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Abstract

What would be the counterfactual wage of civil servants if they were employed in the private sector? Using the French European Household panel, we present a new approach to the wage differential between the public and the private sectors. We estimate a model, which controls both for selection into employment, and for self-selection into the public sector. We also introduce unobserved heterogeneity in the propensity to be employed in either job sector, and in the sector-specific productivity. Evidence based on the counterfactual distributions suggests a large public-private wage premium for low public wages. This conclusion also holds for women but may be explained by a weaker discrimination in the public sector. Unlike women, most male civil servants would earn more in the private sector.

Keywords: counterfactual distributions, wage differentials, public and private sector, unobserved heterogeneity

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Les écarts de salaire public-privé : un capital humain spécifique à la fonction publique ?

Résumé

Quel serait le salaire des fonctionnaires s'ils travaillaient dans le secteur privé ? À l'aide du Panel Européen des Ménages, nous présentons une nouvelle approche au différentiel de salaires entre secteur public et secteur privé. Nous estimons un modèle où nous contrôlons de la double sélection : participation et choix de secteur, et de l'hétérogénéité inobservée dans la propension à être en emploi, dans l'un ou l'autre des secteurs, et dans la productivité spécifique à chaque secteur. Les distributions contrefactuelles estimées permettent de conclure à une prime à l'emploi public pour les bas salaires. La même conclusion tient pour les femmes, mais pour ces dernières, cet « avantage » est dû à une moindre discrimination. À l'inverse, la plupart des hommes en emploi dans le secteur public bénéficieraient de salaires plus élevés dans le secteur privé.

Mots-clés : distributions contrefactuelles, différentiel de salaire, secteurs public et privé, hétérogénéité inobservée

Classification JEL : J31, J45, J64, C21, C33, C35

1. Introduction

There has been an increasing interest in studying public sector employment for more than two decades. This process was initiated by Smith (1977) and this is justified by the large share of public employment in total employment. Over that period of time, this proportion does not decrease for any western country but for UK. For instance, in France, in 2006, this share amounts to one quarter of total employment, and it has been relatively stable since the beginning of the nineties. Providing a study that properly takes into account the factors that can explain differences between public and private wages is therefore an important policy issue.

In this paper, we evaluate the counterfactual wage people currently employed in the public sector, would have in the private sector. We also determine whether public workers benefit from a wage premium along the public wage distribution. To do so, we model private sector and public sector wages, in a panel framework, controlling for the double selection in employment and in sector choices, and we account for unobserved heterogeneity through the use of finite mixture distributions. We derive from this model the unobserved productivity public workers would have in the private sector, and reciprocally.

Hence this paper contributes to the scarce literature dealing with the French case regarding the classical analysis of the public wage gap. Fournier (2001) studies raw public wage premiums.Fougère and Pouget (2003) concentrate on the main determinants of the entry into the public sector. Bargain and Melly (2008) focus on the public sector pay gap using quantile regressions on a short panel data set and compare the quantiles of both distributions. Unlike Bargain and Melly (2008), we observe each individual for 8 years, which ensures convergence properties that can not be ensured when people are surveyed only three times.

This paper also expands some previous approaches: many recent studies rely on cross sectional switching regressions, endogenous or not (see Disney and Gosling (1998) and Gyourko and Tracy (1988) for UK, Dustman and Van Soest (1998) for Germany, Hartog and Oosterbeek (1993) and Van Ophem (1993) for the Netherlands, Fougère and Pouget (2003) for France and Heitmueller (2006) for Scotland). In a different way, Heitmueller (2006) controls for participation and sector selections, but in cross-sectional analysis. In order to overcome these potential biases, Disney and Gosling (2003) uses the natural experiment that happened in the UK in the nineties with the privatization programme. They show that their results are robust to self-selection.

A second set of papers raise close but different issues about wages and mobility between both sectors. Bell, Elliott, and Scott (2005) exploit mobility between both sectors, and study the wage incentives to change sector. They identify the wage premium after a job change. Other studies focus on the link between the wage distribution and mobility. Postel-Vinay and Turon (2007) and Cappellari (2002) focus on earnings dynamics and lifetime values of employment in both sectors. They argue that public and private sectors differ not only in their log wage distribution but also in their income mobility. They conclude, for UK and resp. for Italy, that adopting a life cycle view of earnings matters in the private sector whereas it does not in the public sector.[1]

Our paper is more in line with Dustman and Van Soest (1998) and Heitmueller (2006). We extend their approach by considering a panel framework, controlling for both self selection into employment and into the public sector. Unobserved heterogeneity, modeled by using the method of Heckman and Singer (1984) allows us to control for individual tastes and propensity to be employed in a given sector, and for individual abilities. An individual has a different propensity to earn low or high wages in different sectors.

[1]Another trend of the literature on public/private differences concerns queue models (Venti (1987), Heywood and Mohanty (1995) and Fougère and Pouget (2003)) and analyzes the individual propensity to seek employment in public sectors. But these models require very detailed information about the supply and demand for public jobs. Furthermore, they are very sensitive to the instruments chosen and it turns out difficult to separately identify the characteristics determining the search for a public job from those determining the access to a public job. Bellante and Link (1981) argue there are more risk adverse workers in the public sector, and Goddeeris (1988) point out a *taste* for public services.

