may also influence their wage. Additionally if the bargaining process is centrally coordinated it is likely to restrain private sector wage growth. We also include an index of central bank independence, *cbi*, to capture potential inflation expectations.

Finally, E_{it-1} in (21) is defined as the percentage difference between public and private sector wages – the public wage premium or gap:

$$E_{it-1} = \ln(Wg_{t-1} / Wp_{t-1}) \times 100 , \qquad (24)$$

where *Wg* and *Wp* are respectively the nominal public and private wage levels per employee. This term can be interpreted as an error correction mechanism. In this sense, if private and public sector wages start diverging, γ_p, in equation (21), measures whether part of the re-balancing is done via the private sector wages.

There are two ways via which public sector wages can affect private sector wages. There is the direct effect, θ_1, and there is the indirect effect through the error correction mechanism of magnitude γ_p. If the ratio of public-to-private wages increases, private sector wages may raise in order to correct the wage differential downwards. This can be seen both as a demonstration effect stemming from the public sector, followed by the private sector, and as well as a catching up effect in salaries demanded (implemented) by (in) the private sector. Therefore, γ_p is expected to be positive.

Additionally, in a specification such as (21)-(22), and according to the estimated value for θ_6, one can assess the cyclicality of private wages. Indeed, if θ_6 is negative this would

imply a pro-cyclical behaviour of private wages towards unemployment, and a positive θ_6 implies a counter-cyclical response of wages to unemployment. While the idea of wage counter-cyclicality was already put forward notably by Keynes (1939), empirical results actually produce evidence of both cyclical and counter cyclical private sector behaviour. Abraham and Haltiwanger (1995) offer several arguments for the possibility of both outcomes.

This specification for the private sector wage growth is inspired by the theoretical model, but with a few differences. First, given that there is long-run growth, which was absent from the model, we estimate the equation in growth rates and include the error correction term. Second, we include several variables that were absent from the model.

3.2. Empirical specification for public sector wages

We also estimate an equation for the public sector wage growth. This equation has somewhat less motivation from the theoretical part, given that we consider public sector wages as exogenous. The baseline wage function for the developments of public sector salaries can be assessed with the following specification

$$wg_{it} = \alpha_i + \delta_g wg_{it-1} + X_{it}^g + Z_{it}^g + \gamma_g E_{it-1} + F_{it} + P_{it} + \mu_{it}, \qquad (25)$$

with

$$X_{it}^g = \delta_1 wp_{it} + \delta_2 p_{it} + \delta_3 l_{it} + \delta_4 tot_{it} + \delta_5 u_{it} + \delta_6 tw_{it}, \qquad (26)$$

$$Z_{it}^g = \eta_1 ud_{it} + \eta_2 bc_{it} + \eta_3 bd_{it} + \eta_4 brr_{it}, \qquad (27)$$

$$F_{it} = \omega_1 BudBal_{it} + \omega_2 Debt_{it}, \qquad (28)$$

$$P_{it} = \lambda_1 Election_{it} + \lambda_2 Left_{it}. \qquad (29)$$

We consider that the government wage can respond to the same variables as the private wages except for the average hour worked per worker, central bank independence and

growth rate of public employment. Indeed, the hours worked in the public sector are more standardized than in the private sector, and the variable average hours per worker is likely to be also more relevant for the private sector. Additionally, F_{it} includes fiscal variables such as the general government budget balance as a percentage of GDP and the general government debt-to-GDP ratio. P_{it} contains the political variables, which consist of the percentage of votes for left wing parties and a dummy variable for parliamentary election years. While the variables in F_{it} are endogenous, we consider the variables in P_{it} as exogenous. α_i stands for the individual effects to be estimated for each country i.

Similarly to the specification for the private sector wages, γ_g now measures to what extent public wages correct the imbalances of the long-term relation between public sector and private sector wages. In this case, increases in the public wages-to-private wages ratio can produce afterwards a reduction in public sector wages, implying an expected negative value for γ_g.

While one would expect that recent fiscal developments may impinge on the development of the public sector wages per employee, this hypothesis is seen as less relevant for the development of private sector wages. On the other hand, if one expects the unemployment rate to impinge negatively on the development of private sector wages, this effect may essentially be more mitigated or even absent in the case of public sector wages, given the higher rigidity of the labour force in the government sector (and a possible higher degree of unionisation). Finally, one should be aware that this aggregate analysis does not directly take into account such issues as labour flows between the two sectors or within the private sector, while different wage scales also co-exist inside the private sector, with different productivity and price developments.

3.3. Econometric issues

There are two main econometric issues when estimating the wage functions (21) and (25). The first issue is the presence of endogenous variables, particularly the simultaneous determination of public and private sector wage growth. To deal with this, we estimate each equation separately and instrument all the endogenous variables by the remaining pre-determined variables and three lags of all variables. We compute the Sargan over-identifying test to access the validity of the instruments. As we are using the lagged variables as instruments, essentially what we are doing is predicting the value of the regressors based on past information, so the interpretation of the coefficients should be, for instance, the effect of expected public sector wage growth on the growth rate of private sector wages.

Although our distinction between endogenous and exogenous variables might seem arbitrary, we also run a Hausman test in some of the estimations to examine the exogeneity of each block of variables.

The second issue is that, as we allow for a country specific error and include a lagged dependent variable, our specification has a correlation between a regressor and the error term. Although we also use the Arellano and Bond GMM estimator, our preferred methodology is a simple panel 2SLS estimation. First, the Arellano and Bond methodology implies estimating the equation in first differences (of growth rates) which inserts a lot of noise in the estimates. Furthermore, as Nickell et al. (2005) point out, the bias created by the presence of a lagged dependent variable in panel data, tends to zero if we have a long time series component. As we have close to 30 average time observations per country, we proceed with the estimation with a panel 2SLS. We also include country fixed effects, and we estimate the equations for both nominal and real wage growth.

4. Estimation results and discussion

4.1. Data and stylised facts

Our main data source is the OECD Economic Outlook database, essentially for the employment and wages data, the European Commission database AMECO and the Labour Market Institutions Database used in Nickell et al. (2005) and expanded by Baker et al. (2003).[5] Private sector wages are defined as total compensation of employees minus compensation of government employees. Private sector wages per employee are defined as private compensation of employees divided by private sector employees (total employment minus government employees minus self-employed persons).[6] We compute the real wage per employee using the consumption price deflator. Although we think it is useful to use aggregate data to study the issues at hand, we should be aware of its limitations. The main problem is that it ignores the composition of public and private employment, in particular with respect to the skill level of the employment.

A cursory look at the main data series provides a first useful insight regarding past trends. The charts that we report in Appendix 3, regarding salaries and employment shares, show that while the share of government employment in total employment increased for most countries in the 1980s, there was an even more generalised decline after the beginning of the 1990s.

Regarding real wage per employee an upward trend can be observed for most countries, both for private and for government salaries. Nevertheless, a decline in real private wages per employee was visible for Italy and Spain since the middle of the 1990s, which also needs to be seen against the increase in female labour participation. Interestingly, real public wages per employee were rather stable for Japan, Germany and Austria since the beginning of

[5] Given data availability, the countries used in the empirical analysis are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. See Appendix 1 for further details and sources.
[6] This approach is also used by Lamo et al. (2007).

the 1990s. The mean and the volatility of private wage growth, reported in Appendix 2, were rather similar to the ones of public wage growth

A further stylised fact is given by the development of the ratio of public-to-private wages per employee, which broadly followed an upward path since the beginning of the 1990s for most European countries. However, such ratio was more stable in the Netherlands, and to some extent in Sweden, while developments were more mixed for the US and Norway. On the other hand, the ratio of public-to-private wages per employee decreased in Canada and in Australia.

4.2. Private wage determinants

Table 2 reports the results for the growth rate of the nominal private sector wages per employee, for the OECD countries. The estimated coefficients are quite similar across the estimation method. In the case of nominal private sector wages we should focus more on the results from 2SLS as the GMM estimators does not pass the Sargan test.

One can observe that both the direct effect and the indirect effect – via the ratio between public wages and private wages – of public sector wages are statistically significant and positive, as expected. A 1% increase in real public sector wage growth increases private sector nominal wage growth by 0.3%.

[Table 2]

The growth rate of public employment also has a positive and significant effect on the growth rate of nominal private sector wages. A 1 percent in public sector employment increases private sector wage growth by close to 0.3%.

The change in the unemployment rate exerts a negative effect on private sector wage growth, in other words, a pro-cyclical behaviour. A 1 percentage point increase in the

unemployment rate reduces the growth rate of nominal private sector wages by around 0.3-0.6 percentage points. On the other hand, private sector wages increase with total factor productivity growth (labour productivity was not statistically significant). Moreover, an increase in the inflation rate of 1 percentage point translates into an increase in the growth rate of nominal private sector wages of around 0.8 percentage points. Some wage stickiness is captured by the statistically significant lagged dependent variable. There are no statistically significant effects reported for the terms of trade, for the hours worked per worker or for the tax wedge.

Regarding the set of pre-determined explanatory variables (in vector *Z*), it is interesting to see that the growth rate of nominal private sector wages is positively affected by the degree of union density, implying that an increase in unionisation may translate into higher private wage growth. Higher central bank independence has an opposite effect, therefore contributing to reduce the growth rate of nominal private sector wages. Benefit duration, and the benefit replacement rate do not statistically affect the growth rate of nominal private sector wages.

To further assess our results, we also report the estimations for the specification regarding the growth rate of real private sector wages per employee in Table 3. Both estimations pass the Sargan test, although the GMM estimations have a slightly higher R-square.

[Table 3]

We can see that in this case, the lagged value of the dependent variable is still statistically significant, while the growth rate of average hours per worker now contributes to increase the growth rate of real private sector wage per employee. Another difference that emerges is the fact that the inflation rate does not affect the growth rate of real private sector

wages per employee.[7] The statistical significance and the estimated coefficients of the remaining explanatory variables are rather similar to the specification for the growth rate of nominal private sector wages, notably the indirect effect of public wages via the error correction component.

In the estimations, for both nominal and real private sector wage growth, the Hausman test clearly supports that the institutional variables block is exogenous and that the variables in the macroeconomic block are endogenous.

4.3. Public wage determinants

We now turn to the analysis of the determinants of public sector wages, and the corresponding estimation results for nominal wages are presented in Table 4. All the estimations pass the Sargan test.

[Table 4]

The lagged dependent variable is statistically significant, denoting some degree of public sector wage stickiness. The growth rate of nominal public sector wages per employee also reacts positively to real private sector wages, with a coefficient between 0.5 and 0.9. It also responds negatively to an increase in the ratio between public and private sector wages. Therefore, this correction mechanism adjusts public wages downward when the differential vis-à-vis private wages rises. Note that the absolute value of the coefficient is roughly three times higher than the one from the similar error correction component's coefficient estimated in the private sector model. This means that three quarters of the adjustment is done via public sector wages.

[7] Such result could be read in this case as an indication of monetary neutrality.

An increase in the inflation rate also increases the growth rate of nominal public sector wages and the magnitude of this effect is around 0.6 percentage points. Total factor productivity is negatively related to the growth rate of nominal public sector wages, and this can be explained by the fact that the productivity measure pertains essentially to the private sector. The terms of trade do not statistically affect the growth rate of nominal public sector wages.

Regarding the two explanatory fiscal variables, improvements in the budget balance increase the growth rate of nominal public sector wages, while a higher government debt-to-GDP ratio reduces it. An increase in the budget balance ratio of 1 percentage point translates into an increase of the growth rate of nominal public sector wages of around 0.1 percentage points. Interestingly, in the GMM estimations, higher government indebtedness is related with decreases in the growth rate of nominal public sector wages. In terms of the pre-determined exogenous variables it is not possible to observe any statistically significant negative effect associated either with bargaining coordination or with benefits duration, and the same is true for the political dummy variables.

When using the growth rate of real public sector wages per employee as dependent variable (Table 5), the inflation rate has a negative impact. This suggests that, unlike the private sector, the public sector wages are more able to contain the repercussion of expected inflation on the public sector wage growth. On the other hand, real public wages react positively to increases in the unemployment rate. The effects of the other explanatory variables still hold, and improvements in the budget balance notably contribute to increase real public wages per employee.

[Table 5]

We also considered only the subset of European Union and euro area countries in our empirical analysis (see Appendix 2). The results are rather similar to the ones for the OECD country sample. Nevertheless, the magnitude of the effect of the budget balance on public wages is now slightly higher.

4.4. Robustness, including further dynamics

In our baseline estimations, the only dynamic element is the inclusion of the lagged dependent variable. Even if that coefficient is small one could argue that there might be direct effects of past explanatory variables on the regressors. Therefore, we included in the regressions one lag of all explanatory variables. Most lags of the variables are not significant. As we are interested on the overall effect of a variable on the wage growth, in Table 6 we only report the sum of the two coefficients (contemporaneous and lagged) and the p-value of the test that the sum of the two coefficients is different from zero. Basically, the main results from the baseline specification remain: notably, there is a spillover of both private and public wages, through the direct effect and via the error correction mechanism, as well as the effect of public employment on private wages.

[Table 6]

In addition, it seems that the inclusion of lags do not carry much explanatory power in this case. Indeed, the R-square changes very little, and the test that all coefficients of the lagged explanatory variables are jointly equal to zero is accepted for the 2SLS case of public sector wages. Consequently, there isn't much gain from the inclusion of the above mentioned lags, which just increases the standard deviations and reduces the significance of some variables.

5. Conclusion

The purpose of this paper was to uncover the determinants of public and private sector wage growth. We also find that a number of variables affect private sector wage growth, for instance: unemployment rate (negative relationship), inflation rate, total factor productivity, and hours per worker. More important, public sector wages and employment also affect private sector wage growth. In terms of magnitude, the estimated values are higher than the values suggested by the model. The empirical estimates show a contemporaneous effect of around 0.3% private sector wages with respect to public sector wages. Higher public sector wages might translate into higher demand, increasing the pressure on the private sector labour market. Similarly, public sector wage growth may also carry a signal to the private sector on what the government expects for inflation.

