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PUBLIC-PRIVATE WAGE GAPS IN THE PERIOD PRIOR TO THE ADOPTION OF THE EURO: AN APPLICATION BASED ON LONGITUDINAL DATA

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Public-private wage gaps in the period prior to the adoption of the euro: an application based on longitudinal data*

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Abstract

This paper analyses the evolution of public wages and the public-private wage gaps in the period prior to the adoption of the euro in the countries then engaged on the fulfillment of the Maastricht criteria. The wage gaps are estimated controlling for employees' observed and unobservable individual attributes, using a novel methodology of fixed effects quantile regressions. The results suggest, on the one hand, a relative moderation in the growth of public sector wages in several European countries in the 1990s. On the other hand, estimates obtained for the public-private wage differential imply an increase in the same period in the majority of countries in the sample, with public employees generally becoming more beneficiated vis-à-vis private sector employees with the same observed and unobservable characteristics. Therefore, the fact that European countries were undertaking efforts to comply with the requirements for adopting the single currency does not seem to have contributed to the reduction of the wage premium that the literature has typically associated with public sector employment. It is noteworthy that the countries where the wage differential is higher are Portugal, Ireland, Greece and Spain. This differential is, to a large extent, an actual wage premium associated with the public sector, but self-selection effects determining that the best workers

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prefer the public sector can not be neglected. Nevertheless, the wage premia tend to be smaller in the case of individuals with higher earnings, making it difficult to attract the more qualified workers to the public sector. This difficulty may be worsened by accross-the-board measures to reduce wages and employees.

Keywords: Public sector, wage gaps, panel data, quantile regression

JEL codes: J31, J45, C21, C23

1 Introduction

Compensation of employees is one of the main drivers of public expenditure in the euro area. Against the current background where most Member-states are undertaking consolidation efforts, the size of the public sector wage bill has been under scrutiny and measures aiming at its reduction have been announced across Europe. Campos (2011) identified and analysed episodes of fiscal adjustment taking place in a period in which, as currently, European countries were engaged in fiscal consolidations with the goal of fulfilling the criteria for adopting the single currency. This study provided evidence that on the run-up to the euro area no major cuts were made in primary expenditure items such as social transfers and compensation of employees. Nevertheless, the need comply with the Maastricht criteria may have offered European governments a chance to eliminate, without major political costs, the positive differentials between public and private sector wages. In order to assess the validity of this idea, in this paper we focus on the analysis of the public-private wage gap in several Member-states in the period bounded by the coming into force of the Maastricht Treaty and the adoption of the euro (1993-1999).

We use data from the European Community Household Panel (ECHP), that covers EU-15 countries in the period from 1993 to 2000, to assess the evolution of public wages and of the gap vis-à-vis the private sector in the period prior to the inception of the euro area. In order to measure this wage differential taking into account the impact of the workers' unobserved individual attributes, we take advantage of the longitudinal structure of the

ECHP and control for those characteristics by resorting to fixed effects regressions. We provide one of first applications of the quantile regression for panel data method presented in Canay (2010). The main advantage of this novel approach is that it allows the estimation of the marginal effect of the employment sector on wages at different points of the distribution, while accounting for both observable and time-invariant unobservable factors. Therefore, this method also gives insight on the way individuals sort between the two sectors.

A short exploratory analysis of the data suggests a relative wage moderation in several Member-states in the period before the adoption of the euro. Notwithstanding, our estimates suggest that European governments did not undertake significant efforts to bring down the public sector wage premium.

The paper is organized as follows. Section 2 presents the data that is then explored in Section 3. In Section 4 provides an overview of the estimation methods used to compute the public-private wage gap, focusing more thoroughly on the novel quantile regression for longitudinal data approach. Section 5 summarizes the main findings. Section 6 concludes.

2 Data

We use data drawn from the ECHP. This dataset, made available by the Statistical Office of the European Communities (Eurostat), is a longitudinal survey of households and individuals that covers 15 EU Member States. Eight waves of data have been released, spanning from 1994 to 2001. However, not all countries participated in the survey from the beginning: Austria, Finland and Sweden were only added in the second, third and fourth years, respectively. The main advantage of this data source is that, since the questionnaire and methodology are standardized, cross-country comparisons are allowed. The panel is supposed to be representative of the EU population both in cross-sectional and longitudinal terms, at the level of households and individuals. The dataset comprises information referring to, for instance, gender, age, education, wage and other income sources, marital status and occupation.

A few preliminary points should be made regarding some of the variables that are used in the sequel to estimate the public-private wage gap. We use the hourly wage as a measure for individual earnings. As the information on gross wages is not available for the Luxembourg we excluded this country from our analysis and, for the remaining countries, we computed the logarithm of hourly earnings using data on the weekly number of working hours.[1] Moreover, the wage variables in the ECHP do not include elements such as performance-related and in-kind payments, that can be an important part of the individuals' total earnings (particularly in the private sector). Other differences between sectors stemming from pension entitlements, health-care schemes or implicit benefits such as life-long job protection are also difficult to quantify. Finally, it is worth highlighting that, while most of the other variables refer to the year of the interview, those related to individual earnings report values for the year prior to the survey. Thus, for the purpose of our analysis, we consider that the period covered is actually 1993-2000.

The information on educational attainment is restricted to a very general categorical variable that distinguishes between third level education and two stages of secondary education. There is no information on the experience accumulated by the individuals since joining the labour force. However, it is possible to identify the tenure in the current job. The inclusion of the "age" variable in our regressions mitigates the absence of data on the total work experience.

The sample was selected according to several criteria. In particular, we excluded the observations corresponding to individuals that are not working with an employer in paid employment, do not have a full-time job, do not report the employment sector, are not of working age (*i.e.*, that are younger than 15 or older than 65 years) or are not followed for, at least, two consecutive years. Moreover, we detected that the sample referring to Belgium suffered considerable depletion along the eight years of the ECHP. As the small size of the Belgian sample may compromise the validity of the results, this country is excluded from the analysis. Denmark, Sweden and the United Kingdom were also excluded. By restricting the sample according to these conditions, we ended up with 206,468 observations, that correspond to 46,752 individuals, for 10 euro area countries.

[1] The observations for which the computation resulted in an amount of hourly earnings below the 1st or above the 99th percentile of the distribution for each country-year pair were excluded from the sample.

3 Exploratory analysis

Table 3.1 compares the share of public sector employees in total employment, as reported in the Eurostat's NewCronos database with the sub-sample of ECHP we are using. It shows that the composition of employment by sector in the sample is close that what would be obtained in official statistics (with the exception of Germany in 1993 and Finland).

Table 3.1 Proportion of public sector employees in total employment (per cent)

	Eurostat		ECHP	
	1993	2000	1993	2000
Germany	21.3	25.1	32.7	26.2
Netherlands	30.3	28.3	28.6	25.4
France	29.3	29.5	25.8	24.9
Ireland	24.6	22.1	23.5	22.0
Italy	28.1	29.0	38.6	37.5
Greece	29.3	28.8	46.4	39.4
Spain	21.8	20.6	32.8	25.8
Portugal(1)	21.0	21.5	22.5	21.1
Austria(2)	22.0	22.3	21.2	22.2
Finland(2)	32.3	28.9	46.2	39.3

Sources: Authors' calculations based on data from the ECHP and Eurostat's Labour Force Survey.
(1) The Labour Force Survey data features a structural break in the case of Portugal. Thus, as an alternative, we use National Accounts data that are only available from 1995 onwards.
(2) For Austria and Finland the earlier figures refer to 1995.

Approximately 86.8 per cent of the individuals that report being a public sector employee have remained in that sector during the entire time span covered by the panel, while 7.6 per cent report having worked in both sectors. Table 3.2 compares public and private sector employees across a set of individual characteristics as of time of the first and last waves of the ECHP. It shows, in particular, that public employees are, on average, older and have more tenure than private sector workers. In every country in our sample with the exception of Greece in 1993, the proportion of women in the public sector is higher than in the private sector. Finally, Table 3.2 indicates that the percentage of individuals reporting tertiary educational level is considerable higher amongst public employees.