We estimate this model with data from the French European Household panel (ECHP) over the period 1994-2001. We obtain a very good model fit in terms of income distribution, employment probability and sector choice. Our results concur with the existing literature, but thanks to the new approach we adopt, we can assess the counterfactual wage civil-servants would get if employed in the private sector. Female are the ones who benefit from a public wage premium since gender discrimination is larger in the private sector. Unlike women, most male civil-servants suffer a public wage penalty. Apart from those at the bottom of the wage distribution, they would get higher wages in the private sector. We also find that mimicking one's father is determinant in the public sector choice whereas the mother status turns out to be non significant. Finally, as it has been already shown in previous papers, the public sector attracts more people when the local labor market is depressed.

We carry out a descriptive analysis of our data in section 2, and the statistical model to be estimated is detailed in section 3. Sections 4 and 5 discuss results and simulations. Finally, Section 6 concludes.

2. The data

2.1. A brief description

We use data from the waves 1994 to 2001 of the French European Household Survey. We restrict our sample to individuals aged from 16 to 59 years old at the beginning of the panel. We do include female in the sample given their high participation rate in France, and given the fact that we control for participation. We define three sectors of activity or labor force status: nonemployment, employment in the private sector, and employment in the public sector. We consider that individuals work in the public sector when they answer they work for state or local governments. Otherwise, they are said to work in the private sector, namely they are employed by national or private firms, or by their own firm.[2] Self-employed workers and unpaid workers in a family business are excluded. We also exclude individuals who work, but who do not declare any wage. This leaves us with $5,092$ individuals, we follow over 8 years.

Concerning educational level, we consider the highest education degree instead of the number of years of studying. In France, civil-servant exams are indeed conditional on degrees.

The French European Household survey provides annual wage earnings and a monthly description of the occupation, but it does not provide the specific wage of the job occupied during the month of the interview. We thus divide the annual wage earnings by the total number of months employed during the year. In order to get an accurate estimate for this monthly wage, cautiousness is required when people have two jobs or more in a given year, but this is actually the case for less than 5% of the employed people in a given year. Hence, for these people, we divide the annual wage earnings by the number of months they are employed whatever the number of jobs they got throughout the year. Finally, monthly wages are assessed in French francs at 1994 prices.

2.2. Some descriptive statistics

The initial sample (without age restriction) contains half nonemployed and half employed people. Logically in the sample restricted to people aged from 16 to 59, employed people are over-represented (see table 1). In the data, the public sector represents one third of employed people.[3]

The proportion of women is traditionally higher in the public than in the private sector, since it is easier to conciliate professional and family lives while employed in the public sector (see table 2). Few foreigners work in the public sector because entrance exams often require French citizenship. Entrance exams also require a minimum degree level, hence the distribution of degrees differs between sectors.

[2]There is no cross-validation of their employment status as in Card (1996) and the different public services cannot be distinguished.

[3]In national statistics, the public sector amounts to one fourth of total employment including the self-employed. In this paper we have excluded the self-employed, which explains the higher proportion of public employment we get. This proportion is roughly the same when assessed on the non-balanced panel data.

Public jobs require usually more qualification, undergraduates and graduates are thus more represented in the public sector. Unlike skilled workers, the unskilled ones are more present in the private sector. Concerning age, the management of older workers' career differs between sectors and private workers are younger on average than their public sector counterparts.

Finally consider some figures about transitions. The following matrix gives details about transition probabilities between different states over 1994-2001. Very few individuals move from the private to the public sector, while opposite movements are more frequent but still rare. 7% of private workers and 4.7% of public workers become nonemployed in the subsequent period. They may have lost their job or decided to stop working for a while (for instance, women may decide to get out of the labor force to bring up their children).

	Nonemployment	Private	Public
Nonemployment	87.56	9.83	2.62
Private	6.95	92.65	0.40
Public	4.69	1.26	94.05

Rows refer to the sector at date $t-1$, and columns to the sector at date t.

Table 1 Nonemployment, employment in public and private sectors.

Activity status	1994	1995	1996	1997	1998	1999	2000	2001
Non Employed	1,692	1,653	1,663	1,671	1,655	1,637	1,692	1,740
	(33%)	(32%)	(33%)	(33%)	(32%)	(32%)	(33%)	(34%)
Employed	3,400	3,439	3,429	3,421	3,437	3,455	3,400	3,352
	(67%)	(68%)	(67%)	(67%)	(68%)	(68%)	(67%)	(66%)
Sector								
Public	1,061	1,084	1,086	1,057	1,052	1,042	1,014	993
	(31%)	(32%)	(32%)	(31%)	(31%)	(30%)	(30%)	(30%)
Private	2,339	2,355	2,343	2,364	2,385	2,413	2,386	2,359
	(69%)	(68%)	(68%)	(69%)	(69%)	(70%)	(70%)	(70%)

Source: French European Household Survey.