This finding has important policy implications. It gives strength to the "wage twist" policy discussed by Pedersen et al. (1990). Therefore, the governments could use their role as an employer to reduce relative public sector wages. This policy, besides reducing the tax burden necessary to finance government spending, would have a downward impact on private sector wages and, most likely, on inflation and unemployment.

Regarding the public sector wages, statistically significant determinants are private sector wages, inflation, and the unemployment rate (positive relationship). Moreover, public sector wages react positively to the budget balance and negatively to government indebtedness. Political variables, however, do not seem to play an important role

References

Abraham, K. and Haltiwanger, J. (1995). "Real Wages and the Business Cycle", *Journal of Economic Literature*, 33 (3), 1215-1264.

Algan, Y.; Cahuc, P. and Zylberberg, A. (2002). "Public employment and labour market performance", *Economic Policy*, 17 (34), 7-66.

Ardagna, S. (2007). "Fiscal policy in unionized labor markets", *Journal of Economic Dynamics and Control*, 21 (5), 1498-1534.

Baker, D.; Glyn, A.; Howell, D. and Schmitt, J. (2003). "Labor Market Institutions and Unemployment: A Critical Assessment of the Cross-Country Evidence", Economics Series Working Papers 168, University of Oxford, Department of Economics.

Forni, L. and Giordano, R. (2003). "Employment in the public sector", CESifo WP 1085.

Friberg, K. (2007). "Intersectoral wage linkages: the case of Sweden", *Empirical Economics*, 32 (1), 161-184.

Gomes, P. (2008) "Labour market flows: facts from UK", Bank of England Working Papers, forthcoming.

Gregory, R. and Borland, J. (1999). "Recent developments in public sector labor markets", in Ashenfelter, O. and Card, D. (eds), *Handbook of Labor Economics, vol III*. Amsterdam, Elsevier Science Publishers.

Gyourko, J. and Tracy, J. (1989). "The Importance of Local Fiscal Conditions in Analyzing Local Labor Markets", *Journal of Political Economy*, 97 (5), 1208-31.

Holmlund, B. and Linden, J. (1993). "Job matching, temporary public employment, and equilibrium unemployment", *Journal of Public Economics*, Elsevier, 51 (3), 329-343.

Jacobson, T. and Ohlsson, H. (1994). "Long-Run Relations between Private and Public Sector Wages in Sweden", *Empirical Economics*, 19 (3), 343-60.

Keynes, J. (1939). "Relative Movements of Real Wages and Output", *Economic Journal*, (193), 34-51.

Lamo, A.; Pérez, J. and Schuknecht, L. (2007). "The cyclicality of consumption, wages and employment of the public sector in the euro area", ECB Working Paper 757.

Matschke, X. (2003). "Are There Election Cycles in Wage Agreements? An Analysis of German Public Employees", *Public Choice*, 114 (1-2), 103-35.

Nickell, S.; Nunziata, L. and Ochel, W. (2005). "Unemployment in the OECD since the 1960s. What Do We Know?" *Economic Journal*, 115, 1-27.

Nunziata, L. (2005). "Institutions and Wage Determination: a Multi-country Approach", *Oxford Bulletin of Economics and Statistics*, 67 (4), 435-466.

Pedersen, P.; Schmidt-Sorensen, J.; Smith, N. and Westergard-Nielsen, N. (1990). "Wage differentials between the public and private sectors", *Journal of Public Economics*, 41 (1), 125-145.

Pissarides, C. (1988). "The search equilibrium approach to fluctuations in employment", *American Economic Review*, 78 (2), 363-68.

Poterba, J. and Ruben, K. (1995). "The Effect of Property-Tax Limits on Wages and Employment in the Local Public Sector", *American Economic Review*, 85 (2), 384-89.

Quadrini, V. and Trigari, A. (2007). "Public employment and the business cycle", *Scandinavian Journal of Economics*, 109 (4), 723-742.

Tables and Figures

Table 1 – Baseline calibration

$A=1$	$\alpha=0.3$	$b=0.5$	$\beta=0.99$	$z=0.3$
$\overline{m}^p=0.6$	$c^p=0.17$	$\eta^p=0.5$	$\lambda^p=0.06$	$\overline{w}^g=0.77$
$\overline{m}^g=0.6$	$c^g=0.17$	$\eta^g=0.3$	$\lambda^g=0.03$	$\overline{L}^g=0.15$
$\overline{u}=0.08$	$\overline{q}^p=0.52$	$\overline{p}^p=0.57$	$\overline{s}=0.19$	
$\overline{w}^g/\overline{w}^p=1.05$	$\overline{q}^g=0.80$	$\overline{p}^g=0.06$	$\overline{\tau}=0.21$	

Table 2 – Nominal private wages per employee

	2SLS		GMM	
	(1)	(2)	(3)	(4)
Δ Unemployment rate	-0.594***	-0.638***	-0.345***	-0.314***
	(-3.45)	(-4)	(-4.77)	(-4.41)
Total factor productivity growth	0.250*	0.293**	0.275***	0.311***
	(1.65)	(2.17)	(3.75)	(4.47)
Inflation rate	0.762***	0.768***	0.777***	0.785***
	(10.47)	(11.02)	(14.19)	(14.59)
Growth rate of real public sector wages	0.379***	0.377***	0.285***	0.289***
	(5.78)	(6.19)	(4.36)	(4.48)
Growth rate of terms of trade	-0.031		0.002	
	(-0.72)		(0.1)	
Growth rate of average hours per worker	1.936		1.013	
	(0.86)		(1.23)	
Δ Tax wedge	0.052		0.044	
	(0.44)		(0.88)	
Growth rate of public employment	0.297**	0.283***	0.339***	0.345***
	(2.57)	(2.63)	(5.34)	(5.21)
Lagged dependent Variable	0.130**	0.127**	0.107*	0.105*
	(2.28)	(2.34)	(1.86)	(1.82)
Error correction component	0.044***	0.042***	0.035**	0.032**
	(3.04)	(3.02)	(2.45)	(2.19)
Δ Union density	0.211**	0.221**	0.198	
	(1.97)	(2.18)	(1.55)	
Bargaining Coordination	0.087		-0.122	
	(0.23)		(-0.28)	
Δ Benefit duration	-1.484		-0.067	
	(-0.47)		(-0.02)	
Δ Benefit replacement rate	0.914		0.112	
	(0.26)		(0.04)	
Central bank independence	-2.668***	-2.656***	-2.412***	-2.405***
	(-2.98)	(-3.07)	(-3)	(-3.43)
R^2	0.875	0.874	0.882	0.881
Sargan test #	57.2 (0.171)	58.7 (0.371)	443.9 (0.004)	445.2 (0.006)
Overidentifying restrictions	48	56	368	374
Hausman Test& (Exogenous)	6.75 (0.944)	1.65 (0.996)		
Hausman Test$ (Endogenous)	31.53 (0.008)	21.81 (0.010)		
Observations	382	382	382	382
Countries	16	16	16	16

Notes: The following variables are considered endogenous: change in unemployment rate, growth rate of total factor productivity, inflation rate, growth rate of real per worker public sector wages, growth rate of terms of trade, growth rate of hours per worker, change in tax wedge and the growth rate of public employment. These endogenous variables are instrumented by the remaining pre-determined variables and three lags of all explanatory variables. The t statistics are in parentheses. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used.. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). # The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. & The null hypothesis is that the block of institutional variables is exogenous. Under the null, the estimator used is efficient but is is inconsistent under the alternative hypothesis. The consistent estimator would be to consider all variables as endogenous and instrument them with lags. The p-value is in brackets. $ The null hypothesis is that the block of macroeconomic variables is exogenous. Under the null, the most efficient estimator is fixed effects estimation taking all variables as exogenous. Under the alternative hypothesis the estimates are consistent estimates. The p-value is in brackets.
Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Time span: 1974-1998.

Table 3 – Real private wages per employee

	2SLS		GMM	
	(1)	(2)	(3)	(4)
Δ Unemployment rate	-0.430**	-0.344**	-0.228**	-0.233***
	(-2.46)	(-2.48)	(-2.48)	(-2.61)
Total factor productivity growth	0.15		0.251***	0.263***
	(1.02)		(3.51)	(4.04)
Inflation rate	0.013		-0.034	
	(0.3)		(-1.53)	
Growth rate of real public sector wages	0.357***	0.346***	0.308***	0.321***
	(5.43)	(5.78)	(4.96)	(5.17)
Growth rate of terms of trade	0.007		0.025	
	(0.14)		(1.13)	
Growth rate of average hours per worker	3.939*	4.884***	1.739**	1.978**
	(1.72)	(2.6)	(2.19)	(2.28)
Δ Tax wedge	-0.013		0.036	
	(-0.11)		(0.65)	
Growth rate of public employment	0.249**	0.257***	0.334***	0.308***
	(2.2)	(3.29)	(5.83)	(5.3)
Lagged dependent Variable	0.130**	0.137***	0.163***	0.152***
	(2.34)	(2.82)	(3.14)	(3.31)
Error correction component	0.042***	0.044***	0.030*	0.031**
	(2.95)	(3.39)	(1.91)	(2.07)
Δ Union density	0.170	0.174*	0.147	
	(1.62)	(1.74)	(1.27)	
Bargaining Coordination	-0.084		-0.217	
	(-0.23)		(-0.46)	
Δ Benefit duration	-1.088		-0.897	
	(-0.35)		(-0.27)	
Δ Benefit replacement rate	1.384		-0.173	
	(0.4)		(-0.06)	
Central bank independence	-2.378***	-2.550***	-2.058***	-1.937***
	(-2.72)	(-3.07)	(-2.86)	(-2.71)
R^2	0.355	0.338	0.381	0.368
Sargan test #	51.9 (0.290)	52.2 (0.543)	387.2 (0.223)	401.1 (0.161)
Overidentifying restrictions	47	56	367	374
Hausman Test& (Exogenous)	5.65 (0.975)	0.38 (1.000)		
Hausman Test$ (Endogenous)	22.27 (0.101)	17.50 (0.025)		
Observations	382	382	382	382
Countries	16	16	16	16

Notes: The following variables are considered endogenous: change in unemployment rate, growth rate of total factor productivity, inflation rate, growth rate of real per worker public sector wages, growth rate of terms of trade, growth rate of hours per worker, change in tax wedge and the growth rate of public employment. These endogenous variables are instrumented by the remaining pre-determined variables and three lags of all explanatory variables. The t statistics are in parentheses. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used.. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). # The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. . & The null hypothesis is that the block of institutional variables is exogenous. Under the null, the estimator used is efficient but it is inconsistent under the alternative hypothesis. The consistent estimator would be to consider all variables as endogenous and instrument them with lags. The p-value is in brackets. $ The null hypothesis is that the block of macroeconomic variables is exogenous. Under the null, the most efficient estimator is fixed effects estimation taking all variables as exogenous. Under the alternative hypothesis the estimates are consistent estimates. The p-value is in brackets.
Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Time span: 1974-1998.

Table 4 – Nominal public wages per employee

	2SLS		GMM	
	(1)	(2)	(3)	(4)
Δ Unemployment rate	0.485**	0.472**	0.009	
	(1.96)	(2.13)	(0.06)	
Total factor productivity growth	-0.394**	-0.388**	-0.124	
	(-2.02)	(-2.04)	(-1.09)	
Inflation rate	0.569***	0.570***	0.574***	0.576***
	(7.43)	(8.03)	(12.51)	(11.46)
Growth rate of real private sector wages	0.826***	0.880***	0.480***	0.475***
	(5.64)	(6.64)	(7.12)	(6.85)
Growth rate of terms of trade	-0.055		0.011	
	(-0.88)		(0.51)	
Δ Tax wedge	-0.093		-0.048	
	(-0.53)		(-0.6)	
Budget Balance	0.135**	0.123*	0.123*	0.125**
	(2.06)	(1.95)	(1.7)	(2.01)
Government debt	-0.016	-0.021	-0.029*	-0.030**
	(-1.09)	(-1.49)	(-1.76)	(-2.02)
Lagged dependent Variable	0.214***	0.222***	0.250***	0.253***
	(4.28)	(4.57)	(3.52)	(3.68)
Error correction component	-0.108***	-0.114***	-0.106***	-0.113***
	(-5.47)	(-5.95)	(-6.82)	(-6.56)
Δ Union density	0.077		0.239	0.201
	(0.49)		(1.57)	(1.29)
Bargaining Coordination	-0.331		-0.447	0.000
	(-0.65)		(-0.69)	
Δ Benefit duration	-5.211		-4.633	
	(-1.12)		(-1.39)	
Δ Benefit replacement rate	0.964		2.346	
	(0.2)		(0.53)	
Election year	-0.141		-0.139	
	(-0.47)		(-0.49)	
% Left wing votes	0.049		0.041	
	(1.17)		(0.84)	
R^2	0.778	0.773	0.800	0.796
Sargan test p-value #	52.02 (0.285)	54.7 (0.487)	393.5 (0.155)	406.6 (0.126)
Overidentifying restrictions	47	55	366	375
Hausman Test& (Exogenous)	5.13 (0.995)	-		
Hausman Test$ (Endogenous)	42.62 (0.000)	87.75 (0.000)		
Observations	382	382	382	382
Countries	16	16	16	16

Notes: The following variables are considered endogenous: change in unemployment rate, growth rate of total factor productivity, inflation rate, growth rate of real per worker private sector wages, growth rate of terms of trade, growth rate of hours per worker, budget balance, government debt and tax wedge. These endogenous variables are instrumented by the remaining pre-determined variables and three lags of all explanatory variables. The t statistics are in parentheses. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used.. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). # The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. . & The null hypothesis is that the block of institutional variables is exogenous. Under the null, the estimator used is efficient but it is inconsistent under the alternative hypothesis. The consistent estimator would be to consider all variables as endogenous and instrument them with lags. The p-value is in brackets. $ The null hypothesis is that the block of macroeconomic variables is exogenous. Under the null, the most efficient estimator is fixed effects estimation taking all variables as exogenous. Under the alternative hypothesis the estimates are consistent estimates. The p-value is in brackets.

Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Time span: 1974-1998.

Table 5 – Real public wages per employee

	2SLS		GMM	
	(1)	(2)	(3)	(4)
Δ Unemployment rate	0.658***	0.655***	0.166	0.202*
	(2.74)	(3.05)	(1.51)	(1.76)
Total factor productivity growth	-0.377*	-0.361*	-0.113	
	(-1.94)	(-1.92)	(-1.07)	
Inflation rate	-0.104	-0.130**	-0.126**	-0.119***
	(-1.6)	(-2.26)	(-2.57)	(-2.66)
Growth rate of real private sector wages	0.765***	0.793***	0.514***	0.515***
	(5.26)	(6.03)	(8.36)	(8.25)
Growth rate of terms of trade	0.015		0.048	0.052
	(0.23)		(1.64)	(1.63)
Δ Tax wedge	-0.175		-0.069	
	(-0.96)		(-0.94)	
Budget Balance	0.139**	0.136**	0.104	0.102
	(2.14)	(2.22)	(1.45)	(1.63)
Government debt	-0.012	-0.018	-0.029*	-0.030**
	(-0.79)	(-1.3)	(-1.93)	(-2.12)
Lagged dependent Variable	0.209***	0.211***	0.241***	0.248***
	(4.29)	(4.65)	(4.03)	(3.91)
Error correction component	-0.111***	-0.119***	-0.115***	-0.119***
	(-5.68)	(-6.35)	(-7.33)	(-6.26)
Δ Union density	0.019		0.18	
	(0.12)		(1.06)	
Bargaining Coordination	-0.614		-0.572	
	(-1.22)		(-1)	
Δ Benefit duration	-4.316		-4.889**	-5.217**
	(-0.93)		(-2.13)	(-2.25)
Δ Benefit replacement rate	0.853		1.708	
	(0.17)		(0.44)	
Election year	-0.327		-0.255	
	(-1.1)		(-0.87)	
% Left wing votes	0.034		0.025	
	(0.81)		(0.55)	
R^2	0.388	0.381	0.427	0.415
Sargan test p-value [#]	49.8 (0.325)	54.1 (0.471)	372.6 (0.395)	377.1 (0.431)
Overidentifying restrictions	46	56	366	373
Hausman Test[&] (Exogenous)	4.57 (0.998)	-		
Hausman Test[$] (Endogenous)	50.60 (0.000)	44.2 (0.000)		
Observations	382	382	382	382
Countries	16	16	16	16

Notes: The following variables are considered endogenous: unemployment rate, growth rate of total factor productivity, inflation rate, growth rate of real per worker private sector wages, terms of trade, hours per worker, budget balance, government debt and tax wedge. These endogenous variables are instrumented by the remaining pre-determined variables and three lags of all explanatory variables. The t statistics are in parentheses. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). [#] The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. [&] The null hypothesis is that the block of institutional variables is exogenous. Under the null, the estimator used is efficient but it is inconsistent under the alternative hypothesis. The consistent estimator would be to consider all variables as endogenous and instrument them with lags. The p-value is in brackets. [$] The null hypothesis is that the block of macroeconomic variables is exogenous. Under the null, the most efficient estimator is fixed effects estimation taking all variables as exogenous. Under the alternative hypothesis the estimates are consistent estimates. The p-value is in brackets.
Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Time span: 1974-1998.

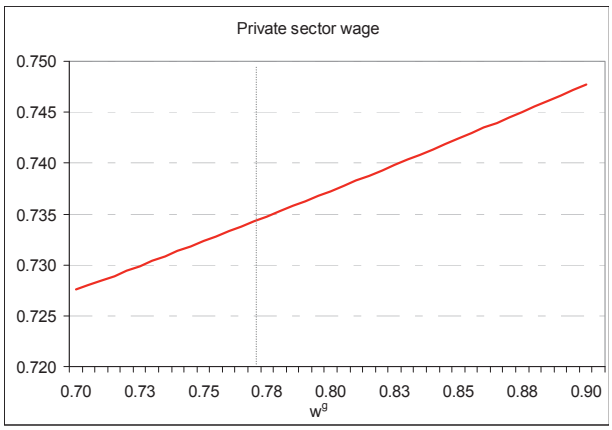
Table 6 – Estimations with lags

	Nominal Private		Real Private		Nominal Public		Real Public	
	2SLS	GMM	2SLS	GMM	2SLS	GMM	2SLS	GMM
Δ Unemployment rate	-0.303	-0.386***	-0.210	-0.339**	1.144***	-0.070	1.169***	-0.061
	(0.248)	*(0.005)*	*(0.435)*	*(0.025)*	*(0.009)*	*(0.727)*	*(0.008)*	*(0.762)*
Total factor productivity growth	0.165	0.308***	0.055	0.271***	-0.356	-0.001	-0.397	-0.036
	(0.312)	*(0.000)*	*(0.548)*	*(0.000)*	*(0.411)*	*(0.647)*	*(0.365)*	*(0.759)*
Inflation rate	0.716***	0.683***	-0.010	-0.019	0.483***	0.530***	-0.150	-0.083
	(0.000)	*(0.000)*	*(0.855)*	*(0.495)*	*(0.000)*	*(0.000)*	*(0.160)*	*(0.215)*
Growth rate of real public sector wages	0.252***	0.198***	0.256***	0.212***				
	(0.001)	*(0.006)*	*(0.000)*	*(0.004)*				
Growth rate of real private sector wages					0.674***	0.447***	0.682***	0.472***
					(0.002)	*(0.000)*	*(0.001)*	*(0.000)*
Growth rate of terms of trade	0.003	0.052*	-0.003	0.045	0.020	0.004	0.022	-0.003
	(0.968)	*(0.100)*	*(0.964)*	*(0.144)*	*(0.833)*	*(0.883)*	*(0.818)*	*(0.930)*
Growth rate of average hours per worker	2.989	0.338	4.345	0.832				
	(0.261)	*(0.721)*	*(0.109)*	*(0.371)*				
Δ Tax wedge	-0.156	-0.139**	-0.096	-0.068	-0.210	-0.079	-0.162	-0.032
	(0.288)	*(0.028)*	*(0.537)*	*(0.253)*	*(0.481)*	*(0.542)*	*(0.596)*	*(0.815)*
Growth rate of public employment	0.322**	0.286***	0.296**	0.280***				
	(0.015)	*(0.000)*	*(0.028)*	*(0.000)*				
Budget Balance					0.102	0.098	0.118	0.108
					(0.501)	*(0.193)*	*(0.435)*	*(0.162)*
Government debt					-0.030	-0.024	-0.027	-0.018
					(0.163)	*(0.159)*	*(0.231)*	*(0.293)*
Lagged dependent Variable	0.176***	0.205***	0.163**	0.166***	0.272***	0.289***	0.253	0.264
	(0.007)	*(0.003)*	*(0.011)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Error correction component	0.034**	0.027**	0.036**	0.025*	-0.118***	-0.108***	-0.121	-0.113
	(0.036)	*(0.046)*	*(0.026)*	*(0.089)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Δ Union density	0.152	0.201	0.161	0.190	-0.133	0.082	-0.138	0.043
	(0.285)	*(0.132)*	*(0.263)*	*(0.147)*	*(0.541)*	*(0.675)*	*(0.530)*	*(0.833)*
Bargaining Coordination	-0.186	-0.304	-0.309	-0.447	-0.162	-0.414	-0.384	-0.603
	(0.653)	*(0.410)*	*(0.465)*	*(0.286)*	*(0.788)*	*(0.462)*	*(0.529)*	*(0.279)*
Δ Benefit duration	-1.270	-0.165	-2.904	-1.978	-2.078	-3.573	-3.496	-5.121*
	(0.724)	*(0.954)*	*(0.428)*	*(0.516)*	*(0.719)*	*(0.298)*	*(0.548)*	*(0.087)*
Δ Benefit replacement rate	6.118	5.113	2.947	2.048	6.379	6.642	2.426	3.082
	(0.144)	*(0.288)*	*(0.493)*	*(0.642)*	*(0.339)*	*(0.100)*	*(0.721)*	*(0.489)*
Central bank independence	-3.491***	-2.831***	-3.176	-2.532***				
	(0.002)	*(0.000)*	*(0.006)*	*(0.000)*				
Election year					0.097	0.266	0.182	0.297
					(0.870)	*(0.623)*	*(0.760)*	*(0.598)*
% Left wing votes					0.050	0.022	0.034	0.007
					(0.327)	*(0.706)*	*(0.509)*	*(0.910)*
R^2	0.889	0.895	0.388	0.371	0.770	0.809	0.359	0.449
Test of zero effect of lagged variables[$]	28.46 (0.008)	1325.87 (0.000)	23.98 (0.031)	961.74 (0.000)	14.29 (0.428)	531.98 (0.000)	10.18 (0.749)	487.70 (0.000)
Sargan test [#]	36.66 (0.531)	356.51 (0.452)	41.30 (0.328)	354.76 (0.478)	35.16 (0.460)	354.37 (0.454)	45.59 (0.217)	353.33 (0.470)
Overidentifying restrictions	38	354	38	354	35	352	39	352
Observations	382	382	382	382	382	382	382	382
Countries	16	16	16	16	16	16	16	16

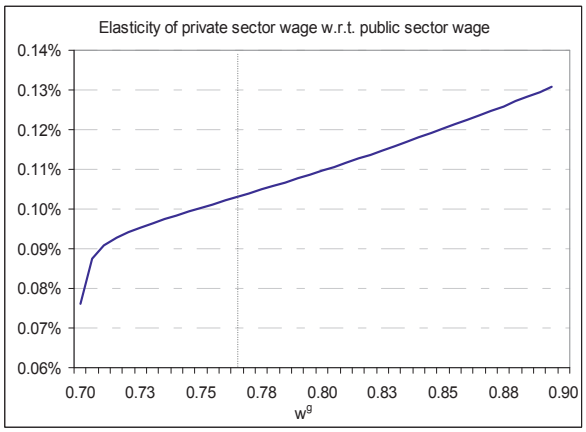
Notes: Estimation included a lag of both endogenous and exogenous variables. The coefficient refers to the sum of the coefficients of the contemporaneous and lagged variable. In parenthesis is reported the p-value of the test that the sum of the coefficients is zero. For the lagged dependent variable and the error correction mechanism we present the p-value of the usual significance test. The following variables are considered endogenous: unemployment rate, growth rate of total factor productivity, inflation rate, terms of trade, hours per worker, growth rate of government employment, budget balance, government debt, change in tax wedge, growth rate of real per worker public sector wages and growth rate of real per worker private sector. The contemporaneous endogenous variables are instrumented by the remaining pre-determined variables and three lags of all explanatory variables. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). [#] The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. [$]The null hypothesis is that the coefficients of all lagged explanatory variables are jointly equal to zero. The p-value is in brackets.
Countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Time span: 1974-1998.

Figure 1 – Steady state effects of public sector employment and wages on private sector wages

1a



1b



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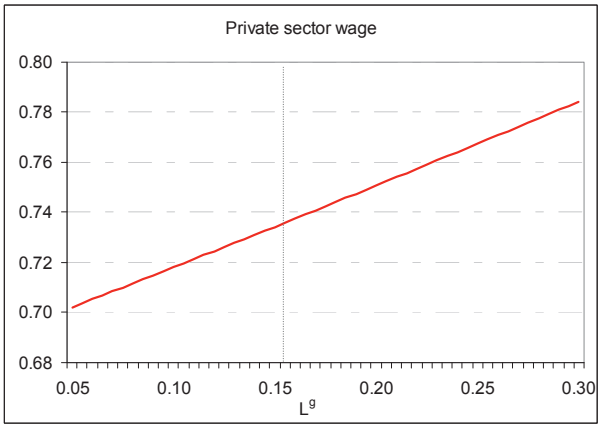

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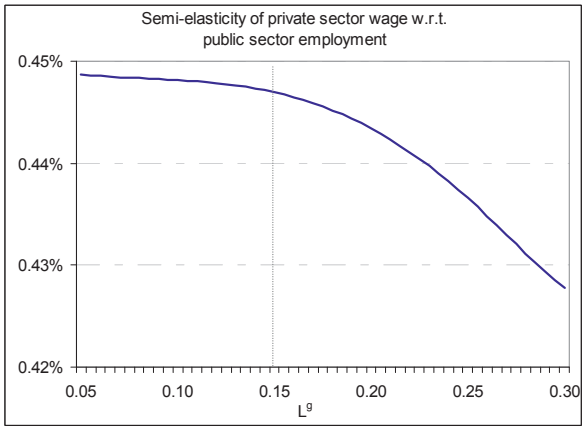
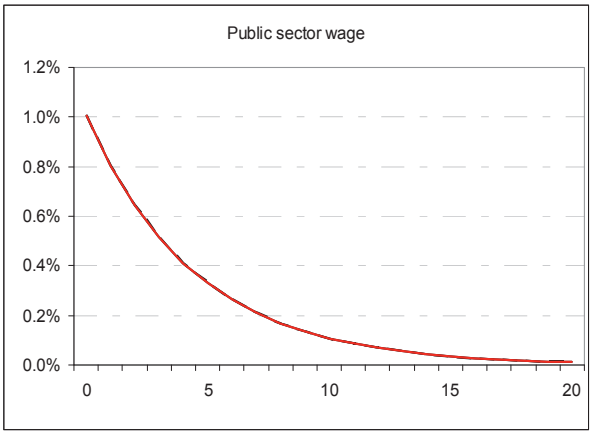
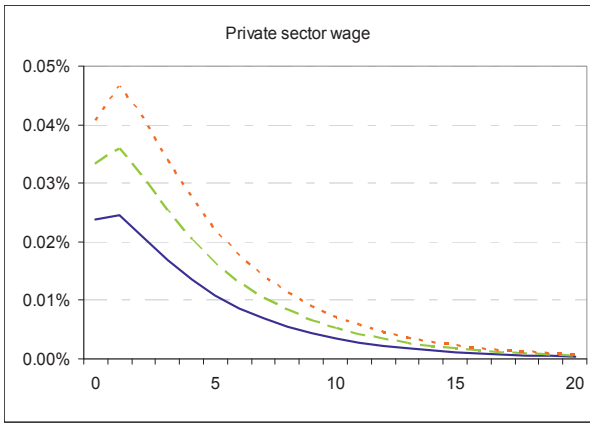