The fact that public and private sector employees are different in terms of the individual characteristics depicted in Table 3.2 brings about differences in what regards their hourly wages. In fact, as shown in Table 3.3, in general,

Table 3.2 Public *vs* private sector employees: summary statistics

	Age (average, years)		Married (percentage)		Males (percentage)		Terciary Education (percentage)		Tenure (average, years)	
1993	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private
Germany	40.6	39.0	70.3	69.8	58.3	71.8	35.2	20.9	13.7	11.2
Netherlands	39.9	37.5	65.3	66.5	67.9	78.4	41.2	17.2	13.9	11.4
France	40.4	38.4	65.8	63.7	42.6	65.4	34.0	21.4	16.3	12.6
Ireland	39.5	35.3	75.6	57.3	54.8	71.3	37.6	16.1	16.2	10.9
Italy	41.9	36.6	80.6	64.1	63.5	69.9	11.0	4.3	17.7	13.3
Greece	40.4	36.5	80.0	65.5	68.9	65.2	38.5	21.9	15.6	9.4
Spain	40.8	38.7	74.6	68.5	60.5	75.4	50.0	18.3	15.9	12.3
Portugal	40.9	36.6	79.3	65.4	46.9	64.9	19.0	2.6	16.3	11.7
Austria(1)	39.7	36.0	67.8	57.6	54.3	71.9	21.0	4.2	10.7	8.6
Finland(1)	43.2	40.1	76.0	66.2	39.7	62.1	51.3	32.4	10.8	8.7
2000										
	Age (average, years)		**Married** (percentage)		**Males** (percentage)		**Terciary Education** (percentage)		**Tenure** (average, years)	
	Public	Private	Public	Private	Public	Private	Public	Private	Public	Private
Germany	42.5	40.6	66.6	68.0	52.9	68.9	43.5	26.6	11.7	9.7
Netherlands	42.8	39.6	61.5	62.3	63.9	76.7	25.4	13.7	11.5	9.1
France	43.0	39.6	65.6	57.9	42.1	61.7	38.2	32.9	15.5	11.4
Ireland	43.1	36.7	70.0	56.4	55.2	66.7	49.3	21.2	15.0	8.3
Italy	43.8	37.7	76.0	66.7	56.4	68.6	17.4	6.7	16.0	10.7
Greece	42.4	36.3	75.6	59.5	60.6	64.1	45.6	21.6	14.5	7.6
Spain	41.4	37.0	70.9	63.2	55.0	68.9	61.2	31.3	13.4	8.3
Portugal	40.9	36.4	74.3	66.9	40.9	61.2	32.0	6.2	13.9	9.8
Austria	41.4	37.6	64.5	54.0	53.6	70.2	26.5	5.5	14.2	11.0
Finland	44.1	40.0	71.4	58.6	35.9	62.6	57.3	35.7	12.0	8.3

Sources: Authors' calculations based on ECHP microdata.
Notes:(1) Data for Austria and Finland refer to 1994 and 1995, respectively.

the average hourly wage is higher among public sector employees. In the first wave of the ECHP the difference averages at 17.3 per cent, ranging from 3.2 per cent in Finland to 36.0 per cent in Portugal. In the last year of the survey, the average gap stands at 17.4 per cent, Portugal continues to present the highest public-private wage differential (36.6 per cent), while France features the smallest gap (1.8 per cent).

As shown in Figure 3.1, the raw wage gap between the public and the private sectors narrowed along the 1993-2000 period in most countries. Greece, Ireland, Italy and Portugal are the only exceptions, with the gap widening by 10.6, 4.7, 1.0 and 0.6 percentage points, respectively. It is noteworthy that

Table 3.3 Hourly wage: summary statistics
(in euro[1])

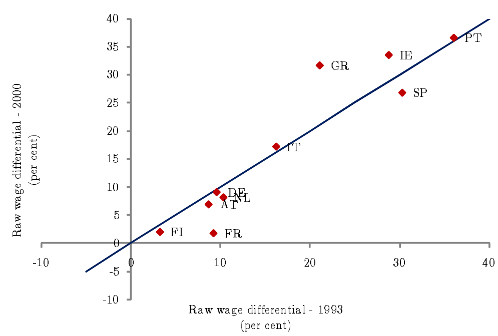
1993									
	Mean			**Standard Deviation**		**Median**		**Skewness**	
	Public	Private	Differential (per cent)	Public	Private	Public	Private	Public	Private
Germany	8.9	8.0	9.6	3.5	3.1	8.0	7.6	1.2	1.0
Netherlands	8.9	7.9	10.3	2.4	2.3	8.5	7.5	1.0	1.1
France	9.6	8.7	9.2	4.1	4.1	8.6	7.7	1.9	1.7
Ireland	9.2	6.5	28.8	3.6	3.0	8.5	6.0	0.7	1.1
Italy	6.2	5.2	16.2	1.6	1.6	5.8	4.8	1.9	1.4
Greece	3.5	2.7	21.1	1.0	1.1	3.3	2.5	0.9	1.5
Spain	6.8	4.7	30.3	2.5	2.1	6.2	4.2	1.0	1.5
Portugal	3.5	2.2	36.0	1.7	1.1	3.0	1.9	1.0	2.0
Austria[2]	8.6	7.9	8.7	2.6	2.7	8.1	7.5	0.8	0.9
Finland[2]	7.5	7.2	3.2	2.1	2.0	7.0	6.8	1.0	1.1

2000									
	Mean			**Standard Deviation**		**Median**		**Skewness**	
	Public	Private	Differential (per cent)	Public	Private	Public	Private	Public	Private
Germany	10.1	9.2	9.1	3.4	3.3	9.5	8.6	0.9	1.0
Netherlands	10.7	9.9	8.2	3.0	3.2	10.4	9.2	1.1	1.2
France	10.5	10.3	1.8	3.8	4.5	9.8	9.2	1.1	1.5
Ireland	16.4	10.9	33.5	7.1	3.9	14.7	10.3	1.0	1.0
Italy	7.9	6.5	17.2	2.2	2.0	7.3	6.1	1.5	1.4
Greece	6.2	4.3	31.7	2.2	1.7	5.7	3.8	1.0	1.8
Spain	8.9	6.5	26.8	3.3	2.9	8.1	5.8	0.7	1.5
Portugal	5.3	3.4	36.6	2.6	1.6	4.5	2.8	1.1	2.4
Austria	8.8	8.2	6.9	2.5	2.3	8.2	7.9	1.2	0.9
Finland	9.2	9.0	2.0	2.5	2.5	8.8	8.4	1.1	1.1

Sources: Authors' calculations based on ECHP microdata.
Notes:(1) The information on wages and salaries was originally expressed in national currency, but we converted it in euro to ensure cross-country comparability. **(2)** Data for Austria and Finland refer to 1994 and 1995, respectively.

results in Campos (2011) suggest that, in the set of countries in our sample, consolidation efforts in the period prior to the adoption of the euro are were not substancial: only a limited number of small episodes of fiscal adjustment was identified, none of which was persistent in reducing the fiscal deficit and public debt ratios. In terms of monthly wages, the gap between public and private sectors is considerably less pronounced (averaging 13.0 per cent and 12.1 per cent, respectively in the first and last waves), which is explained by the fact that the average number of working hours per week is higher in the private sector (a feature that is observable in every country in our sample).

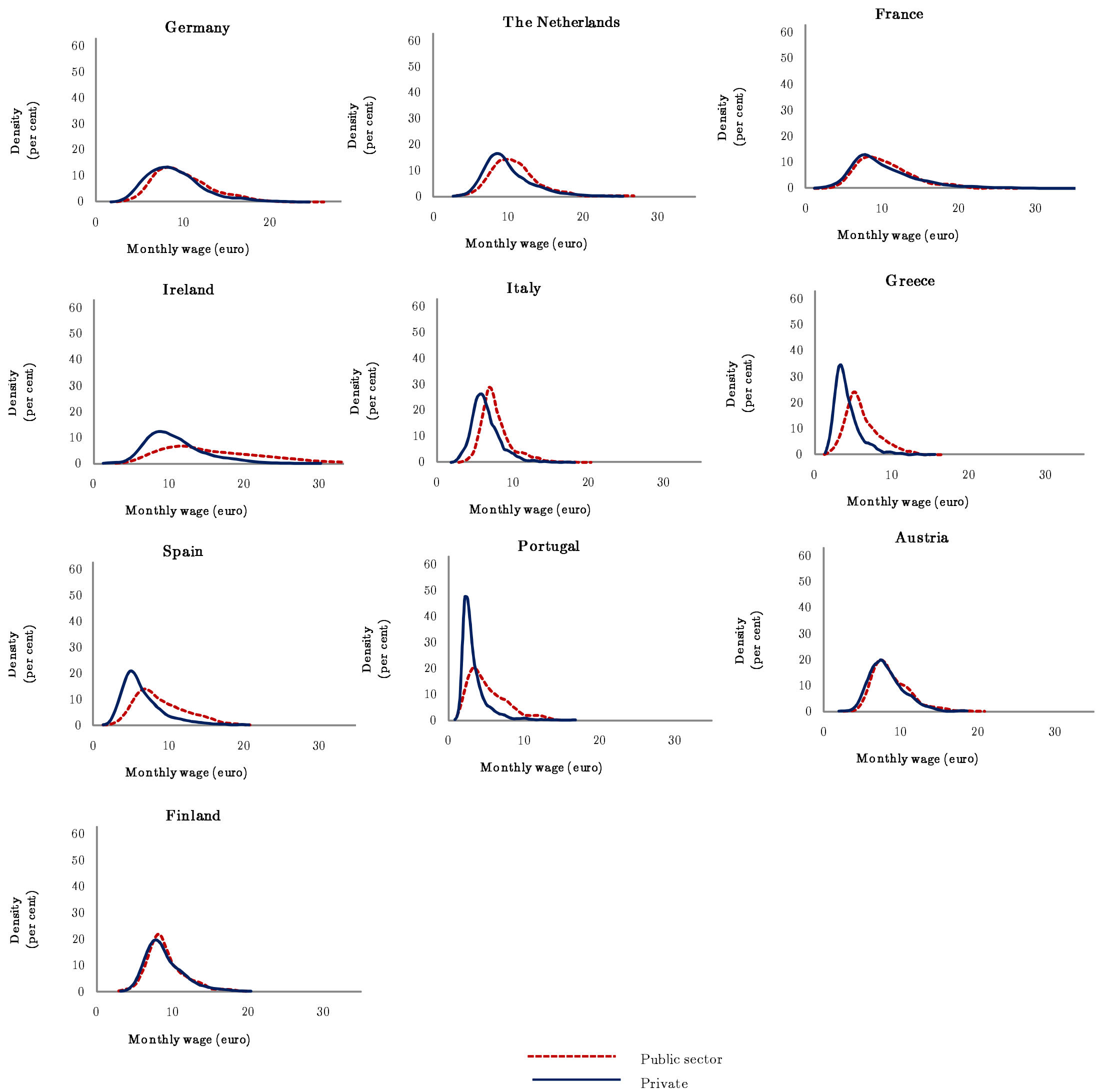
Figure 3.1 Public *vs* private sector: Raw wage differential



Sources: Authors' calculations based on ECHP microdata.
Notes: The raw wage gap is measured as the difference between the public and private sector average wages as a percentage of the first.