2.3. Simple regressions

Table 3 presents the results we get with simple regressions. We first regress the log of the monthly wage on a public sector dummy and a few covariates. The first column of Table 3 shows that the raw public-private gap over 1994-2001 is 22.3 log points (around 25%). Conditioning on more covariates, such as age, a proxy of experience -the age at the end of studies, and degrees (second specification), this public-private pay gap is still significant and amounts to 8.5%. In specification 3, we process 2SLS to take into account that sector selection is endogenous.[4] In this specification 3, the public wage premium estimate is 24%. In a final specification, we process separate regressions allowing different returns to experience, to degrees in both sectors. And if we evaluate the raw premium as the constant coefficient, it turns out to be 39%, but this measure does not take into account the different returns to covariates between the public and the private sector. Hence it is not certainly the good way to proceed.

[4]In the sector choice equation, we include a proxy of the father status, as well as a proxy of the mother status, at the end of the individual's studies. Were the father or the mother civil-servants? The instruments we consider are the gender times the status of one's mother, and the gender times the status of one's father. Finally we also include the unemployment rate to explain the sector choice.

Table 2 General descriptive statistics - 1994

	Whole Sample		**Private Sector**		**Public Sector**	
	Number	Percent	Number	Percent	Number	Percent
Gender						
Women	2,750	54.01	955	40.83	628	59.19
Men	2,342	45.99	1,384	59.17	433	40.81
Nationality						
French	4,887	95.97	2,220	94.91	1,053	99.25
Not French	205	4.03	119	5.09	8	0.75
Region						
Paris	698	13.71	351	15.01	170	16.02
Out of Paris	4,394	86.29	1,988	84.99	891	83.98
Age						
16-29	1,442	28.32	555	23.73	170	16.02
30-39	1,395	27.40	742	31.72	340	32.05
40-49	1,378	27.06	741	31.68	372	35.06
50-59	877	17.22	301	12.87	179	16.87
Highest diploma						
No secondary degree	1,838	36.10	742	31.72	276	26.01
Vocational technical school (Basic)	1,449	28.46	851	36.38	242	22.81
High school degree (general or vocational)	745	14.63	308	13.17	143	13.48
Technical College, undergraduate university, or *Licence, Maitrise*	765	15.02	299	12.78	270	25.45
Graduates	295	5.79	139	5.94	130	12.25
Part-time	553	16.3	360	15.4	181	17.1

The statistics given above are assessed on the first year 1994.

Source: French European Household Survey.

The differences in the estimation of the public wage gap prompt us to carefully examine our specification, and the way we estimate this premium.

From descriptive statistics the log monthly wage variance is lower in the public sector than in the private one whatever the degree, except for high school dropouts. Internal exams may promote significantly upward mobility for lower degrees, increasing the wage variance of this group. For other degrees, this is consistent with wage compression in the public sector. The log monthly wage mean is also higher in the public sector when degree is not controlled for (see figure 1). Conditional on degree, this still holds except for graduates who seem to be less rewarded in the public than in the private sector. Hence the public sector seems to protect lower degrees from unemployment and lower wages. As descriptive statistics do not control for selectivity, we need to go one step further. The model we propose control for participation selection, and for sector choice, as well as unobserved and observed heterogeneity: age, potential experience,[5] region, number of children less than 3 years old, between 3 and 6...

[5]Experience cannot be precisely measured in the data. Hence we use the age at the end of studies as a proxy of potential experience. It is a proxy for general experience and not for sector-specific experience. We do not introduce potential experience itself in the wage equation to avoid colinearity between potential experience and age.

Table 3 Simple regressions on the log of monthly wage

	Specification				
	1	*2*	*3*	*4*	
				Private Sector	Public Sector
Constant	7.165	5.304	5.354	5.262	5.593
	-0.010	0.048	0.050	0.058	0.086
Public	0.223	0.082	0.212		
	0.007	0.006	0.045		
Gender	-0.418	-0.241	-0.260	-0.262	-0.184
	0.007	0.005	0.009	0.007	0.009
Paris region		0.193	0.196	0.238	0.096
		0.009	0.009	0.011	0.015
Age ($years/10$)		0.661	0.639	0.698	0.581
		0.020	0.022	0.025	0.036
Age squared ($years^2/10$)		-0.063	-0.062	-0.069	-0.052
		0.003	0.003	0.003	0.004
Age of end of study ($years/10$)		0.089	0.125	0.094	0.002
		0.019	0.007	0.026	0.028
Age of end of study squared ($years^2/10$)		-0.018	0.364	-0.015	-0.013
		0.003	0.009	0.005	0.004
Vocational degree		0.125	0.464	0.129	0.102
		0.007	0.012	0.008	0.012
High School degree		0.370	0.728	0.355	0.398
		0.009	0.015	0.010	0.015
College and undergraduate		0.486	0.081	0.465	0.506
		0.008	0.019	0.011	0.013
Graduate		0.756	-0.017	0.796	0.714
		0.011	0.003	0.015	0.016
Part-time		-0.613	-0.613	-0.640	-0.554
		0.007	0.007	0.009	0.011

Source: French European Household Survey.