Figure 2 – Response to a 1% increase in public sector wages

2a



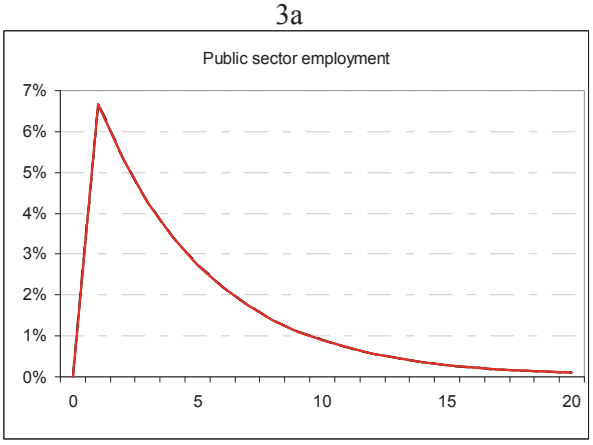
2b



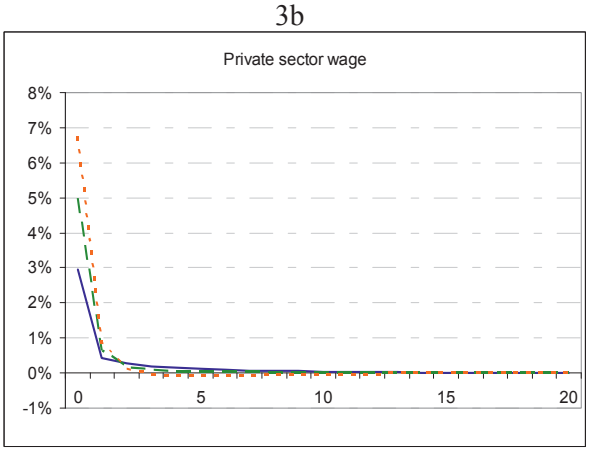
Note: All impulses are in percentage deviations from their steady-state value. Solid line corresponds to the case with $\overline{L}^g = 0.10$, the dash line to the case with $\overline{L}^g = 0.15$ and the dotted line to $\overline{L}^g = 0.20$.

Figure 3 – Response to a 1 percentage point increase in public sector employment

3a



3b



Note: All impulses are in percentage deviations from their steady-state value. Solid line corresponds to the case with $\overline{w}^g / \overline{w}^p = 1.00$, the dash line to the case with $\overline{w}^g / \overline{w}^p = 1.05$ and the dotted line to $\overline{w}^g / \overline{w}^p = 1.10$.

Appendix 1 – Summary statistics and sources

Table A1 – Compensation of employees over total general government spending (%)

	1995	2000	2005	2006	2007
Belgium	22.9	23.5	23.2	24.4	24.1
Bulgaria			24.6	24.4	23.9
Czech Rep.	13.5	16.9	17.7	17.8	17.8
Denmark	29.0	32.0	32.7	33.1	33.3
Germany	18.1	17.9	16.0	15.9	15.8
Estonia	27.0	29.9	27.8	26.7	25.1
Ireland	24.6	25.3	27.2	28.4	27.5
Greece	22.1	22.4	26.2	25.7	25.6
Spain	25.2	26.3	26.0	26.0	26.1
France	25.0	25.8	24.7	24.6	24.3
Italy	20.9	22.6	22.9	22.1	22.2
Cyprus		36.6	33.8	33.9	31.0
Latvia	28.7	28.9	28.2	27.2	28.8
Lithuania	27.9	31.1	30.9	30.9	29.6
Luxemburg	21.3	20.1	18.9	18.9	19.0
Hungary		22.5	25.2	23.5	22.6
Malta	36.9	31.6	31.4	30.6	30.3
Netherlands	20.5	21.5	21.6	20.5	20.0
Austria	22.3	21.2	18.8	18.9	18.9
Poland	22.3	24.6	23.2	22.4	22.5
Portugal	30.2	32.9	30.3	29.4	28.2
Romania		16.8	25.9	26.1	26.3
Slovenia	21.6	24.2	25.5	25.3	25.3
Slovakia	19.4	17.2	19.2	19.9	20.1
Finland	24.6	26.9	27.4	27.4	27.5
Sweden	24.6	27.3	28.5	28.3	29.0
United Kingdom	24.1	26.4	25.5	25.5	25.2
Euro Area 15		22.5	21.9	21.7	21.7
European Union 27			23.0	22.8	22.8
United States	28.5	28.4	28.3	28.0	

Source: European Commission AMECO database.

Table A2 – Summary statistics and sources

	Observations	Mean	Standard deviation	Minimum	Maximum	Source
Growth rate of nominal private sector wages	382	7.12	4.97	-1.62	27.52	OECD
Growth rate of real private sector wages	382	1.30	2.10	-7.46	9.40	OECD
Growth rate of nominal public sector wages	382	6.82	5.26	-3.28	28.56	OECD
Growth rate of real public sector wages	382	1.00	3.09	-8.24	11.06	OECD
Unemployment rate	382	7.45	3.81	1.38	19.11	OECD
Total factor productivity growth rate	382	1.19	1.52	-3.39	6.69	OECD
Inflation rate	382	6.11	4.79	0.02	23.23	OECD
Terms of Trade	382	1.00	0.10	0.63	1.49	Labour Market Institutions Database
Hours per worker	382	7.46	0.09	7.23	7.67	OECD
Budget Balance	382	-3.30	4.40	-15.71	9.75	AMECO / IMF
Government Debt	382	55.14	28.83	2.31	140.85	AMECO / IMF
Growth rate of public employment	382	1.35	2.19	-5.76	9.47	OECD
Tax wedge	382	0.52	0.12	0.24	0.83	Labour Market Institutions Database
Union density	382	0.45	0.21	0.09	0.91	Labour Market Institutions Database
Bargaining Coordination	382	2.06	0.62	1.00	3.00	Labour Market Institutions Database
Benefit duration	382	0.43	0.31	0.00	1.02	Labour Market Institutions Database
Central bank independence	382	0.50	0.18	0.22	0.93	Labour Market Institutions Database
Election	382	0.31	0.46	0	1	Comparative parties dataset
% Left wing votes	382	35.51	14.72	0	56	Comparative parties dataset

Note: Labour Market Institutions Database (LMID) created by Nickell et al. (2005). Data was further expanded by Baker et al. (2003) - BHHS. The comparatives party dataset was created by Duane Swank and it is available on http://www.mu.edu/polisci/Swank.htm.

Employment and wage variables

The data on public employment and wages is taken from the OECD (Economic Outlook database).

For most countries there is information on Government employment (EG). To calculate the per employee wage we divide Government final wage consumption expenditure (CGW) by Government employment. To get the wage in real terms we deflate it using the Private final consumption expenditure deflator (PCP).

We also have the value for the Compensation of employees (WSSS) and Total employment (ET), which refers to the total economy. We define Private sector compensation as the total compensation of workers minus the government final wage consumption (WSSS-CGW). We define the private employment (EP) as total employment minus government employment minus Self Employed (ES): EP=ET-EG-ES. The private sector nominal wage per employee is Private sector compensation divided by private sector employees.

For the case of Australia, there is no information on government employment but there is on Private sector employment and Compensation of private sector employees. In this case, Government employment is defined as Total employment minus Private sector employment

and Compensation of public sector employees defined as the value of Compensation of employees minus Compensation of private sector employees.

Other variables

Benefit replacement rate - Benefit entitlement before tax as a percentage of previous earnings before tax. Source: LMID, BHHS from 1995-1999.

Benefit duration index. Source: LMID, BHHS from 1995-1999.

Coordination index - Captures the degree of consensus between actors in collective bargaining (1 low, 3 high). Source: LMID, BHHS from 1995-1999.

Trade union density – Ratio of total reported union members (minus retired and unemployed) to all salaried employees. Source: LMID, BHHS from 1995-1999.

Tax wedge – Payroll tax plus income tax plus the consumption tax rate. Source: LMID, BHHS from 1995-1999.

Productivity growth – Growth rate of productivity per worker. Source: OECD, own calculation.

Terms of trade – Growth rate of terms of trade. Source: BHHS.

Inflation – Source: OECD.

Unemployment rate – Source: LMID, OECD from 1995-1999.

Budget Balance – Government balance as percentage of GDP. Source: AMECO, complemented with IMF data for early years.

Government debt – Government debt as percentage of GDP. Source: AMECO, complemented with IMF data for early years.

Election year – Dummy if there was a parliamentary of presidential election. Source: Comparative parties dataset.

Left wing – Percentage of left with votes of last parliamentary elections. Source: Comparative parties dataset.

Appendix 2 – Further results

Table A1 – Summary statistics (selected variables)

	Growth rate of nominal private sector wages		Growth rate of real private sector wages		Growth rate of nominal public sector wages		Growth rate of real public sector wages		Inflation	
	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.
Australia	6.96	4.86	1.03	3.06	7.07	4.91	1.14	3.03	6.19	4.14
Austria	5.36	3.49	1.92	1.94	5.29	2.96	1.84	1.76	3.70	2.30
Belgium	5.57	7.13	1.59	6.61	2.84	2.81	-0.41	4.07	4.17	3.14
Canada	5.81	3.44	1.21	1.96	4.82	4.13	0.21	2.08	4.76	3.36
Denmark	5.70	5.70	1.08	4.57	5.69	3.46	0.92	2.39	5.21	3.86
Finland	7.69	5.21	2.33	2.82	6.90	4.70	1.55	2.37	5.58	4.76
France	6.55	4.89	1.60	1.64	6.66	4.88	1.71	2.12	5.14	4.22
Germany	4.45	3.70	1.61	2.74	3.89	3.37	1.05	2.55	3.08	1.95
Ireland	9.34	6.13	2.45	2.43	10.19	5.66	3.31	3.59	7.23	6.00
Italy	9.35	6.90	1.59	2.69	9.34	6.52	1.57	3.66	7.84	6.02
Japan	4.29	5.92	1.49	2.29	4.87	6.38	2.07	2.86	3.37	4.67
Netherlands	4.93	4.02	1.27	2.11	3.42	3.37	-0.25	2.47	3.75	2.72
Norway	6.09	2.77	1.45	1.74	5.82	2.65	1.18	2.01	5.29	3.59
Spain	9.37	6.86	1.55	2.94	8.00	6.06	0.18	3.05	8.34	5.90
Sweden	7.11	3.85	1.44	2.62	6.53	3.65	0.86	2.88	5.49	4.01
United Kingdom	8.23	5.26	1.98	2.10	9.33	5.86	3.08	3.07	6.57	5.27
United States	5.15	2.02	1.11	1.33	5.06	2.19	1.02	1.81	4.67	2.97
All countries	6.60	5.27	1.57	2.94	6.27	4.95	1.26	2.90	5.33	4.44

S.d. – standard deviation.

Table A2 – Summary statistics (selected variables)

	Unemployment rate		TFP growth rate		Terms of Trade		Hours per worker		Public-private per employee wage ratio (log)	
	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.	Mean	S.d.
Australia	6.41	2.29	0.73	1.30	1.09	0.10	7.49	0.02	23.10	4.12
Austria	3.66	1.78	1.20	1.28	1.02	0.04	7.41	0.01	24.27	5.13
Belgium	7.20	2.79	1.21	1.39	0.98	0.03	7.42	0.06	11.98	22.76
Canada	8.21	1.83	0.69	1.39	0.98	0.06	7.49	0.03	4.84	11.96
Denmark	5.20	2.16	1.14	1.33	1.01	0.07	7.38	0.06	4.37	10.03
Finland	7.44	4.42	1.93	1.69	0.97	0.04	7.50	0.04	1.52	7.62
France	7.22	2.61	1.05	0.98	0.98	0.07	7.46	0.08	-3.04	5.05
Germany	5.18	2.76	1.03	0.76	0.95	0.06	7.39	0.09	19.46	10.07
Ireland	10.08	4.66	2.27	2.02	1.08	0.07	7.56	0.09	17.13	14.83
Italy	7.91	2.48	0.97	1.55	0.97	0.10	7.54	0.03	13.64	8.18
Japan	2.88	1.20	1.21	1.63	0.99	0.19	7.60	0.08	9.56	7.37
Netherlands	5.01	2.35	1.12	1.04	1.01	0.02	7.34	0.11	58.28	16.98
Norway	3.23	1.43	1.57	1.33	1.27	0.20	7.34	0.07	-15.75	3.60
Spain	12.39	4.18	0.95	1.27	0.86	0.13	7.50	0.07	40.46	17.86
Sweden	3.86	2.14	1.11	1.41	1.04	0.07	7.37	0.03	-14.32	7.22
United Kingdom	7.05	2.57	1.36	1.46	1.00	0.06	7.48	0.04	-26.94	14.21
United States	6.13	1.37	1.05	1.27	1.07	0.13	7.46	0.02	5.23	4.69
All countries	6.36	3.56	1.22	1.44	1.01	0.13	7.46	0.10	10.38	22.86

S.d. – standard deviation.