We also find important differences between the two sectors' wage distributions. In the first place, the coefficients of variation, computed using the figures in Table 3.3, are generally higher in the private sector, implying that the wage distribution tends to be more compressed in the public. Figure 3.2 shows that the densities vary greatly across countries. As a matter of fact, there are countries, such as Germany, France and Ireland, in which both sectors' wage distributions are relatively disperse, but in Italy, Greece and Portugal they feature heavier tails. A within-country comparison between the distributions referring to the public and private sector wages also points out several interesting differences. On the one hand, in the cases of Germany or Austria, the wage distribution in the private sector is very similar to that of public employees. On the other hand, data concerning countries such as Greece, Spain, Portugal and Ireland imply that the distributions of public and private sector wages are quite different, with the distribution estimated for the private sector centered in the left hand-side and the probability mass concentrated around lower wage levels.

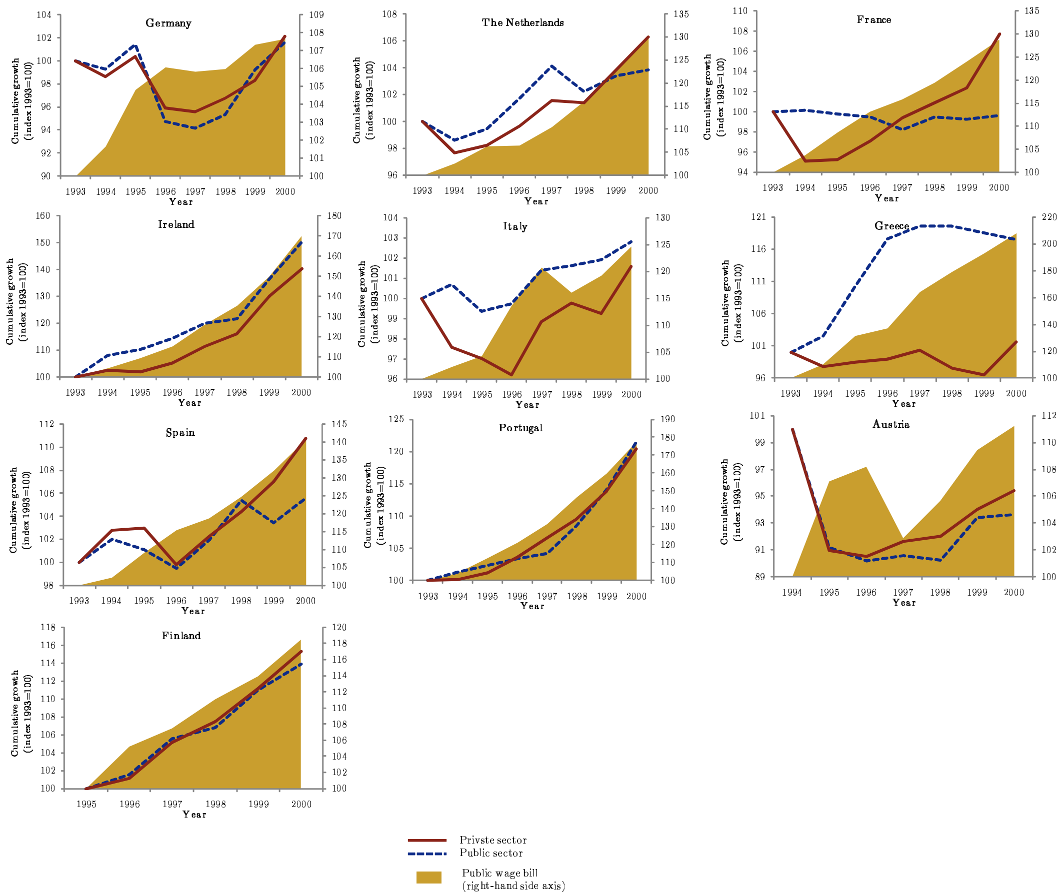
Figure 3.2 Estimated density functions for public and private sector hourly wages - 2000



Sources: Authors' calculations based on ECHP microdata.
Notes:The figures depict, for each country, the distribution of hourly wages estimated using the Epanechnikov kernel function.

Figure 3.3 shows that in our ECHP sample wages in the public and private sectors typically feature similar growth paths. On average, real public wages increased by 11.0 per cent between 1993 and 2000 (in cumulative terms) in the set of countries in our sample. The growth rate of public sector wages ranges between 50.3 per cent, obtained for Ireland, and -6.3 per cent, computed for Austria. In general, wages increased more sharply in the private sector, except in the cases of Ireland, Italy, Greece and Portugal. Figure 3.3 also depicts the evolution of the public sector wage bill along the period covered by the ECHP, showing that it increased, in many cases considerably, in every country in our sample. All in all, these pieces of evidence are consistent with a feature documented in Alesina, Ardagna and Galasso (2008): in the period leading to the adoption of the euro, the countries that were then engaged in fulfilling the Maastricht criteria experienced a certain degree of wage moderation. This moderation was naturally less obvious in a set of countries coinciding with those for which results in Campos (2011) suggest that consolidation efforts in the period prior to the inception of the euro area were not significant. However, the need to comply with the requirements for adopting the single currency may have offered European governments a window of opportunity to eliminate the markup rate that the literature generally associates with public service. In order to assess the validity of this idea, in what follows we analyse how the public-private wage gap changed along the period corresponding to the run-up to the inception of the euro area.

Figure 3.3 Public vs private sector: Cumulative growth rate of real wages and the evolution of the government wage bill



Sources: Authors' calculations. Data on public and private sector wages is from the ECHP, deflated by the annual Consumer Price Index from the Ameco database. Data on the public wage bill is from OECD.

4 Estimation of the public-private wage gap: empirical strategy

In the previous section we point out that public and private sector employees differ in terms of their personal characteristics. In particular, we provide evidence that, on average, public employees are older, have more tenure and higher levels of education than workers in the private sector. These features can explain the existence of the raw wage differential depicted in Figure 3.1, as well as the differences between both sectors' wage distributions, depicted in

Figure 3.2. These raw differences may reflect the sorting of workers between sectors or distinct distributions of employee attributes and not necessarily a true sector wage differential. Hence, to assess whether individuals that otherwise share the same productivity-related characteristics are paid differently because they work in the public sector, those characteristics must be controlled for.

Previous works on this matter include Disney and Gosling (1998), focusing on data for the United Kingdom, Jurges (2002) and Melly (2002), that analise the German case, Lucifora and Meurs (2004), that use French, Italian and British data, Boyle, McElligott and O'Leary (2004), that focused on Ireland, Bargain and Melly (2008), that shed light on the public sector pay gap in France, and studies by Portugal and Centeno (2001) and Campos and Pereira (2009), applied to Portugal. The public wage gap varies considerably across countries, reflecting differences in the institutional settings that govern employment and wage determination both in the public and the private sector. In general, these studies provide evidence of the existence of a positive public-private wage gap. This gap tends to be higher in the case of women and typically narrows as one moves up the earnings distributions.

In order to identify the existence of significant public-private wage gaps, the most extensively used strategy consists in a wage regression including work-related characteristics of individuals and a dummy indicating public sector employment. The coefficient referring to this dummy is interpreted as a premium, if positive, or a penalty, if it is negative. As Melly (2002) points out, the dummy-based approach has an important shortcoming: implicitly, it assumes that the returns to individual attributes and job characteristics are equal in the public and the private sectors and limits the effect of the sector of employment to a single coefficient. An alternative approach consists in the break-down of the wage gap in two components: differences between the public and private sector in terms of measurable attributes of its workers and differences in the returns to the same attributes. The latter difference is interpreted as the wage premium. These differences may be evaluated at the means of the two sectors wages distributions (as in the seminal works of Blinder (1973) and Oaxaca (1973)) or at different quantiles (as in Machado and Mata (2001)). The analysis undertaken in this paper relies on the dummy approach, applied to cross-section and longitudinal data.

4.1 Cross-sectional approach

We begin by estimating the public-private wage gap using cross-sectional methods. In particular, to obtain estimates of the impact of working in the public sector at the mean of the distribution of wages, we run Ordinary Least Squares (OLS) regressions using a basic Mincerian specification on data for each country and each year, pooling data for public and private sector employees:

$$ln(wage_i) = X_i'\beta + \delta P_i + \varepsilon_i, \tag{4.1}$$

where the dependent variable, $ln(wage_i)$, is the logarithm of the hourly wage, X_i is a vector representing the set of individual characteristics described in Table 4.1[2], P_i represents a binary variable that equals one if individual i is a public sector employee and zero otherwise and ε_i is a random error term. The parameter δ represents the public-private wage gap.