We control for time dummies in the wage equation.

Specifications 1 and 2: OLS regressions. Specification 3: 2SLS regression to control for sector choice endogeneity.

Specification 4: OLS regressions for each sector.

3. Econometric model and estimation principles

3.1. Model

As unobserved heterogeneity is crucial to understand different economic behaviors and unobserved productivity, we add unobserved terms to each equation. Following the method of Heckman and Singer (1984), we model unobserved heterogeneity θ via a discrete random variable whose distribution has a given number of support points to be estimated. We assume that there are K types of individuals, π_k denotes the probability of type k. Within this framework, unobserved heterogeneity is type specific such as sector specific. An individual may for instance have a sector specific ability and his unobserved ability may be rewarded differently according to the sector. Hence an individual of type k has a different propensity to earn low or high wages in both sectors, this propensity is captured by θ_k^{Pu} and θ_k^{Pr}. The propensity to work rather in the public than in the private sector is captured by θ_k^{Z}, it may represent a particular taste for public services.

In a first equation, we consider the employment status. It describes the fact that the individual works or does not ($y_{it} = 1$ if the individual works, $y_{it} = 0$ otherwise). In a second equation, as the structural model described above confirms it, we consider the sector choice as a binary variable ($z_{it} = 1$ when the individual works in the private sector, $z_{it} = 0$ when he works in the public sector): the nonemployed search for both public and private jobs when $c_{Pu} \leq \mathcal{U}_{pu}$. And this threshold depends on explanatory variables such as individual covariates and the local unemployment rate. We also include in the explanatory variables the difference of the expected log wages between the public and the private sectors. This difference depends on the type of the individual. Finally we have a switching wage equation: the third (resp. fourth) equation is the log monthly wage in the private sector w_{it}^{Pr}(resp. in the public sector w_{it}^{Pu}).[6]

$$y_{it} = \mathbf{1}\left(X_{it}^{Y}\beta^{Y} + \theta_{k(i)}^{Y} + u_{it}^{Y} > 0\right) \tag{3.1}$$

And if the individual works,

$$z_{it} = \mathbf{1}\left(X_{it}^{Z}\beta^{Z} + \gamma\mathbb{E}\left(w_{it}^{Pr} - w_{it}^{Pu}|k(i)\right) + \theta_{k(i)}^{Z} + u_{it}^{Z} > 0\right) \tag{3.2}$$

$$w_{it}^{Pr} = z_{it}\left(X_{it}^{Pr}\beta^{Pr} + \theta_{k(i)}^{Pr} + u_{it}^{Pr}\right) \tag{3.3}$$

$$w_{it}^{Pu} = (1 - z_{it})\left(X_{it}^{Pu}\beta^{Pu} + \theta_{k(i)}^{Pu} + u_{it}^{Pu}\right) \tag{3.4}$$

where

$\theta = \left(\theta^{Y}, \theta^{Z}, \theta^{Pr}, \theta^{Pu}\right)$ denotes the vector of the unobserved heterogeneity components,

$k(i)$ denotes the type of the individual i,

$X = \left(X^{Y}, X^{Z}, X^{Pr}, X^{Pu}\right)$ denotes the vector of observable characteristics,

$\beta = \left(\beta^{Y}, \beta^{Z}, \beta^{Pr}, \beta^{Pu}\right)$ denotes the vector of parameters,

$u = \left(u^{Y}, u^{Z}, u^{Pr}, u^{Pu}\right)$ denotes the vector of residuals, which are assumed to be independent and normally distributed across time and individuals, with variance σ_{Pr}^2 (resp. σ_{Pu}^2).[7]

3.2. Identification strategy

The model identification does not only rely on functional assumptions (imposed on the residual distributions), but also on exclusion restrictions. On the one hand, in the nonemployment/employment equation, we include the number of children between 0 and 3, the number of children between 3 and 6, and the spouse income. These variables are crucial for explaining female participation (see Hyslop (1999) and Edon and Kamionka (2008)). And they are excluded from the sector choice and the wage equations. Female may indeed have a higher propensity to choose the public sector when they intend to have children, but their precise number of children may rather influence their participation decision and it does not influence the sector choice.

On the other hand, in the sector choice equation, a proxy of the father status, as well as a proxy of the mother status at the end of the individual's studies, are included. These are known to be determinants of the civil servant status (Audier (2000)). As the true status of the parents' occupation is not directly

[6]The model does not include lagged dependent variables. It could be included to capture state dependence. In such a case, the introduction of initial conditions could be solved using the method proposed by Wooldridge (2005) or the one proposed by Heckman (1981). This would entail to compute the likelihood recursively, conditional on the initial conditions.