Table A3 – Correlation between variables

		1	2	3	4	5	6	7	8	9	10	11
Growth rate of real private sector wages	1	-	0.40	-0.15	0.17	0.04	0.09	0.05	0.06	0.22	0.12	-0.21
Growth rate of real public sector wages	2	0.39	-	-0.10	-0.04	-0.14	0.14	-0.03	-0.04	-0.24	0.16	0.00
Δ Unemployment rate	3	-0.14	-0.07	-	-0.03	0.32	-0.08	-0.21	-0.10	0.04	-0.32	-0.15
Total factor productivity growth	4	0.18	0.04	0.05	-	-0.12	-0.02	0.24	0.07	-0.12	-0.14	-0.02
Inflation rate	5	0.06	-0.02	0.28	-0.07	-	-0.29	-0.33	0.11	0.55	-0.06	-0.61
Growth rate of terms of trade	6	0.09	0.07	-0.09	-0.01	-0.23	-	0.14	0.01	-0.12	0.03	0.19
Growth rate of average hours per worker	7	0.02	-0.05	-0.17	0.18	-0.20	0.12	-	0.04	-0.25	-0.08	0.26
Δ Tax wedge	8	0.08	-0.01	-0.04	0.02	0.15	0.02	0.04	-	0.07	0.09	0.05
Growth rate of public employment	9	0.17	-0.22	-0.01	-0.13	0.47	-0.08	-0.21	0.11	-	-0.02	-0.46
Budget Balance	10	0.03	0.12	-0.20	-0.06	-0.16	0.00	-0.07	0.03	0.08	-	-0.06
Government Debt	11	-0.04	-0.02	-0.09	0.02	-0.32	0.12	0.10	0.00	-0.37	-0.48	-

Note: the values below the diagonal are the overall correlation between the variables. The values above the diagonal are cross-country averages of the time correlation between the variables.

Table A4 – Estimations for the European countries

	Nominal Private		Real Private		Nominal Public		Real Public	
	2SLS	GMM	2SLS	GMM	2SLS	GMM	2SLS	GMM
Δ Unemployment rate	-0.495***	-0.343***	-0.390**	-0.206*	0.464*	0.014	0.546**	0.14
	(-2.7)	(-3.33)	(-2.07)	(-1.65)	(1.67)	(0.08)	(1.99)	(1.06)
Total factor productivity growth	0.357**	0.253***	0.318**	0.251***	-0.464**	-0.155	-0.452**	-0.145
	(2.4)	(3.28)	(2.17)	(2.86)	(-2.22)	(-1.1)	(-2.16)	(-1.19)
Inflation rate	0.721***	0.745***	0.031	-0.025	0.614***	0.591***	-0.097	-0.115**
	(8.33)	(10.6)	(0.6)	(-0.8)	(6.85)	(11.95)	(-1.33)	(-2.4)
Growth rate of real public sector wages	0.349***	0.233***	0.346***	0.264***				
	(4.95)	(4.78)	(4.93)	(6.1)				
Growth rate of real private sector wages					0.839***	0.491***	0.787***	0.532***
					(5.27)	(6.27)	(4.98)	(7.31)
Growth rate of terms of trade	0.003	-0.017	0.042	0.039	-0.118	-0.024	-0.064	0.042
	(0.06)	(-0.47)	(0.72)	(0.93)	(-1.34)	(-0.71)	(-0.71)	(0.85)
Growth rate of average hours per worker	3.330	1.024	5.391**	2.037**				
	(1.49)	(1.23)	(2.36)	(2.45)				
Δ Tax wedge	-0.075	0.032	-0.124	0.016	-0.100	-0.046	-0.138	-0.079
	(-0.62)	(0.61)	(-1.01)	(0.29)	(-0.53)	(-0.54)	(-0.72)	(-1.08)
Growth rate of public employment	0.360***	0.279***	0.313**	0.280***				
	(2.75)	(3.7)	(2.42)	(4.14)				
Budget Balance					0.200***	0.157*	0.213***	0.151*
					(2.68)	(1.79)	(2.92)	(1.81)
Government debt					-0.006	-0.027	0	-0.022
					(-0.32)	(-1.49)	(0.01)	(-1.33)
Lagged dependent Variable	0.187***	0.151***	0.185***	0.203***	0.175***	0.222**	0.171***	0.222***
	(2.84)	(2.63)	(2.91)	(5.73)	(2.87)	(2.54)	2.95	3.21
Error correction component	0.040**	0.037***	0.040**	0.035**	-0.113***	-0.111***	-0.112***	-0.115***
	(2.5)	(3.05)	(2.55)	(2.56)	(-4.85)	(-6.01)	(-4.87)	(-6.08)
Δ Union density	0.047	0.125	-0.004	0.061	0.244	0.296	0.205	0.238
	(0.39)	(1.09)	(-0.04)	(0.61)	(1.4)	(1.61)	(1.19)	(1.18)
Bargaining Coordination	0.453	-0.028	0.412	0.007	-0.799	-0.671	-1.020*	-0.776
	(1.02)	(-0.05)	(0.94)	(0.01)	(-1.34)	(-0.86)	(-1.73)	(-1.15)
Δ Benefit duration	-3.992	-2.209	-3.122	-3.015	-2.166	-3.252	-1.487	-3.442*
	(-1.19)	(-0.56)	(-0.95)	(-0.95)	(-0.42)	(-1.08)	(-0.29)	(-1.93)
Δ Benefit replacement rate	3.018	2.148	2.688	1.661	0.24	1.175	-0.732	0.38
	(0.82)	(0.6)	(0.74)	(0.5)	(0.04)	(0.24)	(-0.13)	(0.09)
Central bank independence	-2.388***	-2.375***	-2.017**	-1.982***				
	(-2.58)	(-3.01)	(-2.21)	(-2.71)				
Election year					-0.139	-0.141	-0.32	-0.297
					-0.36	-0.37	-0.84	-0.77
% Left wing votes					0.056	0.045	0.032	0.023
					0.99	0.81	0.56	0.46
R^2	0.879	0.891	0.335	0.371	0.770	0.790	0.399	0.431
Sargan test #	63.74	319.1	49.48	280.2	51.1	284.7	52.02	269.7
	(0.063)	(0.016)	(0.374)	(0.277)	(0.315)	(0.206)	(0.251)	(0.425)
Overidentifying restrictions	47	267	47	267	46	266	46	266
Hausman Test& (Exogenous)	7.22		4.47		3.06		3.22	
	(0.926)		(0.996)		(0.999)		(0.999)	
Hausman Test$ (Endogenous)	35.18		28.48		50.40		63.03	
	(0.002)		(0.019)		(0.000)		(0.000)	
Observations	282	282	282	282	282	282	282	282
Countries	12	12	12	12	12	12	12	12

Notes: The following variables are considered endogenous: unemployment rate, growth rate of total factor productivity, inflation rate, terms of trade, hours per worker, growth rate of government employment, budget balance, government debt, change in tax wedge, growth rate of real per worker public sector wages and growth rate of real per worker private sector. These endogenous variables are instrumented by the remaining pre-determined variables and three lags of all explanatory variables. The t statistics are in parentheses. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). # The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. . & The null hypothesis is that the block of institutional variables is exogenous. Under the null, the estimator used is efficient but they are inconsistent under the alternative hypothesis. The consistent estimator would be to consider all variables as endogenous and instrument them with lags. The p-value is in brackets. $ The null hypothesis is that the block of macroeconomic variables is exogenous. Under the null, the most efficient estimator is fixed effects estimation taking all variables as exogenous. Under the alternative hypothesis the estimates are consistent estimates. The p-value is in brackets.

Countries: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden and United Kingdom. Time span: 1974-1998.

Table A5 – Euro area countries, longer time sample

	Nominal Private		Real Private		Nominal Public		Real Public	
	2SLS	GMM	2SLS	GMM	2SLS	GMM	2SLS	GMM
Δ Unemployment rate	-0.470**	-0.202*	-0.194	0.114	-0.059	-0.133	0.026	0.021
	(-2.3)	(-1.7)	(-0.85)	(0.71)	(-0.18)	(-0.83)	(0.08)	(0.13)
Total factor productivity growth	0.359**	0.300**	0.301*	0.301*	-0.022	0.005	-0.019	-0.026
	(2.27)	(2.04)	(1.65)	(1.89)	(-0.08)	(0.04)	(-0.06)	(-0.15)
Inflation rate	0.489***	0.433***	-0.044	-0.057*	0.668***	0.605***	-0.066	-0.114***
	(7.61)	(7.18)	(-0.77)	(-1.78)	(11.11)	(7.83)	(-1.51)	(-2.98)
Growth rate of real public sector wages	0.119*	0.211***	0.08	0.307***				
	(1.8)	(5.37)	(1.01)	(5.75)				
Growth rate of real private sector wages					0.740***	0.627***	0.507***	0.647***
					(4.27)	(11.57)	(2.89)	(24.56)
Growth rate of public employment	0.208	0.232***	0.301*	0.291***				
	(1.47)	(3.99)	(1.87)	(3.8)				
Budget balance					0.302***	0.174***	0.333***	0.176***
					(4.13)	(2.63)	(4.5)	(2.62)
Lagged dependent Variable	0.434***	0.489***	0.285***	0.270***	0.158***	0.214**	0.176***	0.188***
	(7.55)	(9.05)	(4.92)	(3.09)	(3.03)	(2.52)	(3.61)	(3)
Error correction component	0.026*	0.029***	0.015	0.026**	-0.116***	-0.097***	-0.115***	-0.103***
	(1.91)	(2.94)	(0.99)	(2.17)	(-6.28)	(-5.8)	(-6.2)	(-5.88)
R^2	0.869	0.913	0.360	0.405	0.783	0.790	0.399	0.424
Sargan test #	44.17 (0.000)	381.6 (0.118)	21.22 (0.170)	404.7 (0.023)	36.64 (0.004)	337.8 (0.523)	27.30 (0.038)	340.3 (0.485)
Overidentifying restrictions	16	350	16	350	16	340	16	340
Hausman Test$ (Endogenous)	48.32 (0.000)		24.69 (0.001)		-		54.66 (0.000)	
Observations	357	357	357	357	347	347	347	347
Countries	11	11	11	11	11	11	11	11

Notes: The following variables are considered endogenous: unemployment rate, growth rate of total factor productivity, inflation rate, terms of trade, hours per worker, growth rate of real per worker public sector wages, budget balance, growth rate of real per worker private sector wages. These endogenous variables are instrumented by three lags of all explanatory variables. The t statistics are in parentheses. For the 2SLS estimation, the conventional standard errors were used. For the Arellano and Bond GMM estimator robust standard errors were used. *, **, *** - statistically significant at the 10, 5, and 1 percent. White diagonal standard errors & covariance (d.f. corrected). # The null hypothesis of the Sargan overidentification test is that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. The p-value is in brackets. $ The null hypothesis is that the block of macroeconomic variables is exogenous. Under the null, the most efficient estimator is fixed effects estimation taking all variables as exogenous. Under the alternative hypothesis the estimates are consistent estimates. The p-value is in brackets.
Countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. Time span: 1974-2006.