Results based on OLS estimates provide an incomplete view on the public-private wage gap. In fact, such regressions are estimated at the mean and, in Section 3, we show that the wage distributions corresponding to the public and the private sector are considerably different. Therefore, it is relevant to assess how the gap varies along the distribution. In order to do so, we follow the quantile regression (QR) methodology introduced by Koenker and Bassett (1978). In addition to providing insight on how the marginal effect of the sector of employment on the logarithm of wages differs at different points of the distributions, models for conditional quantiles are more efficient than OLS estimators when the assumption of normality of the error term fails (see Koenker and Bassett (1978)).

In this framework, to estimate the public-private wage gap across the distribution, we assume that

[2]It should be mentioned that, although differences in individual characteristics are relevant in explaining pay differentials between civil servants and their private sector counterparts, there are other factors that may also play a role. In particular, public employees commonly carry-out tasks that are exclusively performed in the public sector and in many cases the goods and services produced do not find substitutes in the private sector. This results in considerably distinct occupational structures in the two sectors. To control for these differences, several authors include indicator variables for occupational categories in the earnings equations. We chose not to do it because the respective coefficients would partially capture the effect of the sector of employment on wages and we want such effect to be uniquely captured by a public sector dummy.

Table 4.1 Definition of the covariates

Variable	Description	Type
male	=1 if the individual is a male	Binary
age	age, measured in years	Continuous
age^2	age squared	Continuous
married	= 1 if the individual is married	Binary
educ_third	= 1 if the individual reports terciary educational level	Binary
educ_sec	= 1 if the individual reports higher secondary educational level	Binary
educ_less_sec	= 1 if the individual reports less than higher secondary educational level (omitted)	Binary
tenure	number of years in the current job	Continuous

$$ln(wage_i) = X_i'\beta_\theta + \delta_\theta P_i + \varepsilon_{\theta_i}$$

and estimate

$$Quant_\theta[ln(wage_i)|X_i, P_i] = X_i'\beta_\theta + \delta_\theta P_i \ , \tag{4.2}$$

where $Quant_\theta[ln(wage_i)|X_i, P_i]$ is the θ^{th} quantile of the distribution of the logarithm of wages, conditional on the set of covariates X_i described in Table 4.1 and P_i. δ_θ represents the public-private wage gap at the θ^{th} quantile, with $\theta = \{0.10, 0.25, 0.50, 0.75, 0.90\}$. Note that, while in (4.1) δ represented the mean wage gap, in this case we estimate θ different coefficients, that measure the marginal effect of the employment sector in the logarithm of wages at θ different points of distribution.

4.2 Longitudinal approach: Accounting for the role of unobservable characteristics

The cross-sectional methods presented so far do not take into account unobserved (and thus unmeasurable) individual heterogeneity. In fact, there are features that can differently affect individuals in the two sectors but cannot be assessed by simple raw wage comparison and remain outside the scope of conditional on observables estimations. This includes not only unobserved personal skills that may affect wages, but also individual preferences determining the sorting of employees between the sectors (for instance, the utility obtained from working in the public sector *per se* or from benefiting from a stable employment relationship). These aspects determine unmeasured individual heterogeneity and may generate self-selection into one of the sectors, in which case cross-sectional results are hampered by endogeneity. Typically, the literature addresses the non-exogenous nature of sector selection using either instrumental variables methodologies or two-stage models based on the joint specification of selection and wage regressions. As Bargain and Melly (2008) and Bargain and Kwenda (2009), we take advantage of the longitudinal structure of our data to control for selection.

We begin by using a standard fixed effects model to obtain evidence regarding developments at the mean. In particular, for each individual i and in each period t, it is assumed that

$$\begin{aligned} ln(wage_{i,t}) = \gamma_t + \alpha_i + X'_{i,t}\beta + \delta P_{i,t} + v_{i,t} \ , \\ i = 1, ...N, t = 1, ..., T \end{aligned} \tag{4.3}$$

where $v_{i,t}$ is an i.i.d. normally distributed random term. The parameter $\hat{\delta}$ is the estimate for the constant public-private wage gap. The parameters γ_t and α_i account, respectively, for time effects and unobserved individual heterogeneity. To control for the time-specific effects, we include dummies for the first seven waves of the panel. The same strategy cannot be used o control for the individual-specific effects given the short length of the panel and the large number of individuals. These factors may be dealt with by random or fixed methods, but the choice between the two approaches requires a more careful analysis.

In particular, choosing between random or fixed effects models as the correct approach to control for the unobserved heterogeneity is underpinned by a fundamental decision related to exogeneity assumptions as regards α_i. In a random effects framework it is assumed that α_i is completely random, which implies that it is totally uncorrelated with the regressors. The random effects model yields estimates for every coefficient in (4.3) but it is inconsistent if the strict exogeneity assumption does not hold. In the alternative fixed effects (or *within*) framework, the estimator is consistent even if the heterogeneity determined by worker-specific unobserved characteristics, α_i, is correlated with the regressors, provided there is exogeneity as regards the idiosyncratic error term $v_{i,t}$. Under the null hypothesis that the individual-specific effects are purely random, both estimators are consistent and yield similar results, while under the alternative consistency holds only in the case of the *within* model. In order to test these hypothesis, we undertook a Hausman test for each country in our sample. In every case, the overall test provides evidence that the probability limit of the two estimators is different. Therefore, the test supports the rejection of the hypothesis of consistency of the random effects model, thus in what follows we account for individual heterogeneity using the fixed effects methodology.

To estimate the public-private wage gap while controlling for unobserved heterogeneity, the first step consists on the removal of the fixed effects represented by α_i. This is done by time-demeaning the data using the *within* transformation undertaken by subtracting to (4.3) the corresponding model for individual means ($\overline{ln(wage)}_i = \overline{X}_i'\beta + \delta\overline{P}_i + \overline{v}_i$).

As mentioned above, OLS estimation of the transformed model is consistent as long as the regressors are not correlated with the time-variant component of the error, $v_{i,t}$. Note that since the application of this methodology is based on an estimation on pooled data for employees from the public and private sectors, it has also implicit the assumption that the returns to the unobservable factors are equal in both sectors (Boyle et al. (2004)). Moreover, the wage gap estimated using this approach, $\widehat{\delta}$, is determined by the individuals that worked in both the public and the private sectors along the period covered in the panel, but, as stated in Bargain and Kwenda (2009), non-random movements between sectors (for instance, as a response to *changes* in unobservable factors) are not controlled for. Note, additionally, that this approach does not allow the estimation of coefficients of time-invariant regressors and the estimates may be imprecise in the case of covariates that vary little overtime (see Cameron and Trivedi (2009) for further details). Although the sector of employment is generally stable, in our panel there is some variation as regards this variable (overall, we identify over 5,000 switches along the period covered), therefore we are confident that the fixed effects estimation provides a fairly good control for our main covariate of interest.

We are also interested in assessing how the gap varies across the wage distribution while still accounting for the unobserved individual-specific heterogeneity. However, the estimation of a panel data fixed effects model within a QR framework is not straightforward. A possible approach would rely on the treatment of each individual effect, α_i, as a parameter to be estimated with the remaining covariates using the standard QR method. However, this is not feasible in short micro-panels such as the one we are using, given that, when the number of coefficients goes to infinity but the number of time periods is relatively small, the incidental parameters problem harms the consistency of the estimators (Kato and Galvão (2010)). Moreover, the differencing techniques commonly used to cope with time invariant effects - including the time-demeaning within transformation - are not applicable: Quantiles, as opposed to expectations, do not commute with linear transformations, thus the quantiles of a difference do not necessarily equal a difference in the quantiles (Ponomareva (2010)).

Recent - and pretty much ongoing - research has attempted to overcome these problems using different strategies. For instance, based on the assumption that α_i has a pure location shift effect on the conditional distribution of the dependent variable (in the sense that it does not change along the distribution), Koenker (2004) suggests an approach based on the penalized estimation of the individual parameters. A similar approach is suggested in Galvão (2008), in the context of dynamic panel data models, but in this case α_i is allowed to vary with the quantiles. Kato and Galvão (2010), on its turn, studies the asymptotic properties of an estimator derived from the smoothing of the standard QR objective-function and proposes a bias-correction method.

In our application we use an intuitive and easy to implement method that is proposed in Canay (2010) and that we briefly describe.