[7]The assumption of independence across residuals is not restrictive since we follow Heckman and Singer (1984) to model the unobserved heterogeneity, see also Cameron and Heckman (1998) and Arcidiacono (2005).

observed, a proxy is built from the two-digit classification of their occupation. Hence we consider the father (resp. mother) was a civil servant when he (resp. she) was either *'senior civil servants, information professionals or creative and performing artists'* or *'middle-level health and teaching workers, middle-level civil servants'* or finally *'middle-level civil servants'*. These variables are excluded from the rest of the model.[8]

Finally, in order to ensure identification of the unobserved heterogeneity, the intercept is excluded from each equation.

3.3. Likelihood and estimation principles

The heterogeneity is modeled by K distinct types $(\theta_1, \theta_2, ..., \theta_K)$ with $\theta_k = \left(\theta_k^Y, \theta_k^Z, \theta_k^{Pr}, \theta_k^{Pu}\right)'$. Let π_k denote the unconditional probability that an individual has the type k. As we consider a discrete distribution for the heterogeneity terms, we rely on the Expectation-Maximization[9] (EM) algorithm (Dempster, Laird, and Rubin (1977)) to estimate the model.[10]

This algorithm iterates the two following steps until the stability of the log-likelihood (for detailed explanations, see appendix D). At each iteration n of the algorithm, we use the estimated values π_k^n and $(\theta_1^n, \theta_2^n, ..., \theta_K^n)$ of the mixture distribution, and the estimated values $\left(\beta^n, \sigma_{Pu}^{2,n}, \sigma_{Pr}^{2,n}\right)$ of the parameters of interest.

E-step

For each type $k = 1, ..., K$ and each individual i, the posterior probability of type k is:

$$\mathbb{P}\left(T_i = k | \underline{y}_i, \underline{z}_i, \underline{w}_i\right) = \pi_{ik}^{(n)} = \frac{\pi_k \mathbb{P}(\underline{y}_i, \underline{z}_i, \underline{w}_i | T_i = k)}{\sum_{l=1}^{K} \pi_l \mathbb{P}(\underline{y}_i, \underline{z}_i, \underline{w}_i | T_i = l)}. \quad (3.5)$$

where T_i is the random variable representing the type of the individual i. $\pi_{ik}^{(n)}$ denotes the posterior probability for the individual i to be of type k.

M-step

The expected completed log likelihood is maximized:

$$\max_{\substack{\beta, \sigma_{Pu}^2, \sigma_{Pr}^2, \\ (\pi_k)_{k=1,...,K}, \\ (\theta_k)_{k=1,...,K}}} \sum_{i=1}^{N} \sum_{k=1}^{K} \pi_{ik}^{(n)} \ln l \left(\underline{y}_i, \underline{z}_i, \underline{w}_i | T_i = k, \beta, \sigma_{Pu}^2, \sigma_{Pr}^2, (\pi_k)_{k=1}^K, (\theta_k)_{k=1}^K\right) \quad (3.6)$$

First $\pi_k^{(n)}$ is updated such that:

$$\pi_k^{(n+1)} = \frac{\sum_{i=1}^{N} \pi_{ik}^{(n)}}{\sum_{l=1}^{K} \sum_{i=1}^{N} \pi_{il}^{(n)}} \quad (3.7)$$

[8] In 1994, among women who work, 13% of them have a father who was civil-servant, and 10.6% a mother who was civil-servant. For men, these percentage are respectively 12.3% and 8.4%.

[9] We do not use *Simulated Maximum Likelihood* to estimate the model, since it is time consuming and it presents convergence failures. Even with precise and accurate initial conditions, the program fails to converge quickly and it seems to get trapped in some regions.

[10] Standard errors are obtained by parametric bootstrap.

Second, due to the partial separability of the conditional completed log-likelihood function (Arcidiacono and Jones (2003)), we get four sequential optimization problems since residuals are assumed to be independent across the four equations (see Appendix D).

Thus, we first maximize the participation equation, then the log-earnings equations. Given the estimates of these two equations, we estimate the parameters of the equation for the sector choice. Although this procedure does not yield full information maximum likelihood estimates, Arcidiacono and Jones (2003) show that this method produces consistent estimates of the parameters. Standard errors estimates are obtained by a parametric bootstrap procedure, instead of a non parametric one, since this last method is unstable when applied to the EM algorithm.[11]

4. Results

4.1. Parameter estimates

Tables 4 to 6 report the parameter estimates of the four equations.

Employment

As expected, the gender negatively affects employment, as well as young children do. Women who work may choose to get out of the labor market to bring up their children. They then usually wait for their entrance into nursery or primary school to work again. In France, some children part-time attend nursery school. The marriage also negatively affects the employment decision. The effect of age on employment is assumed to be quadratic: we find that the employment probability first increases, and then decreases with age.

Moreover, the higher the degree, the higher the probability to be employed. Graduate degrees are the most rewarding ones in terms of employment probabilities. High-school degree and vocational degree estimates do not statistically differ.

Individuals who live in the region around Paris or in Paris have a greater probability to be employed because of job offer opportunities. Finally, as expected, the local unemployment rate has a negative effect on the probability to be employed.