Figure A1 – Steady state effects of public sector wages on other variables

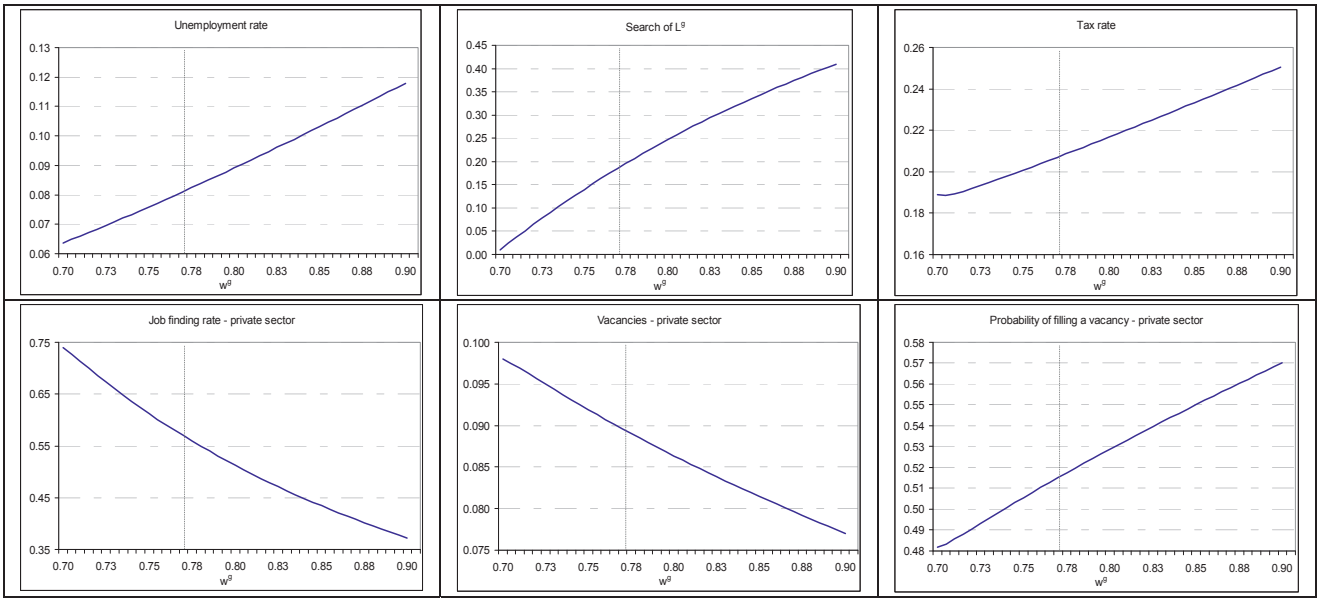


Figure A2 – Steady state effects of public sector employment on other variables

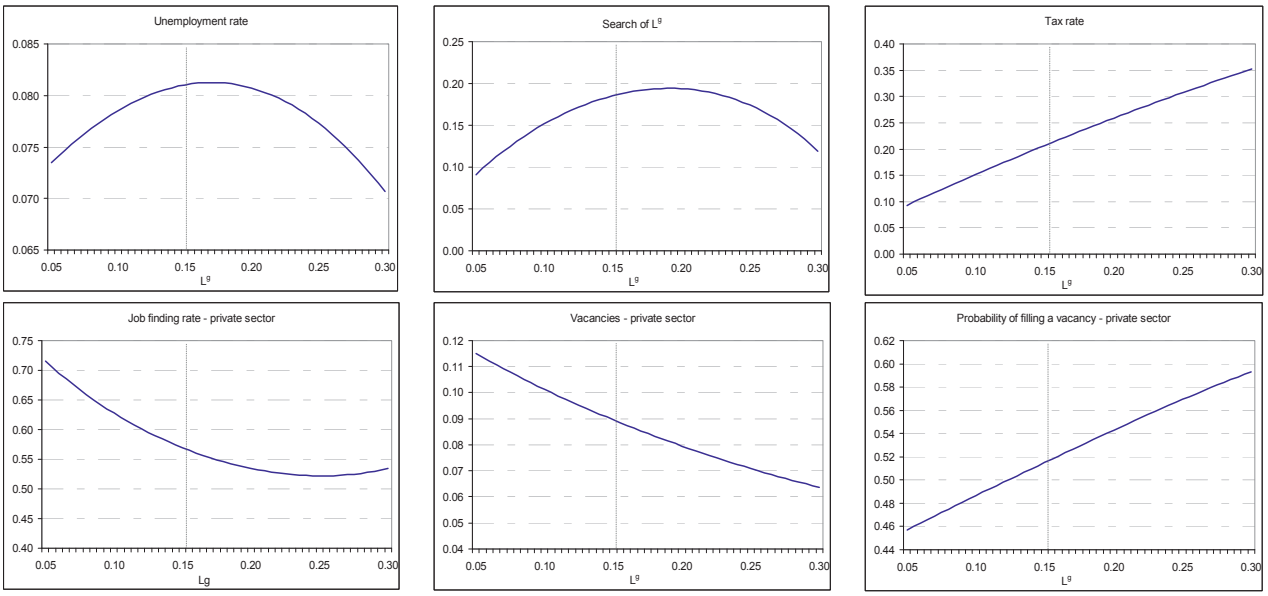
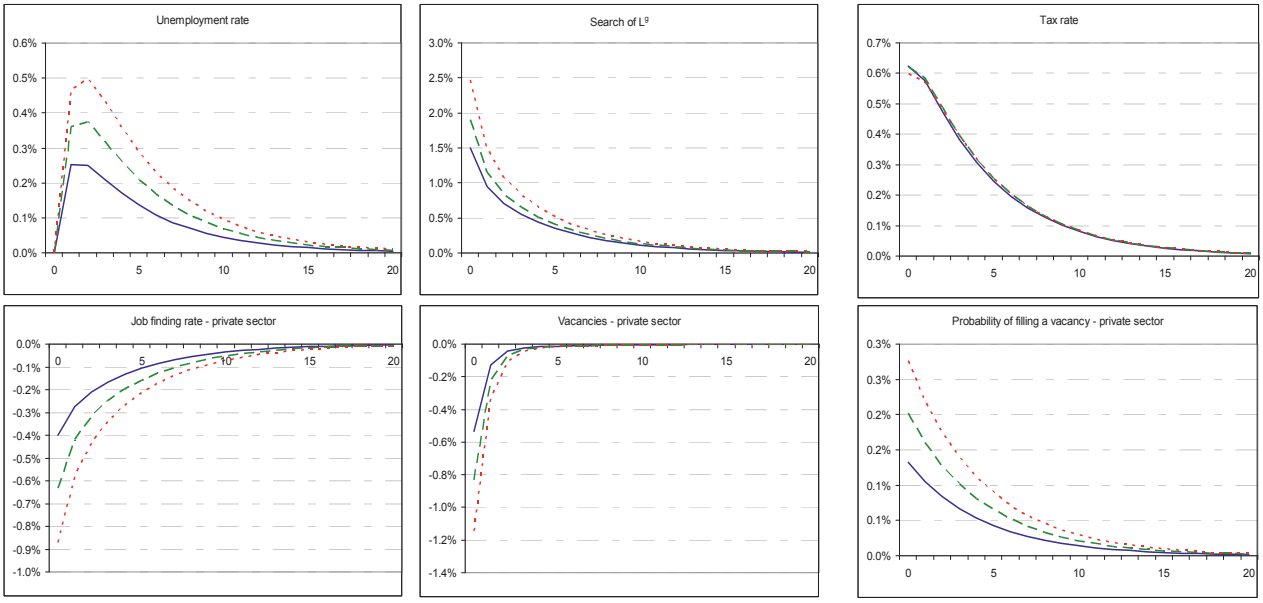
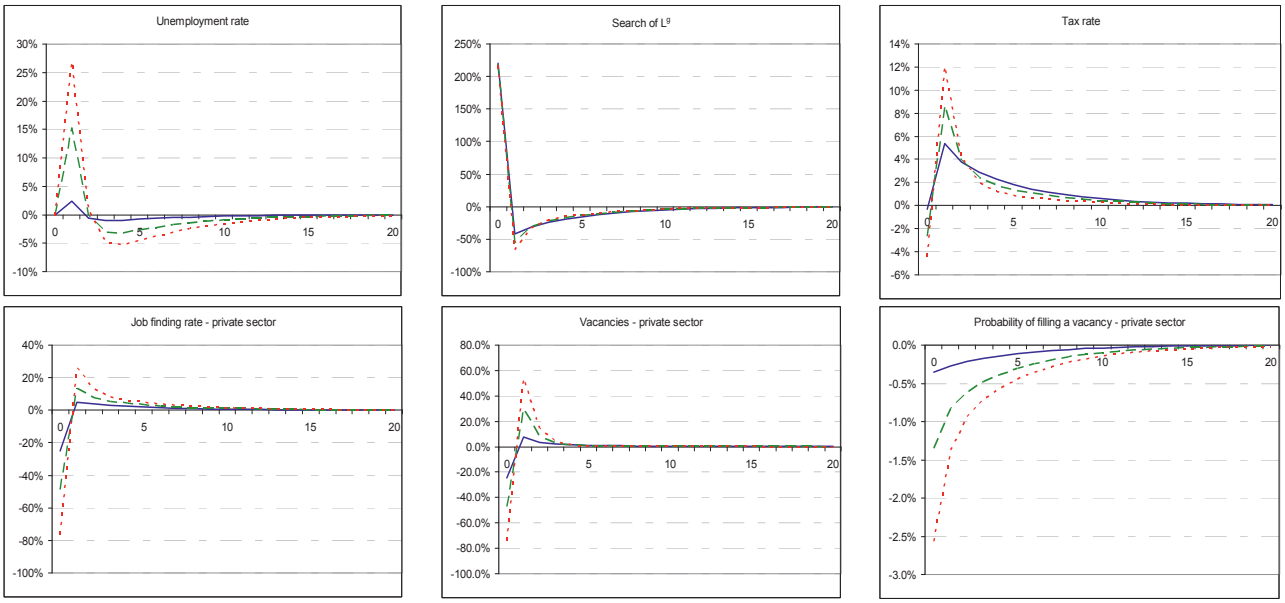


Figure A3 – Response to a 1% increase in public sector wages



Note: All impulses are in percentage deviations from their steady-state value. Solid line corresponds to the case with $\overline{L}^g = 0.10$, the dash line to the case with $\overline{L}^g = 0.15$ and the dotted line to $\overline{L}^g = 0.20$

Figure A4 – Response to a 1 percentage point increase in public sector employment

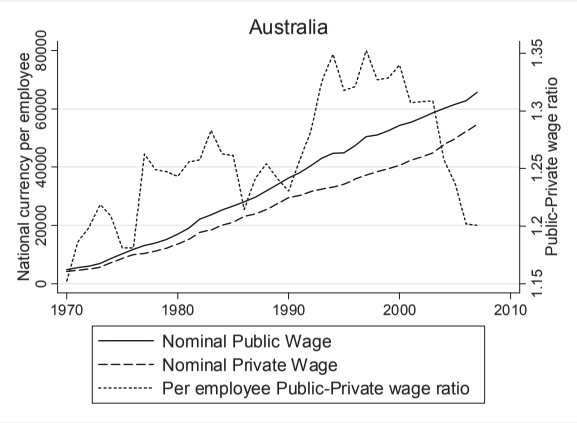


Note: All impulses are in percentage deviations from their steady-state value. Solid line corresponds to the case with $\overline{w}^g / \overline{w}^p = 1.00$, the dash line to the case with $\overline{w}^g / \overline{w}^p = 1.05$ and the dotted line to $\overline{w}^g / \overline{w}^p = 1.10$.

Appendix 3 – Stylised data on wages and employment

Charts 1-19

1a



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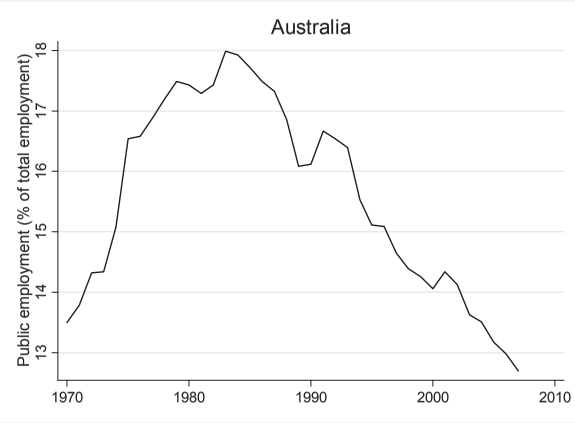

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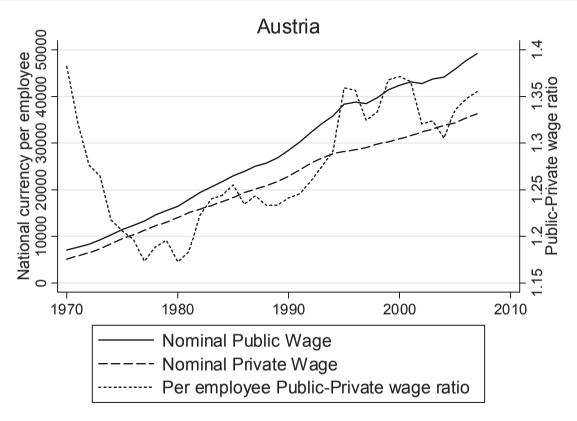

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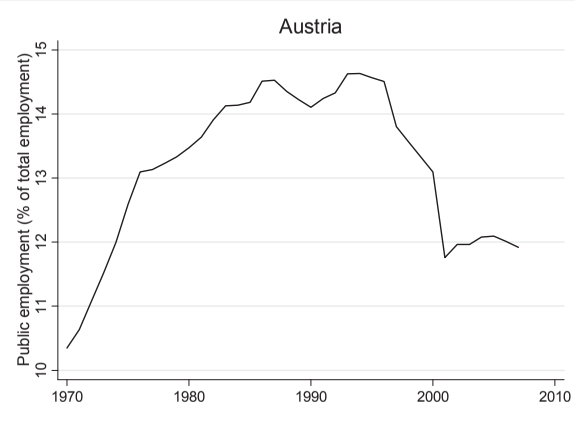

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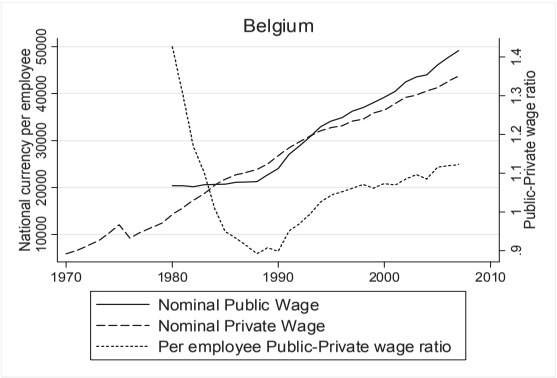

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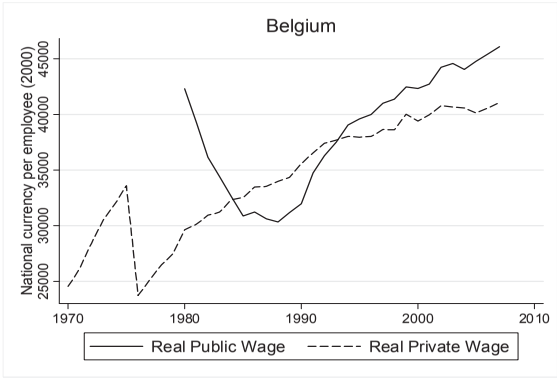

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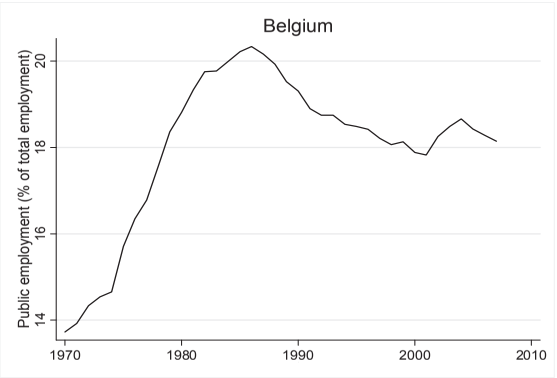

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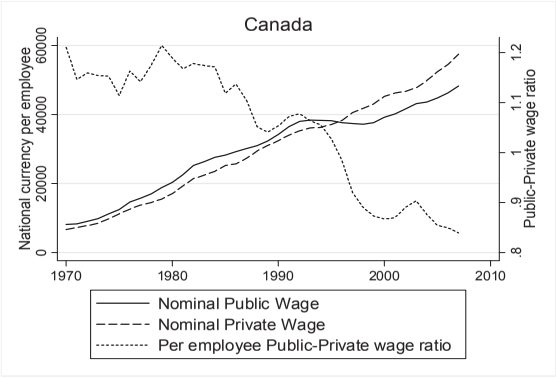