Consider the generic model

$$\begin{aligned} Quant_\theta(y_{i,t}|X_{i,t}) &= \alpha_i + X'_{i,t}\beta_\theta \ , \\ \text{with } y_{i,t} &= \alpha_i + X'_{i,t}\beta_\theta + \upsilon_{\theta_{i,t}} \end{aligned} \tag{4.4.i}$$

This model differs from the standard QR specification due to the presence of the unobserved individual-specific heterogeneity, α_i. As in Koenker (2004), Canay (2010)'s approach is based on the assumption that α_i operates as simple location shifter on the conditional distribution of $y_{i,t}$.[3] Exploiting this ideia, Canay (2010) suggests the following two-step procedure:

Step 1 Using a $\sqrt{NT}$-consistent mean estimator for β, estimate

$$y_{i,t} = \alpha_i + X'_{i,t}\beta + v_{i,t}, \tag{4.4.ii}$$

Given that α_i is time-invariant, the OLS estimator in first-differences is a suitable method to use in this step. The results of this estimation, $\widehat{\beta}$, are then used to estimate the individual heterogeneity parameters,

$$\widehat{\alpha_i} = T^{-1}\sum_{t=1}^{T}[y_{i,t} - x_{i,t}\widehat{\beta}] \tag{4.4.iii}$$

Step 2 Using the standard QR methodology presented in Koenker and Bassett (1978), estimate

$$Quant_\theta(\widehat{y_{i,t}}|X_{i,t}) = X'_{i,t}\beta_\theta, \tag{4.4.iv}$$

with $\widehat{y_{i,t}} = y_{i,t} - \widehat{\alpha_i}$.

According to Canay (2010), this approach provides a $\sqrt{T}$-consistent and asymptotically normal estimator for β_θ, as long as:

1. $(y^*_{i,t}, X_{i,t}, \alpha_i) \sim i.i.d.$ and $E(\alpha_i) = 0$, where
   $y^*_{i,t} \equiv \widehat{y_{i,t}} - \widehat{r_i}$, with
   $\widehat{r_i} \equiv (\alpha_i - \widehat{\alpha_i})$.
2. For all $\theta \in \Theta$, $\beta_\theta \in \mathbf{B}$, where the parametric space $\mathbf{B}$ is compact and convex and Θ is a closed subinterval of $[0, 1]$.

[3]Note that it is theoretically possible to estimate a distributional shift for each individual, α_{θ_i}, but, taking into account the short length of our panel, it would be unrealistic. Although the assumption that α_i does not vary across the conditional distribution limits the kind of unobserved effects captured by the model by restricting them to affect all quantiles in the same way, note that the remaining covariates are allowed to change with the quantile of interest.

3. Y^* has bounded conditional on X density and $\prod(\beta,\theta,r) \equiv E[g_\theta(W,\beta,r)]$ has a Jacobian matrix such that

   $J_1(\beta,\theta,r) = \frac{\partial \prod(\beta,\theta,r)}{\partial \beta}$ is continuous and fully-ranked

   $J_2(\beta,\theta,r) = \frac{\partial \prod(\beta,\theta,r)}{\partial r}$ is uniformly continuous

   where

   $W = (Y^*, X)$ and $g_\theta(W,\beta,r) = \varphi_\theta(Y^* - X\beta + r)X$, with

   $\varphi_\theta(u) = \theta - 1(u < 0)$.

Under these assumptions, Monte-Carlo simulations for $T = 10$ and $N = 100$ provided in Canay (2010) show a bias slightly different from zero. For the sake of applicability and computational simplicity, a bias of this magnitude seems to be acceptable. Therefore, we used this method to assess how does the public-private wage gap change across the wage distribution.[4]

In particular, we estimate for each country

$$Quant_\theta[ln(\widehat{wage}_{i,t})|X_{i,t}, P_{i,t}] = \gamma_{\theta_t} + X'_{i,t}\beta_\theta + \delta_\theta P_{i,t} \ , \qquad (4.5)$$

assuming $ln(\widehat{wage}_{i,t}) = \gamma_{\theta_t} + X'_{i,t}\beta_\theta + \delta_\theta P_{i,t} + v_{\theta_{i,t}}$, where

$$ln(\widehat{wage}_{i,t}) = ln(wage_{i,t}) - \widehat{\alpha}_i.$$

In (4.5) γ_{θ_t} accounts for time-specific fixed effects (implemented as dummies for the seven first waves of the panel), $\widehat{\alpha}_i$ represents the estimated individual heterogeneity and the remaining parameters and variables assume the same meaning as in equation (4.2). The model is estimated for each quantile θ of the wage distribution, with $\theta = \{0.10, 0.25, 0.50, 0.75, 0.90\}$.

[4]To our knowledge, the only studies using QR on longitudinal data to address the issue of wage gaps are Bargain and Kwenda (2009) and Bargain and Melly (2008). The latter relies solely in Koenker (2004)'s approach, while the former also used Canay (2010)'s methodology (with similar results).

5 Results

5.1 Cross-sectional approach

The results of the estimation of the public-private wage gap based on (4.1) for each country and for the first and last waves of the panel are summarized in Table 5.1.[5] This table shows that the evolution of the conditional gap is similar to the trend obtained for the raw differential (in Figure 3.1), but its level is - in some cases considerably - lower. This suggests that, although the better human capital endowments of civil servants explain part of the wage gap between them and their private sector counterparts, a non-negligible part remains attributable to a pure sector effect. In most countries in our sample the unexplained part is favourable to public employees but the results vary greatly across countries. The highest average gaps were obtained for Portugal (19.8 per cent), Ireland (18.9 per cent) and Greece (17.6 per cent). On the contrary, the smaller gaps correspond to France and Austria (2.9 and 3.0 per cent, respectively), while Finland is the only country for which the estimate for the public sector coefficient is negative across the entire period. Table 5.1 also shows that the average public-private wage gap decreased along the time-span covered in our analysis. Nonetheless, small increases are observable in the cases of Germany and the Netherlands, while in Greece and Ireland the gap considerably widened.

The estimates in Table 5.1 are broadly in line with previous literature on public-private wage gaps. For instance, using data from the Bank of Italy Survey of Household Income for 1998, Lucifora and Meurs (2004) presents figures that are very similar to those we estimate for Italy using the 1998 wave of ECHP, but their results for France point to higher gaps. Bargain and Melly (2008) also obtained higher values for the public-private wage gap in France, using data from the French Labour Force Survey for the 1991-2002 period. Campos and Pereira (2009) used the Portuguese Public Administration Census and matched employer-employee data from "*Quadros de Pessoal*" to estimate the public-private wage gap in Portugal in 1996 and 1999 and obtained figures very close to ours. Finally, Boyle et al. (2004) estimated the wage gap in Ireland using the ECHP and focusing on the

[5] The full set of results of OLS estimations based on (4.1) (available from the authors upon request) shows that, in the majority of cases, the coefficients have the expected sign and are statistically significant. In particular, our results for every country point out that, both for men and women, earnings are positively related to tenure, age (although there is evidence of non-linearity), and third-level education.

same period and, although the covariates in the regressions and the sample selection criteria are slightly different, obtained essentially the same results.

Table 5.1 Public-private wage gap at the mean
(per cent)

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Average**
Germany	7.9*	8.2*	9.2*	8.6*	8.4*	8.1*	10.4*	9.5*	8.79
Netherlands	3.6*	5.3*	5.1*	6.6*	7.5*	6.5*	5.6*	4.4*	5.58
France	3.9*	7.7*	7.6*	5.7*	2.8*	0.2	-1.5	-3.2*	2.90
Ireland	16.3*	21*	21.9*	19.2*	18.6*	16*	17.3*	20.5*	18.85
Italy	10.3*	12.1*	10.3*	12.1*	11*	10.7*	11*	10.1*	10.95
Greece	9.6*	12.5*	15.8*	20.8*	20.1*	21.8*	21.8*	18.2*	17.58
Spain	20.3*	18.8*	17.6*	15.3*	15.2*	16.4*	13.5*	13.8*	16.36
Portugal	22.9*	23*	21.3*	19.6*	16.7*	17.4*	17.8*	19.7*	19.80
Austria	n.a.	3.9*	4.3*	3*	2.8*	2.2	3.4*	1.5	3.01
Finland	n.a.	n.a.	-0.2	-0.1	-0.1	-1.3	0	-1.6	-0.55
Average	11.85	12.50	11.29	11.08	10.30	9.80	9.93	9.29	10.33

Sources: Authors' calculations based on ECHP microdata.
Notes: The table presents, for each country-year pair, the estimated coefficient for the public sector dummy in equation (4.1), multiplied by 100 and obtained using OLS and a robust variance-covariance matrix. Coefficients tagged with "*" are significant, at least, at the 10 per cent level.

Regarding the estimates of the wage gap across the distribution, based on the estimation of (4.2) for each country and repeated for each of the eight years covered by the ECHP, they are synthesized in Table 5.2. The table shows that the gap generally decreases with the wage level, suggesting that the public sector compresses the wage dispersion, reducing within-group pay inequality. It also shows that the narrowing of the public-private differential between 1993 and 2000 is noticeable in most countries across the entire distribution, albeit more obvious below the median. However, it should be highlighted that the decrease in the differentials across the distribution is not as obvious as in previous studies, a feature that may be justified by the fact that we are estimating the premia using hourly wages (i.e., controlling for differences in the number of working hours in each sector), while monthly wages are generally used.