Sector Choice

Our theoretical model teaches us that, given risk aversion, a higher unemployment rate diminishes the cost of searching for a public job when unemployed. The relative return associated to the private sector drops when the unemployment rate rises. This is confirmed by our estimations: the local unemployment rate favors the choice of public sector (Table 5). Fougère and Pouget (2003) also find that the number of candidates for a public job and the macroeconomic cycle go along. Hence the local unemployment rate is a core variable to understand public sector attractiveness.

[11] The parametric bootstrap consists first in obtaining reliable parameter estimates for the whole set of unknown parameters denoted $\widehat{\chi}$. $\widehat{\chi}$ is obtained by replicating the previously described EM algorithm with different random initial values for the parameters. The iteration process is necessary to ensure that a global maximum is obtained. Then, given X and $\widehat{\chi}$, we generate H vectors of the endogenous variables $\left(y_i^h, z_i^h, w_i^h\right)_{h=1\ldots H}$. For each newly generated data set, we estimate the whole set of unknown parameters. Final parameters and standard error estimates are computed as

$$\overline{\beta^*} = \frac{1}{H}\sum_{h=1}^{H}\beta_h^* \quad (3.8)$$

$$\sigma_{\beta^*} = \frac{1}{H-1}\sum_{h=1}^{H}(\beta_h^* - \overline{\beta^*})^2. \quad (3.9)$$

Moreover, the greater the difference between expected log wages, the larger the probability to choose the private sector. Individuals rationally choose the sector where they anticipate the highest wage.

Unlike the mother's position, the father's position has an effect on his children's sector choice. A son tends to prefer public services if his father is a civil-servant. The observation that civil servants' children are over-represented in the public sector (Audier (2000)) is therefore robust to the inclusion of covariates such as degree, local unemployment rate. Unlike men, women whose father is a civil-servant tend to prefer private sector compared to women whose father is not a civil-servant.

Moreover, as expected, women have a higher propensity than men to work in public services. This result will be reenforced by wage analysis. This result is in line with Bell, Elliott, and Scott (2005), who find, for UK, that the gains to staying in the public sector are greater for women than for men, and that women tend to gain by joining the public sector, almost irrespective of their position in the earnings distribution. We find similar results for France (see following sections). Fougère and Pouget (2003) also find that the length of the queue for public sector is longer for female.

Individuals with lower degree tend to work in the private sector unlike individuals with post-secondary education. Two reasons may explain this effect: first, French public jobs are more qualified on the whole than jobs in private sector (teaching, executive...). And many public jobs require to pass an exam which is conditional on a given degree.

Wages

Standard results are obtained for different variables, such as age, experience, degree... For instance, living around Paris and in Paris gives a positive premium for wages. The comparison between private and public wages is more instructive.

Unlike the descriptive statistics, the residual variance is estimated slightly higher in the public sector (0.109) than in the private one (0.084). For identification reasons, we cannot compute what people usually call "the public raw wage premium". For all degrees, except for graduates, the returns to education are roughly the same in both sectors. But returns to education for graduates are greater in the private sector: the highest wages are observed in the private sector.

Worth to be pointed out is the highest penalty to be a women in the private sector. As Gregory and Borland (1999) underlined, public sector wage inefficiency may counterbalance wage discriminations. That seems to be the case in France as gender is concerned. Nonetheless, to be a woman has also a negative effect on public wages. Indeed women have lower probabilities to be promoted than men with similar characteristics (Bessière and Pouget (2007)). And in public services, wage increases are closely linked to grade promotions. Thus career differences may explain wage differences between men and women in public services.

We give further details on wages in the following section thanks to simulations.

4.2. Types

The results are obtained under the assumption that there are four types of individuals within the sample ($K = 4$, see table 7). The number of heterogeneity components is chosen on the basis of the BIC penalized likelihood criterion: models with $K = 3$ and $K = 2$ yield substantially larger BIC values, and a model with five types yields a similar BIC criterion than a model with four types.

In a first step, we compute the individual posterior probability to be of a given type at the initial date 1994. In this subsection, we consider that an individual is of type k when the individual posterior probability $\mathbb{P}\left(T_i = k | \underline{y}_i, \underline{z}_i, \underline{w}_i, \underline{X}_i\right)$ associated to the type k is the highest. The results show that a clear

Table 4. Employment equation

Variables	*Estimates*	*Standard Error*
Women	-0.601	0.049
Not French	0.157	0.044
Not Married	0.049	0.020
Children under 3	-0.241	0.024
Children between 3 and 6	-0.268	0.028
Age ($years/10$)	4.530	0.204
Age squared ($years^2/10$)	-0.564	0.025
Vocational degree	0.234	0.028
High School degree	0.284	0.039
College and Under Graduate	0.378	0.030
Graduate	0.726	0.060
Paris	0.174	0.027
Local unemployment rate	-0.010	0.002
Log spouse income	0.026	0.006

Source: French European Household Survey.

The log spouse income is standardized.