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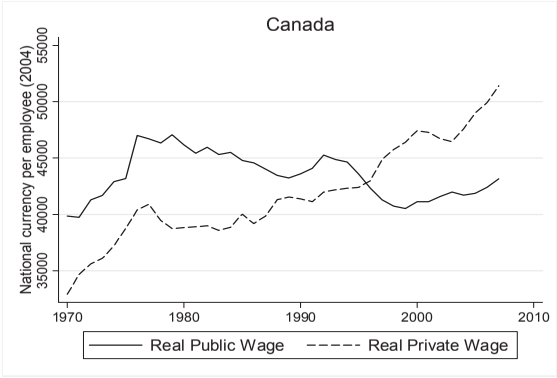

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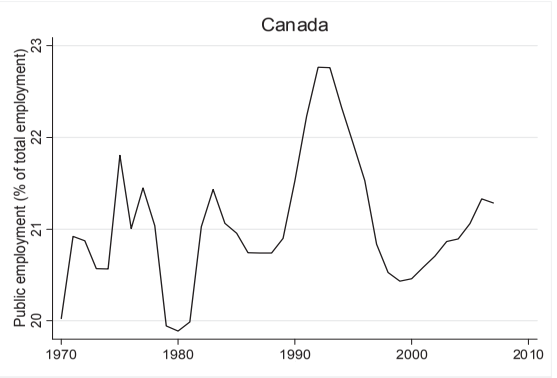

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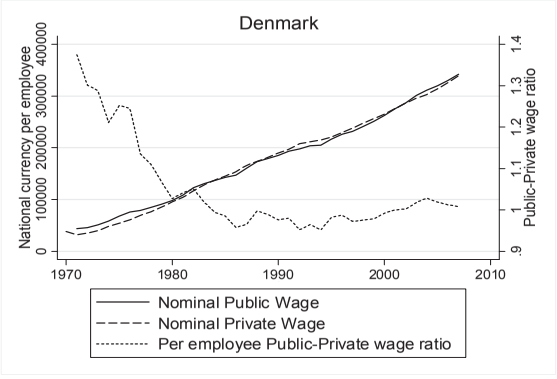

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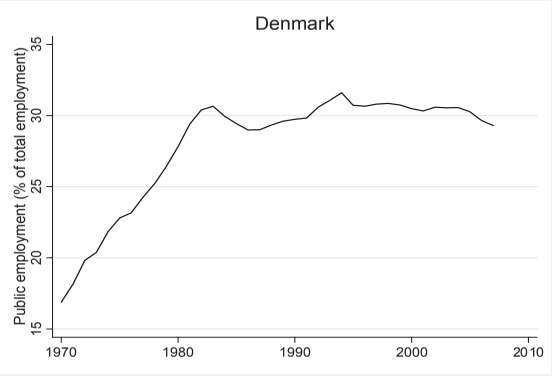

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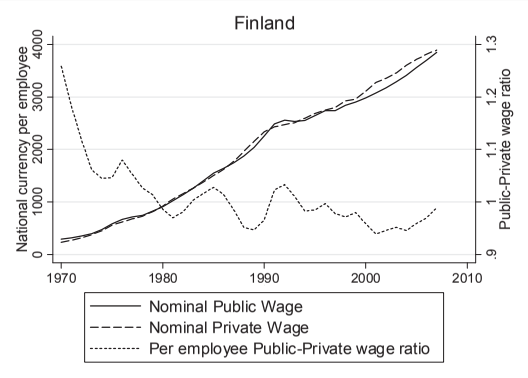

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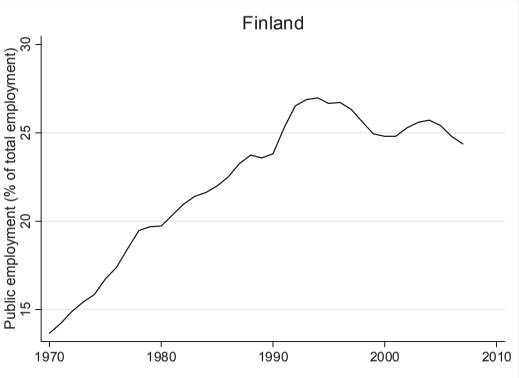

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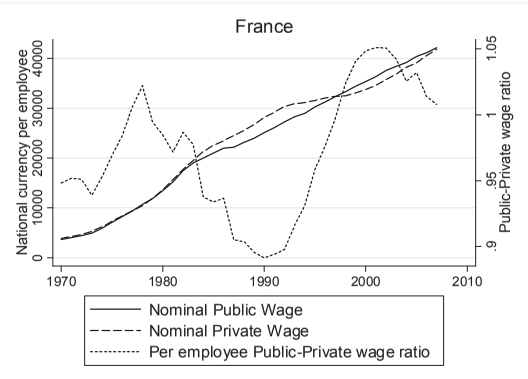

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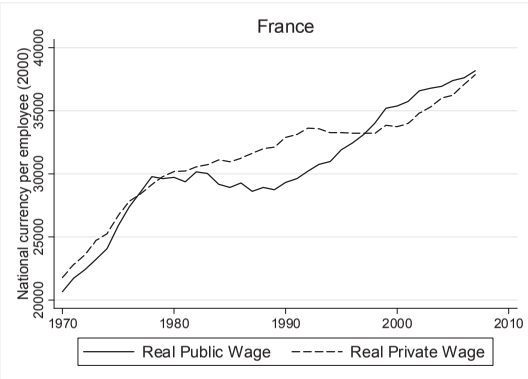

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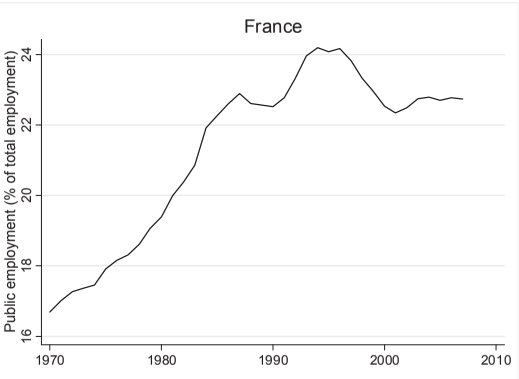

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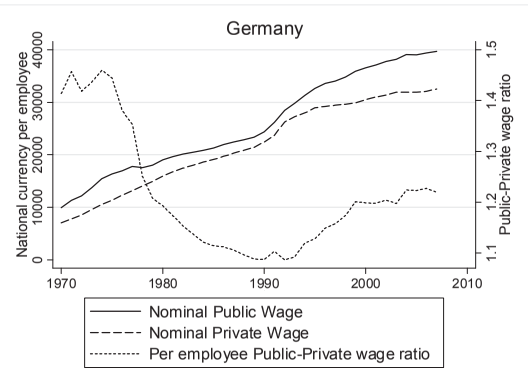

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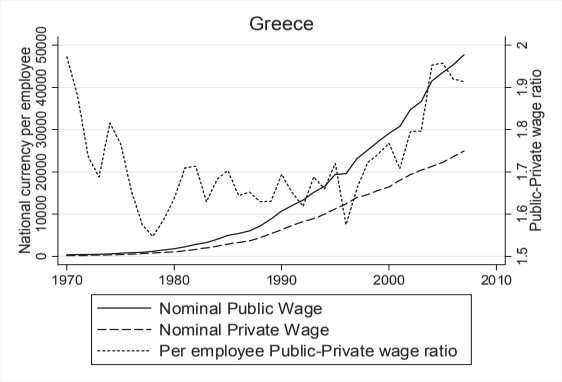

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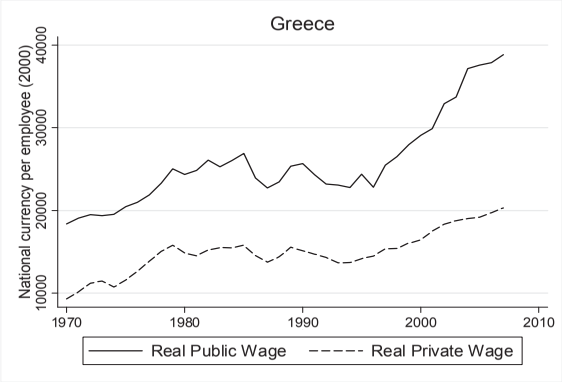

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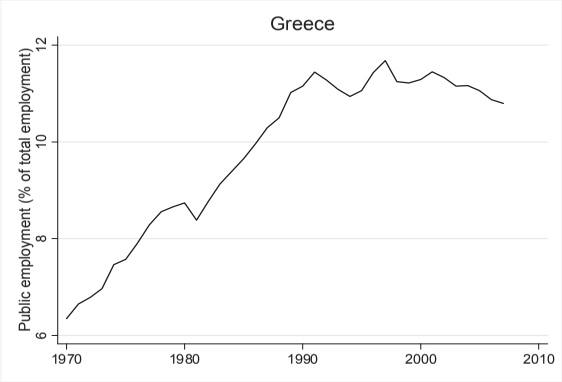

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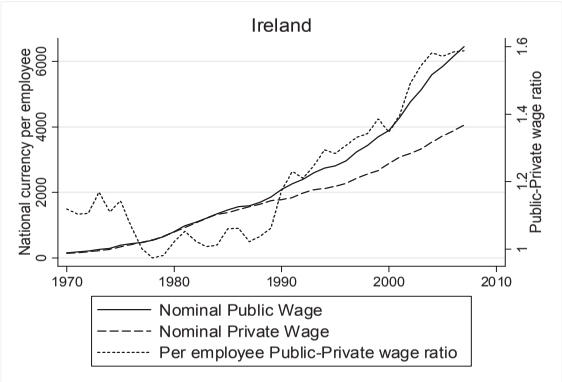

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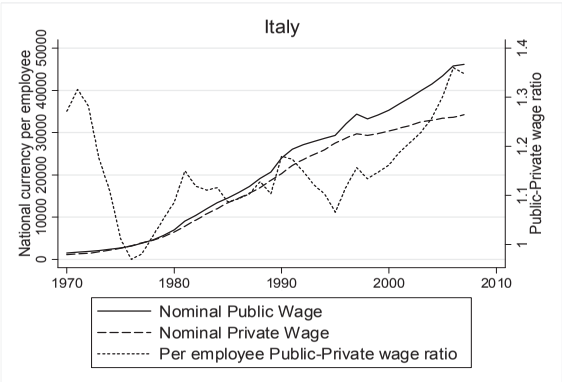

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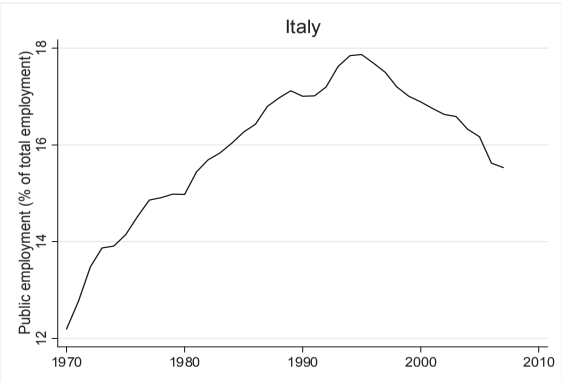

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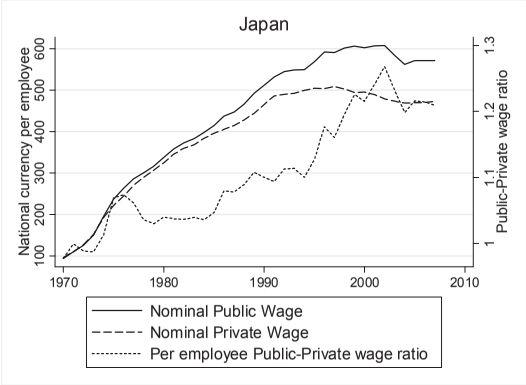

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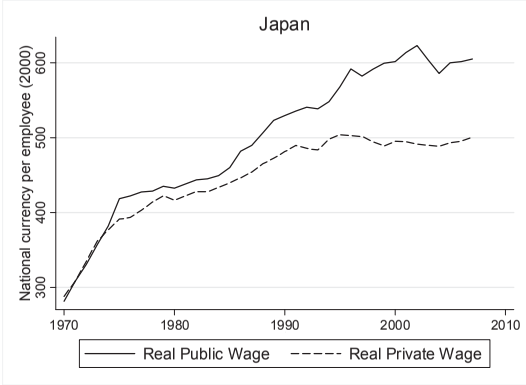

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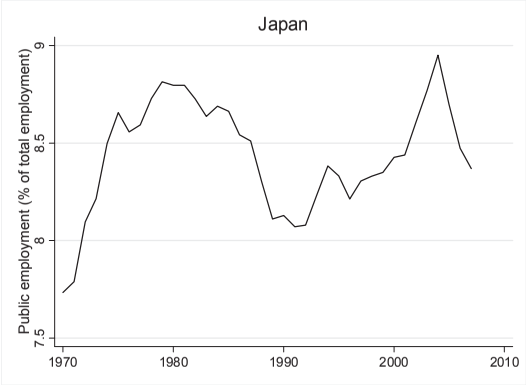

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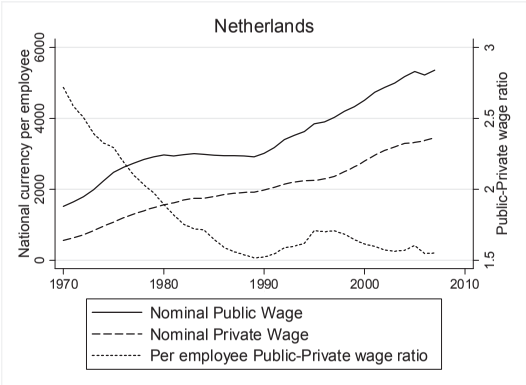