Table 5.2 The public-private wage gap across the distribution

	1993			1996			1999		
	Q25	Median	Q75	Q25	Median	Q75	Q25	Median	Q75
Germany	9.6*	6.7*	6*	10.9*	6*	4.7*	12.4*	7.6*	7.6*
Netherlands	5.8*	4.5*	2.8*	8.4*	7.8*	5.9*	8.2*	7.8*	4.5*
France	7.5*	4.3*	-0.6	7.2*	5.2*	2.4	1.8	-2.1	-4.9*
Ireland	17.2*	14.8*	14.2*	18.2*	16.3*	16.3*	16.4*	14.1*	13.7*
Italy	14.1*	10.4*	9.5*	13.3*	11.5*	10.5*	11.4*	10.6*	11.6*
Greece	15.2*	10.8*	5.5*	24.2*	21.8*	20*	24.5*	19.7*	21.9*
Spain	22.8*	18.9*	16.8*	19*	14.5*	9.7*	15.1*	12.6*	10.3*
Portugal	23.6*	20*	20.7*	16.6*	19.2*	21*	19.5*	17.7*	14.7*
Austria	-	-	-	3.1*	4.7*	3.5*	3*	4.2*	2.3
Finland	-	-	-	1.9*	-0.9	-1.9	0.8	-0.6	-2.5*

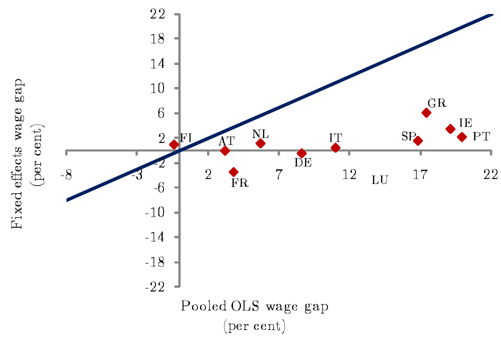
Sources: Authors' calculations based on ECHP microdata.
Notes: The table presents, for each country-year pair, the estimated coefficient for the public sector dummy in equation (4.2), multiplied by 100. Coefficients tagged with "*" are significant, at least, at the 10 per cent level.

5.2 Longitudinal approach: the public-private wage gap and the role of unobservable characteristics

A first assessment of the role of unobservable attributes in explaining pay differences between public and private sector employees can be drawn from the analysis of Figure 5.1. This figure provides a comparison between the coefficients estimated using fixed effects and those obtained through a pooled-OLS approach (with time-dummies).

Figure 5.1 shows that the estimates for the public-private wage gap based on the fixed effects approach are, in general, lower than those obtained using the pooled approach. According to Bargain and Melly (2008), this fact suggests a positive selection effect determining that better-endowed individuals choose to work in the public rather than in the private sector. The only exception refers to Finland, in which case pooled-OLS estimates yield penalties associated with public employment that are attenuated when unobserved and time-invariant factors are taken into account. Note that, while the OLS-based estimates are generally statistically different from zero, the fixed effects estimator typically yields non-significant mean gaps. The only countries for which our findings suggest that the average gap is not null are Greece, Ireland, Portugal and the Netherlands. Thus, these results suggest

Figure 5.1 Public-private wage gap at the mean: the role of selection



Sources: Authors' calculations based on ECHP microdata.
Notes: The figure presents, for each country-year pair, the coefficient for the public sector dummy (multiplied by 100) estimated using fixed effects regressions (on the axis of ordinates) and pooled OLS (on the axis of abcissas). The covariates are those in Table 4.1.

that in most countries, once both observed and time-invariant unobservable factors are controlled for, there is no evidence of a positive wage gap between the public and the private sectors.

Next, we follow Bargain and Melly (2008) and let the wage gap vary over time by including in model (4.3) terms expressing the interaction between the public sector dummy and time dummies (omitting the one referring to the last year covered in the panel). The time-varying gap can be compared to that depicted in Table 5.1 and the differential between them can be attributed to the fact that we are now controlling for unobserved individual heterogeneity. Table 5.3 confirms, in the first place, that controlling for unobserved individual heterogeneity generally brings down the public-private wage gap and in several cases the results imply statistically significant penalties. Along the 1993-1999 time-span the magnitude of the gaps estimated using the fixed effects model appears to have increased.

The differential between results obtained by fixed effects and OLS suggests that the latter may be hampered by an upward bias stemming from the omission of relevant factors contributing to the determination of wages (and sector of employment). Note, however, that if the variation in the "sector" regressor is mostly cross-sectional and there is a relative stability over time, fixed effects estimates also tend to be imprecise (Cameron and Trivedi (2007)). Although we identify 2,888 changes from the public to the private sector and 2,554 switches in the opposite direction, we cannot rule out that

Table 5.3 Public-private wage gap at the mean along time: the role of unobservables
(per cent)

	1993	1994	1995	1996	1997	1998	1999	Average
Germany	-1.4*	-1.2*	-0.9*	-0.5*	-0.1	-0.5*	1.5	-0.4
Netherlands	0.5	0.9	1	2.6*	2.6*	1.9*	0.1	1.4
France	-4.5*	-1.5*	-0.4*	-0.9*	-2*	-2.9*	-4.9*	-2.4
Ireland	3.3	4.8*	3.5	4.6*	3.9*	3.1	0.3*	3.4
Italy	1.2	1.1	-0.6	1.3	0.9	0.3	0	0.6
Greece	-2.8*	-1.6*	1.8*	6.9*	7.5*	11.4*	10.6*	4.8
Spain	5.2*	4.3*	2.8*	2.3*	1.4*	1.3*	-1.7	2.2
Portugal	0.1*	1.7*	2.6*	1.2*	0.9*	1.4*	4.4*	1.8
Austria	-	0.4	0.9	-0.5	-0.3	-0.6	0.2	0.0
Finland	-	-	1.7	2.5*	0.9	-0.3	0.7	1.1
Average	0.2	1.0	1.2	2.0	1.6	1.5	1.1	1.2

Sources: Authors' calculations based on ECHP microdata.
Notes: The table presents, for each country-year pair, the estimated coefficient (multiplied by 100) for the public sector dummy in equation (4.3) including interaction terms between the public sector dummy and year dummies. Coefficients tagged with "*" are significant, at least, at the 10 per cent level.

our estimates are hampered by a lack of variability. Moreover, fixed effects results are particularly prone to attenuation bias arising from measurement errors. In fact, since the model is identified using a differencing of the data, the estimate for the coefficient associated to the variable "sector" is obtained based on switches between sectors. Thus, if this variable is miscoded or misreported, those switches did not actually happened, resulting in a measurement error that changes from wave to wave and that tends to bias the coefficient towards zero (Angrist and Pischke (2009)). This inconsistency caused by measurement errors may possibly offset the bias generated by the omitted factors. In order to assess to what extent is this issue actually affecting our results, we perform a series of robustness checks, summarized in Table 5.4.

Table 5.4 shows, in the first place, that the fixed effects and first-differences estimators yield very similar figures for the public-private wage gap and that restricting the sample to sector switches in only one direction does not result in dramatic changes in the coefficients. Notwithstanding, in most countries the positive fixed effects estimates for the public-private gap seem to be mostly driven by transitions from the private to the public sector. This

Table 5.4 Fixed effects estimations: robustness checks

	FE	First diff. OLS	FE, without Pri-Pub switches$^{(1)}$	FE, without Pub-Priv switches$^{(2)}$	FE, without "false" switches$^{(3)}$	FE, exogenous switches only$^{(4)}$
Germany	-0.4	-0.4	-0.5	0.6	-0.6	-0.2
Netherlands	1.2*	1.2*	1.3	2.2*	1.5*	1.0
France	-3.4	-2.6	-4.4	-3.1	-3.1	-2.4
Ireland	3.5*	5.2*	9.7*	2.7	4*	2.9*
Italy	0.5	1.4*	-0.4	0.7	0.1	0.3
Greece	6.1*	5.1*	6.8*	9.2*	7.0*	5.5*
Spain	1.6	1.3	0.9	3.1	1.8	1.5
Portugal	2.2*	2.7*	3.9*	1.4	2.5*	1.5*
Austria	0.0	-0.2	0.7	0.6	0.6	-0.1
Finland	1.0	1.5*	2.6*	-3.0*	0.8	0.9

Sources: Authors' calculations based on ECHP microdata.
Notes: The table presents the estimates of the coefficient of the public sector dummy (multiplied by 100), obtained assuming the following alternatives: **(1)** Excluding from the sample switches from the private to the public sector; **(2)** Excluding from the sample switches from the public to the private sector; **(3)** Excluding from the sample possibly false switches (to mitigate the probability of measurement errors, we exclude from the sample movements across sectors that are not accompanied by a reset of the job-specific tenure); **(4)** Considering only "exogenous" sector switches (identified as those that are motivated by factors that are exogenous to the individual: "obliged to stop by employer"; "end of contract/ temporary job"; "sale/ closure of own or family business"; "study / national service"). Coefficients tagged with "*" are significant, at least, at the 10 per cent level.

is particularly obvious in the case of Greece. It is also worth highlighting that the wage penalties associated with public employment estimated for Germany and France appear to stem from switches from the public to the private sector, as they are attenuated when transitions in that direction are excluded from the sample. Also noteworthy is the fact that corrections to mitigate problems likely to bias the fixed effects estimates (such as erroneous or endogenous sector switches) do not seem to have an impact on the magnitude and significance of the coefficients. Thus, the pieces of evidence provided in Table 5.4 suggest that the fact that fixed effects estimates are in most countries considerably lower than those obtained by pooled-OLS does not appear to stem from attenuation bias generated by measurement error. Such a relationship implies, instead, a positive selection effect that justifies that individuals with better human capital endowments prefer to work in the public rather than in the private sector.