Table 5. Private sector choice

Variables	*Estimates*	*Standard Error*
Women	-0.236	0.055
Age ($years/10$)	-0.219	0.177
Age squared ($years^2/10$)	0.019	0.021
Not Married	0.046	0.042
Vocational degree	0.084	0.065
High School degree	0.092	0.063
College and Under Graduate	-0.114	0.048
Graduate	-0.625	0.079
Women times Father civil servant	0.480	0.083
Men times Father civil servant	-0.266	0.076
Women times Mother civil servant	-0.084	0.068
Men times Mother civil servant	0.043	0.088
Local unemployment rate	-0.037	0.005
Difference of expected log wage	1.665	0.195

Source: French European Household Survey.

type-partition exists. At the initial date, type-3 people are mainly nonemployed (84.5%) whereas type-1, type-2 and type-4 individuals are mainly employed. These latter groups differ according to the sector choice. 85.5% of type-2 individuals are employed in public services in 1994, whereas 87.9% of type-1 individuals and 75.4% of type-4 individuals are employed in the private sector. Thus employment and sectors distinctly partition individuals in our sample.

Considering the values of unobserved heterogeneity for different types, remark that *type-4* individuals have an unobserved ability similar in both sectors ($\theta^{W_{Pr}} = 4.631$ and $\theta^{W_{Pu}} = 4.700$), whereas type-1 and type-2 individuals would have a different unobserved ability in both sectors. Type-2 individuals, mainly employed in the public sector, clearly have chosen the sector in which they are the most paid

Table 6. Wage equations

	Private Sector		Public Sector	
Variables	*Estimates*	*Standard Error*	*Estimates*	*Standard Error*
Women	-0.423	0.016	-0.183	0.008
Paris	0.284	0.010	0.100	0.014
Age ($years/10$)	0.889	0.063	0.493	0.030
Age squared ($years^2/10$)	-0.093	0.008	-0.042	0.003
Age of end of study ($years/10$)	0.190	0.016	0.041	0.027
Age of end of study squared ($years^2/10$)	-0.018	0.005	-0.018	0.008
Vocational degree	0.113	0.008	0.065	0.010
High School degree	0.351	0.013	0.338	0.013
College and undergraduate	0.453	0.012	0.452	0.012
Graduate	0.791	0.012	0.667	0.015
Part-time	-0.491	0.007	-0.436	0.012
Year dummies				
Year 1995	-0.044	0.015	0.027	0.016
Year 1996	-0.008	0.012	0.024	0.013
Year 1997	0.008	0.013	0.092	0.012
Year 1998	0.019	0.014	0.030	0.014
Year 1999	0.063	0.013	0.068	0.016
Year 2000	0.020	0.012	0.088	0.014
Year 2001	-0.010	0.014	0.047	0.016
Variance of residuals	0.083	0.014	0.109	0.004

Source: French European Household Survey.

($\theta^{W_{Pr}} = 4.838$ and $\theta^{W_{Pu}} = 5.774$). They may have sorted themselves into the sector that pays them more. For the type-1 individuals, this explanation does not hold. They would have a higher productivity in the public sector.

5. Simulations

5.1. Model fit

This section presents a brief fit analysis of the statistical model presented above. Table 8 presents the predicted probabilities for nonemployment, public jobs and private jobs.[12] The frequencies of nonemployment such as those of employment in either sector are well replicated whatever the date considered.

Further the model replicates well the cross sectional distribution. Figure 2 plots the observed and predicted log of monthly wage densities for the two sectors separately, which are quite close.

5.2. Counterfactual wage distributions

In this section, we derive the counterfactual wage distribution for the individuals employed in the public sector: we aim at estimating the log of monthly wages of the *public workers* if they were employed in the private sector. This is a crucial issue to understand whether the public sector wages are economically justified, or whether they help to circumvent some discrimination issues, for women for instance.

To estimate these counterfactual distributions at date t, we use bootstrapping methods. We draw H independent individual replicates, drawn from the empirical distribution of the explanatory variables of

[12]We evaluate the predicted probability to be employed at date t thanks to: $\mathbb{E}(y_t) = \mathbb{E}\left(\mathbb{E}(y_t|T)\right) = \sum_{k=1}^{K} \pi_k \mathbb{E}(y_t|T = k)$.

Table 7. Unobserved heterogeneity

Variables	*Estimates*	*Standard Error*
Probability of different types		
Type 1	0.193	0.170
Type 2	0.223	0.216
Type 3	0.233	0.233
Type 4	0.351	0.382
Type-specific heterogeneity parameters		
	Type 1	
θ^Y	-6.520	0.628
θ^Z	3.430	0.902
$\theta^{W_{Pr}}$	5.121	0.238
$\theta^{W_{Pu}}$	5.915	0.228
	Type 2	
θ^Y	-6.676	0.902
θ^Z	-0.880	1.391
$\theta^{W_{Pr}}$	4.838	0.299
$\theta^{W_{Pu}}$	5.774	0.180
	Type 3	
θ^Y	-9.138	1.187
θ^Z	2.433	1.308
$\theta^{W_{Pr}}$	3.973	0.421
$\theta^{W_{Pu}}$	5.216	0.232
	Type 4	
θ^Y	-7.301	0.254
θ^Z	2.012	0.377
$\theta^{W_{Pr}}$	4.631	0.160
$\theta^{W_{Pu}}$	4.700	0.159