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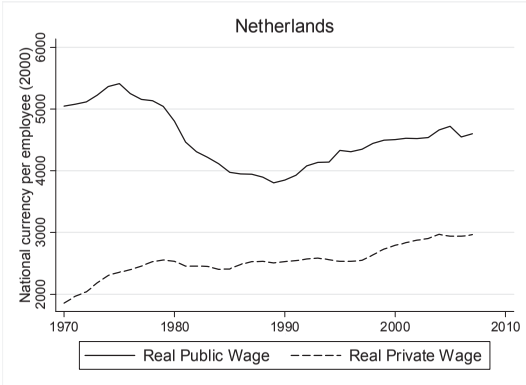

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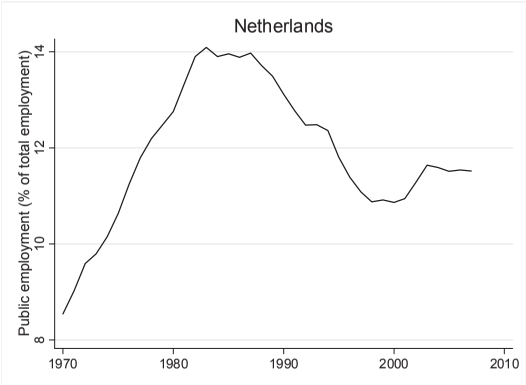

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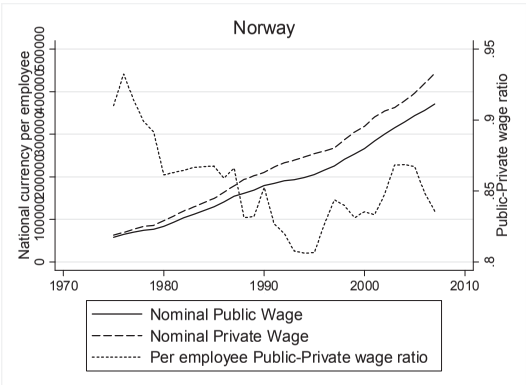

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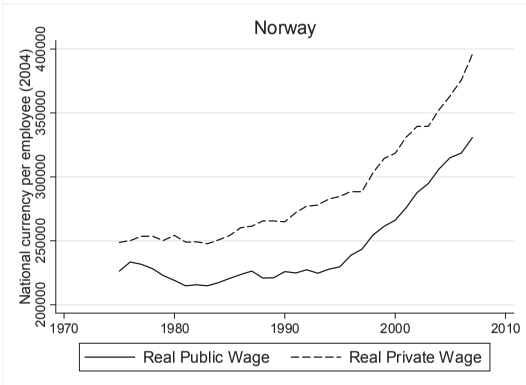

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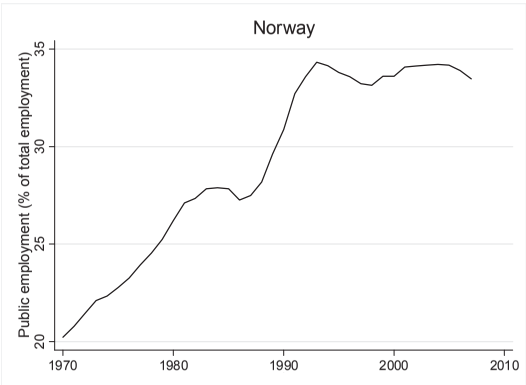

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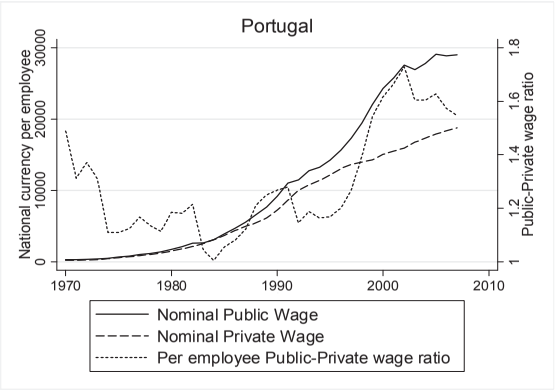

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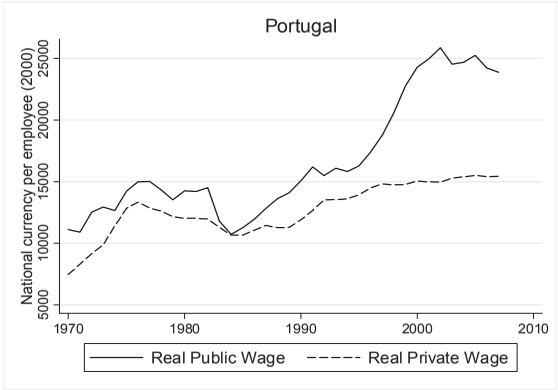

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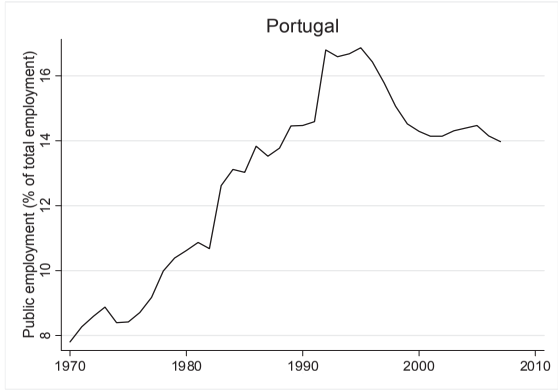

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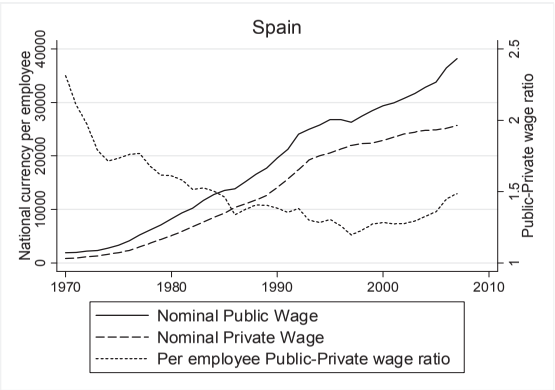

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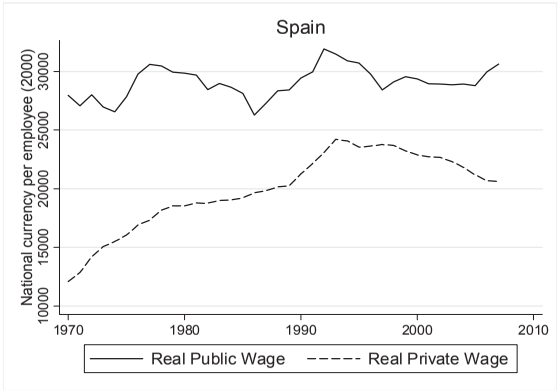

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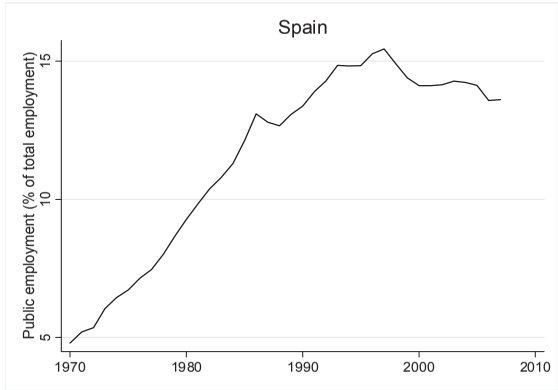

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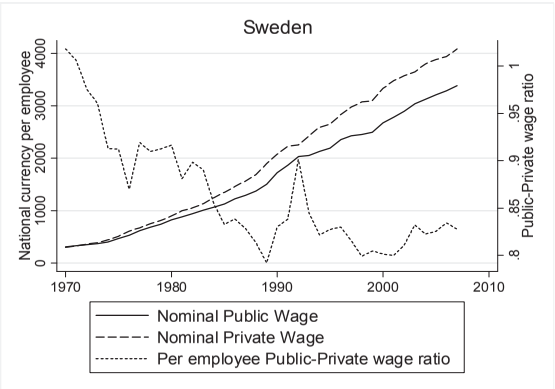

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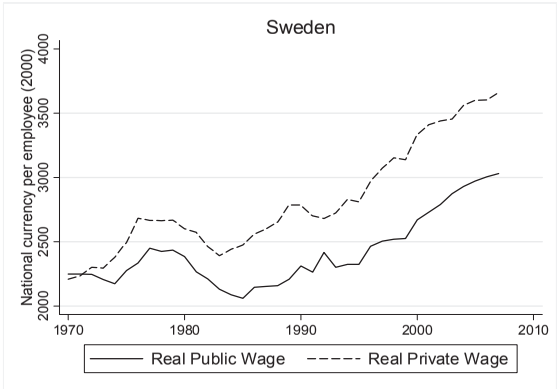

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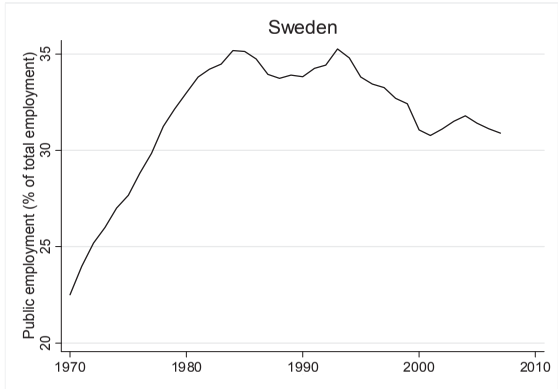

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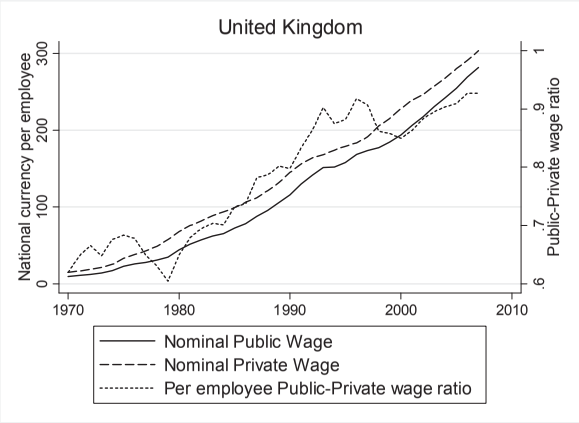

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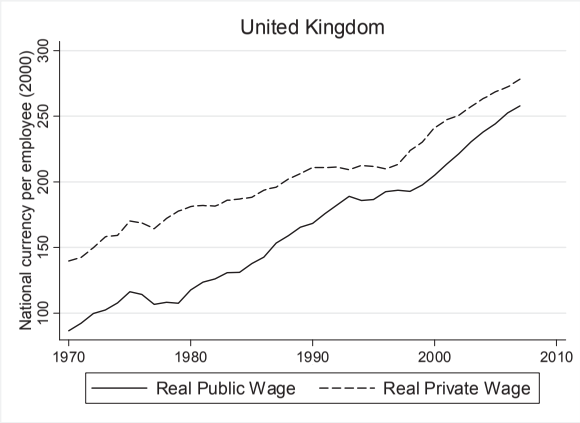

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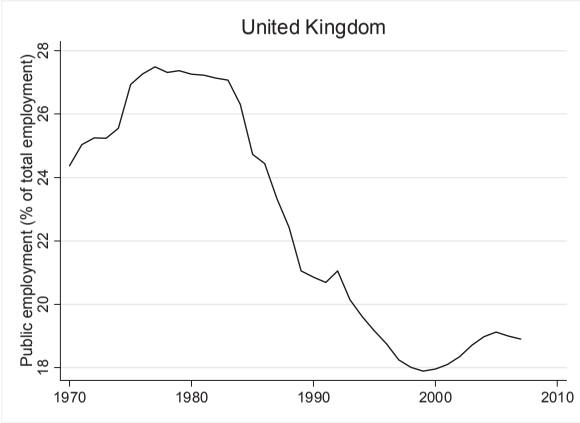

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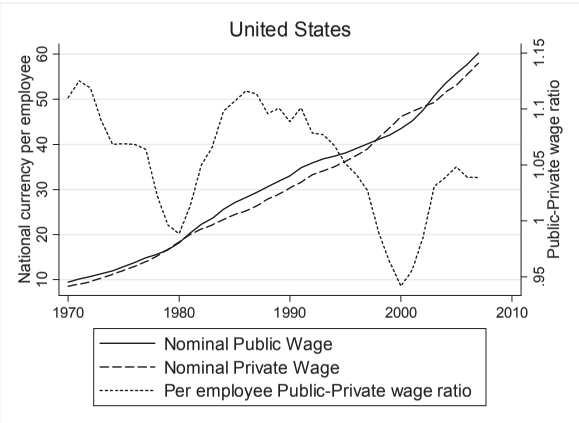

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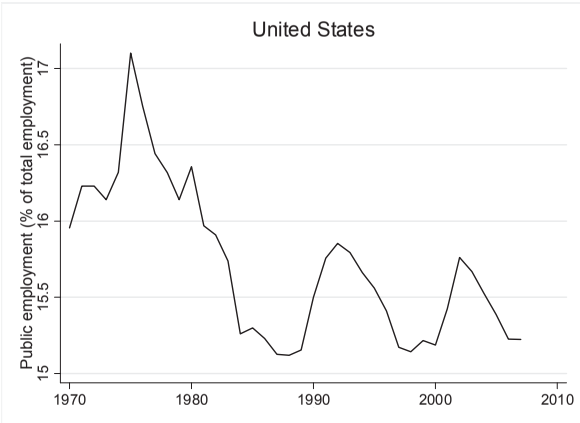

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