The existence of a public sector effect can be further analysed by disentangling the differences between results obtained using OLS and fixed effects. In particular, such analysis is useful to assess whether the public-private conditional wage differential should be seen as an actual public sector premium, as a result of the sorting of individuals across sectors determined by their unobserved idiosyncratic characteristics or the combined effect of the two. In order to do so, we undertake an exercise similar to that in Gibbons and Katz (1992), focusing on the sub-sample of individuals constituted by sector switchers and assuming that there are only two moments in time: pre- and post-switch (respectively, $t = 1$ and $t = 2$).

We begin by estimating the pre-switch wage differential between the public and private sectors from the function

$$ln(wage_{i,1}) = X'_{i,1}\beta + \delta P_{i,1} + \varepsilon_{i,1}, \tag{5.1}$$

where the variables and parameters have the same meaning as in the previous equations. Again, $\hat{\delta}$ represents the public-private wage gap.

Second, we estimate the first-differenced equation:

$$\Delta ln(wage_{i,2}) = X'_{i,2}\beta + \rho\Delta P_{i,2} + \Delta\varepsilon_{i,2}, \tag{5.2}$$

where the dependent variable represents the percent change of the individual's hourly wage and the remaining variables are measured after the switch. Note that this estimation takes into account individual-specific and time-invariant unobservable factors, under the assumption that they are equally valued in the public and private sectors.

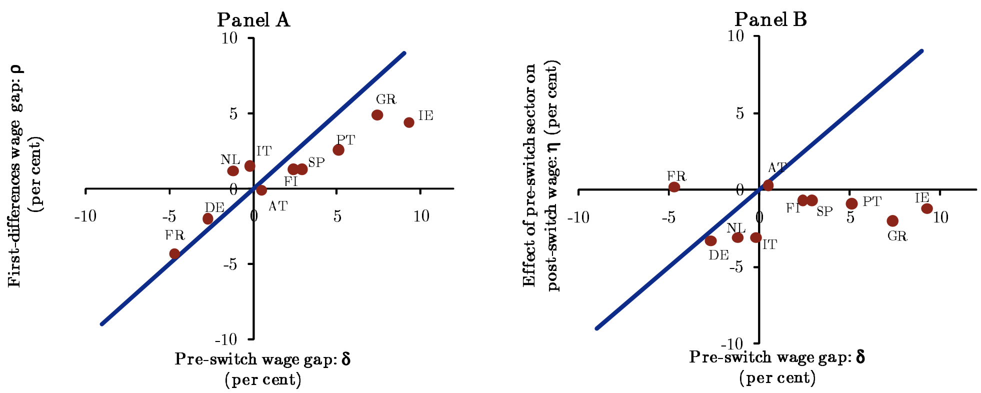
Finally, we estimate the effect of the pre-switch sector on post-switch wage:

$$ln(wage_{i,2}) = X'_{i,1}\beta + \eta P_{i,1} + \varepsilon_{i,2}, \tag{5.3}$$

where the dependent variable is the wage earned after the change of sector and the set of covariates in vector $X_{i,1}$ is measured before the switch. $P_{i,1}$ equals one if the switcher left the public sector and joined the private sector (and zero if the switch was in the opposite direction). Therefore, the impact of the pre-switch sector on the post-change earnings is given by $\hat{\eta}$.

As Gibbons and Katz (1992) points out, if the conditional wage differential given by $\hat{\delta}$ is exclusively due to individual-specific factors, the $\hat{\rho}$ parameter in equation (5.2) should be null. Moreover, one would expect that if individual unobserved heterogeneity is the sole explanation for public-private wage gap, employees in better-remunerated positions that switch sector would continue to earn higher post-switch wages. This would imply a positive relationship between the $\hat{\eta}$ and $\hat{\delta}$ parameters. On the contrary, if the wage differential is a true public sector premium, then $\hat{\rho}$ should equal $\hat{\delta}$.

Figure 5.2 Public-private wage differential: a "pure" public premium or the result of self-selection?



Sources: Authors' calculations based on ECHP microdata.
Notes: The figure plots the estimates for the public-private wage gap obtained from equation (5.1) against the $\hat{\rho}$'s, from (5.2), and the $\hat{\eta}$'s, from (5.3) (respectively in panels A and B). Note that, in both cases, the estimations were conducted only for the sub-sample of individuals that switch sectors along the 1993-2000 period.

Results in Panel A of Figure 5.2 (that plots $\hat{\delta}$ against $\hat{\rho}$) show that, in general, individuals that move from the private to the public sector are affected by wage changes of the same sign and of similar magnitude of the public-private gap estimated from equation (5.1) (although in the majority of countries individuals originally in the public sector tend to benefit from higher premia than those that switched from the private sector). Moreover, as expected, the gap estimated for the sub-sample of switchers is generally smaller than that obtained using the fixed effects estimator for the entire sample (depicted in Figure 5.1), suggesting that the individuals that change sector are those for which the wage premia were originally lower. These pieces of evidence seem to suggest that movements across sectors are motivated by pay differences, implying the existence of a "sector effect". Additionally, the absence of a positive relationship between the $\hat{\eta}$ and $\hat{\delta}$ parameters (depicted in Panel B of Figure 5.2) implies that in most countries the individuals that move from high pay jobs in the public sector do not continue to benefit from a positive wage differential. This is consistent with a "pure" public sector premium that is particularly obvious in the cases of Ireland, Greece and Portugal. On the contrary, results for Germany, the Netherlands, Italy and Austria suggest that individual unobserved heterogeneity justifies the maintaining of the wage differentials after a switch of sector. Therefore, this exercise shows that, although the public-private wage differential is partially explained by self-selection effects, in most countries there is evidence of non-negligible "sector effects".

In order to assess how does individual unobserved heterogeneity impacts the public-private wage gap at different points of the distribution of earnings, we begin by comparing, in Table 5.5 the results of the estimation of δ_θ using specification (4.5) with those obtained using a pooled-QR approach (with time-dummies):

$$Quant_\theta[ln(wage_i)|X_i, P_i] = \gamma_{\theta_t} + X_i'\beta_\theta + \delta_\theta P_i \ , \tag{5.4}$$

assuming $ln(wage_i) = \gamma_{\theta_t} + X_i'\beta_\theta + \delta_\theta P_i + \varepsilon_{\theta_i}$.

Table 5.5 shows that after controlling for both observable and time-invariant unobservable factors there is still evidence of a significant and positive public-private wage gap in most countries. These gaps decrease with the wage level and at the upper quantiles of the distribution there is evidence of penalties in most countries in our sample (the exceptions are Ireland, Greece, Portugal and Finland), reinforcing the ideia that the public sector compresses the wage distribution. The comparison between the estimates based on the QR fixed effects approach and the pooled-QR methodology shows that the former tend to be considerably lower. This confirms the insight provided by the estimates obtained at the mean, suggesting that the fact that individual heterogeneity contributes to attenuate the public-private wage gap is present along the entire distribution. Moreover, our results suggest that, once unobservable time-invariant factors are accounted, differences in the gaps computed at different points of the distribution are less pronounced, thus the usually documented effect of conditional wage compression by the public sector appears to be attenuated. This means that the observed compression seems to be actually due to selection.

In most countries in our sample differences between fixed effects and traditional QR estimates are more obvious at the lower quantiles of the wage distribution. This means that the positive selection effect implied by these differential suggests that, on average, better-endowed individuals with lower

Table 5.5 Public-private wage gap across the distribution: the role of selection (per cent)

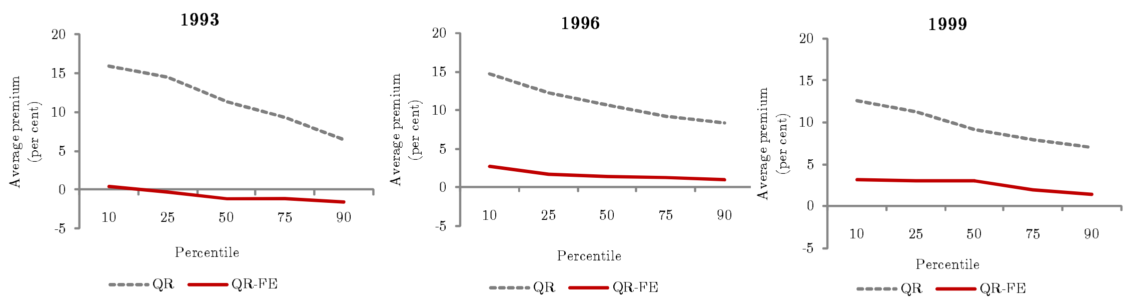
	Pooled QR					Fixed Effects QR				
	10%	25%	50%	75%	90%	10%	25%	50%	75%	90%
Germany	13.90 *	10.40 *	6.70 *	6.20 *	5.40 *	0.30	0.10	-0.20 *	-0.90 *	-1.30 *
Netherlands	7.10 *	7.60 *	7.00 *	4.30 *	1.30 *	2.40 *	1.60 *	1.00 *	0.30 *	-0.30
France	7.50 *	6.00 *	3.20 *	0.70	-0.70	-1.50 *	-1.90 *	-2.70 *	-3.20 *	-3.50 *
Ireland	21.70 *	18.30 *	17.60 *	16.10 *	18.90 *	4.20 *	4.80 *	4.60 *	4.40 *	4.30 *
Italy	16.40 *	13.30 *	10.70 *	9.40 *	6.70 *	2.10 *	1.20 *	0.60 *	-0.20	-0.70 *
Greece	22.90 *	20.40 *	16.90 *	15.00 *	13.30 *	4.90 *	4.50 *	4.80 *	5.00 *	4.00 *
Spain	24.00 *	19.50 *	15.80 *	13.30 *	9.80 *	3.70 *	2.80 *	1.30 *	0.10	-1.20 *
Portugal	20.20 *	19.60 *	18.80 *	18.30 *	18.40 *	2.50 *	2.30 *	2.10 *	2.60 *	1.90 *
Austria	4.10 *	2.60 *	3.40 *	3.10 *	1.30	-0.50	-0.60 *	-0.40 *	-0.50 *	-0.70
Finland	2.40 *	1.40 *	-0.70	-2.30 *	-4.00 *	2.30 *	1.70 *	1.40 *	1.10 *	0.30

Sources: Authors' calculations based on ECHP microdata.
Notes: The table presents the coefficients of the public sector dummy estimated using specifications (4.5) and (5.4), multiplied by 100. The coefficients tagged with "*" are significant, at least, at the 10 per cent level.

wages self-select into the public sector and this effect becomes less obvious as one moves up the wage distribution. According to Bargain and Melly (2008) (that found the same patterns using data from the French Labour Force Survey), this kind of evidence may have the following interpretation: the individuals at the lower part of the wage distribution are those that, due to personal preferences, self-select into the public sector, but also those that, probably because of relatively better endowments, have succeeded in entry examinations or other screening procedures (that are typically more common and stricter in the public sector). At the upper quantiles, results show several cases of penalties.

In order to check how the evidence just described varies along time, we repeat the estimation of model (4.5) including terms expressing the interaction between the public sector dummy and year dummies (taking the last available year as a reference). Figure 5.3 compares the average public sector coefficients obtained using Canay (2010)'s approach with those obtained using traditional QR (presented in Table 5.2). Such comparison provides insight on how does self-selection affects the wage gap at different points of the distribution and along time. Again, results show that, when both observables and unobservables are controlled for, the coefficient associated with public sector employment decreases vis-à-vis the obtained using standard QR and that the role of unobserved heterogeneity is more relevant at the lower part of the distribution. As regards the evolution along the period under scrutiny, while results obtained with traditional QR point, on average, to a decrease of the public-private wage gaps, estimates controlling for unobserved factor imply that in the countries in our sample the average gap has increased. This increase is more obvious at the upper part of the earnings distribution, suggesting that pay-compression in the public sector has become less relevant. Moreover, the approximation of the curves depicted in Figure 5.3 suggests that the contribution of unobserved factors to explain the public-private wage differential has decreased along the 1993-2000 period.

Figure 5.3 Public-private wage gap across the distribution and along time: the role of selection



Sources: Authors' calculations based on ECHP microdata.
Notes: The figure presents, for each year, the average gap computed using the coefficients of the public sector dummy estimated using specification (4.5) and compares it with those obtained based on specification (5.4).

6 Concluding remarks

This paper focuses on the estimation of the public-private wage gap in several European countries in the period immediately before the inception of the euro area. The estimation is undertaken using traditional methods that allow to control for differences in observable endowments but we also resort to fixed effects methods that take into account the impact of unobserved individual characteristics on wages and sector selection. Such analysis is also made at different points of the distribution using a novel approach that allows the estimation of quantile regressions with panel data.

In the period prior to the inception of the euro area there seems to have been a relative moderation as regards the growth of public sector wages in the countries than engaged on the fulfilment of the Maastricht criteria. Such moderation is less obvious in a set of countries, including Greece, Portugal and Ireland, for which results in Campos (2011) suggest that no major fiscal consolidation efforts were made along the period in analysis. Regarding the average public-private wage gap, the estimates obtained controlling for the impact of both observed and unobservable individual characteristics show a slight increase along the period. It should be highlighted that the widening of the gap is more noticeable in countries for which Campos (2011) identified small fiscal adjustments that were not accompanied by significant cuts in primary expenditure and, in particular, in compensation of employees. Note also that the premia estimated using the fixed effects methodology are considerably lower than the obtained using OLS, a feature that, to a large extent, can be explained by the fact that in the latter case unobserved individual characteristics are not taken into account. However, fixed effects estimates may be underestimated as a result of a downward bias arising from measurement errors, while those obtained using cross-sectional methods may be hampered by an overestimation stemming from the omission of relevant unobserved factors. Thus, the actual wage premia are expected to lie in between.

The public-private wage premia typically narrow along the distribution. In particular, for individuals with lower wages there is evidence of a positive wage gap in several countries, mostly arising from a positive selection effect. At the upper part of the wage distribution results point to a considerable decrease in the premia and, in several cases, to the existence of penalties associated with public employment. These results imply that, in several euro area countries, the wage compression generally associated with the public sector is largely driven by selection and is underpinned by its ability to attract individuals with comparatively better characteristics for positions at the bottom of the wage distribution and failure to retain the most capable in better-remunerated positions. This problem may hamper the efficiency in the provision of services by the public sector, with possible consequences as regards its quality. Notwithstanding, it is note highlighting that the decrease in the differentials across the distribution is not as obvious as in previous studies, a feature that may be justified by the fact that we are estimating the premia using hourly wages (*i.e.*, controlling for differences in the number of working hours in each sector), while monthly wages are generally used.

Measures specifically aiming at reducing the weight of the public sector wage bill have recently been adopted in several European countries. It will be interesting to assess if these measures will be reflected in the public-private wage gaps or if the consolidation efforts will not be accompanied by relevant developments in this regard - as appears to have been the case along the 1990s. Note, however, that wage cuts that compress the wage distribution may be effective in reducing general government primary expenditure and raw wage differentials, but fail to reduce pure premia benefiting particular categories of public employees. In order to do it, the implementation of this sort of measures should be carefully thought of and should ideally be underpinned by a full understanding of the factors determining the pay differential between the public and the private sector (along the entire wage distributions).

References

Alesina, A., Ardagna, S. and Galasso, V. (2008), The euro and structural reforms, Technical Report 14479, NBER.

Angrist, J. and Pischke, J. (2009), *Mostly harmless econometrics*, Princeton University Press.

Bargain, O. and Kwenda, P. (2009), The informal sector wage gap: New evidence using quantile estimations on panel data, Discussion paper 4286, IZA.

Bargain, O. and Melly, B. (2008), Public sector pay gap in France: new evidence using panel data, Discussion paper 3427, IZA.

Blinder, A. (1973), 'Wage discrimination: reduced form and structural estimates', *Journal of Human Resources* **8**.

Boyle, G., McElligott, R. and O'Leary, J. (2004), 'Public-private wage differentials in Ireland, 1994-2001', *Quarterly Economic Commentary: Special Articles* **2004**(2).

Cameron, A. C. and Trivedi, P. K. (2007), *Microeconometrics methods and applications*, Cambridge University Press.

Cameron, A. C. and Trivedi, P. K. (2009), *Microeconometrics using Stata*, Stata Press.

Campos, M. M. (2011), 'Learing from the past: Fiscal adjustments on the run-up to the euro area', *Banco de Portugal Economic Bulletin* **17**(2).

Campos, M. M. and Pereira, M. C. (2009), 'Wages and incentives in the Portuguese public sector', *Banco de Portugal Economic Bulletin* **14**(2).

Canay, I. (2010), A note on quantile regression for panel data models, Mimeo, Department of Economics, Northwestern University.

Disney, R. and Gosling, A. (1998), 'Does it pay to work in the public sector?', *Fiscal Studies* **19**(4).

Galvão, A. (2008), Quantile regression for dynamic panel data with fixed effects, working paper, University of Wisconsin-Milwaukee.

Gibbons, R. and Katz, L. (1992), Does unmeasured ability explain inter-industry wage differences?, Working Paper Series 3182, NBER.

Jurges, H. (2002), 'The distribution of German public-private wage gap', *Labour* **16**.

Kato, K. and Galvão, A. (2010), Smoothed quantile regression for panel data, Mimeo.

Koenker, R. (2004), 'Quantile regression for longitudinal data', *Journal of Multivariate Analysis* **91**.

Koenker, R. and Bassett, G. (1978), 'Regression quantiles', *Econometrica* **44**(1).

Lucifora, C. and Meurs, D. (2004), The public sector pay gap in France, Great Britain and Italy, Discussion paper 1041, IZA.

Machado, J. A. F. and Mata, J. (2001), 'Earning functions in portugal 1982-1994: Evidence from quantile regressions', *Empirical Economics* **26**(1).

Melly, B. (2002), Public-private sector wage differentials in Germany: Evidence from quantile regression, Technical report, SIAW, University of St. Gallen, Switzerland.

Oaxaca, R. (1973), 'Male-female wage differentials in urban labor markets', *International Economic Review* **14**.

Ponomareva, M. (2010), Quantile regression for panel data models with fixed effects and small T: Identification and estimation, Mimeo, Department of Economics, Northwestern University.

Portugal, P. and Centeno, M. (2001), 'Wages of civil servants', *Banco de Portugal Economic Bulletin* **7**(3).

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