Source: French European Household Survey.

the public sector workers at date t ($y_{it} = 1$ and $z_{it} = 0$). For each individual replicate h, we draw his type $t(h)$ in the following posterior distribution

$$\mathbb{P}\left(T_h = k | y_{ht} = 1, z_{ht} = 0, X_{ht}\right) = \frac{\pi_k \mathbb{P}(y_{ht} = 1, z_{ht} = 0 | T_h = k, X_{ht})}{\sum_{l=1}^{K} \pi_l \mathbb{P}(y_{ht} = 1, z_{ht} = 0 | T_h = l, X_{ht})}, \tag{5.10}$$

where T_h is the random variable representing the type of the individual h. Then we compute the corresponding fitted value of the log monthly wages in both sectors:

$$w_{ht}^{s,Pr} = X_{ht}\widehat{\beta^{Pr}} + \widehat{\theta_{t(h)}^{Pr}}, \tag{5.11}$$

$$w_{ht}^{s,Pu} = X_{ht}\widehat{\beta^{Pu}} + \widehat{\theta_{t(h)}^{Pu}}. \tag{5.12}$$

Finally we add a sector-specific residual term that is i.i.d normally distributed with the estimated sector-specific variance. The results rely on the hypothesis that the 4 types are homogeneous as regards the public and private sector capabilities.

Anyway on the figure 3, we observe that the counterfactual distribution remains close to the log of wage public distribution. But this hides different effects according to gender and degrees (see figure

Table 8. Model Fit

Variables	*Year*	*Predicted probability* %	*Observed probability* %
Nonemployed	1994	34.50	33.23
	1995	33.67	32.46
	1996	33.32	32.66
	1997	33.04	32.82
	1998	32.96	32.50
	1999	33.08	32.15
	2000	33.42	33.23
	2001	32.57	34.17
Public sector	1994	20.08	20.84
	1995	20.33	21.29
	1996	20.54	21.33
	1997	20.57	20.76
	1998	20.50	20.66
	1999	20.27	20.46
	2000	19.96	19.91
	2001	20.06	19.50
Private sector	1994	45.42	45.94
	1995	46.00	46.25
	1996	46.14	46.01
	1997	46.39	46.43
	1998	46.55	46.84
	1999	46.65	47.39
	2000	46.62	46.86
	2001	47.37	46.33

Source: French European Household Survey.

4). The counterfactual distribution for men is rather stable except for the upper tail, whereas the female counterfactual distribution shifts left.

In order to precisely evaluate the public wage premium, let us derive and compare quantiles of the former distributions: the public log of wage distribution and the counterfactual distribution. Further details are given in appendix E. Figures 5 and 6 plot the difference of quantiles between the current and the counterfactual distributions according to gender and degrees. The term "public wage premium" seems to be justified at the bottom of the distribution, whereas it does not hold anymore for the upper tail. But when detailed by degree and gender, we find that the public sector, when compared with the private sector, actually gives a premium to women, whereas men would be better paid in the private sector except for those at the lower tail of the distribution. As expected given previous estimations, male graduates would be far better paid in the private sector. So we find similar results to Disney and Gosling (1998) and Bell, Elliott, and Scott (2005): public sector premium is higher for women than for men, and this premium differs across the pay distribution. The lower part of the distribution gains from staying in the public sector. Does it mean that female public workers are overpaid? It may only suggest that the public sector succeeds in reducing the wage gap between male and female, which is large in the private sector. Finally most male public workers would have the same or a higher wage if they were employed in the private sector...[13]

[13]It is essential to control for selection into employment and for selection into sector choice to assess the public wage premium. Naive estimations of this public wage premium given in section 2 cannot be appropriate since they only rely on the

6. Conclusion

This paper presents a new approach on the public-private pay gap: it evaluates the counterfactual wage distribution of public workers if employed in the private sector.

It estimates sector-specific wage equations controlling both for sector choice and employment selection. Thanks to panel data, it captures unobserved heterogeneity which differs between equations. The unobserved heterogeneity is modeled using the method of Heckman and Singer (1984) via a discrete distribution.

The main results are that the wage public premium is significant at the bottom of the public wage distribution. But it turns out to be negative at the upper tail. This is in line with empirical observations: low-wage civil-servants are weakly mobile, whereas high-wage civil servants move more frequently from the public to the private sector, attracted by higher wages. However these results are mitigated when analyzed by gender. The female public sector workers have a comparative advantage in the public sector. Their counterfactual wages in the private sector would be lower whatever their position in the public wage distribution. Whereas graduated men in the public sector would have higher wages in the private sector, graduated women would have the same one. Could we conclude that the public sector overpays women? It may rather counterbalance wage discrimination (see Gregory and Borland (1999)). Finally, for men employed in the public sector, except at the very bottom of the distribution, they would have the same or higher wages in the private sector.

value of the constant covariate.

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A. The Search Model

We derive a continuous time search model in a stationary labor market environment. There are three possible states: employment in the public sector, employment in the private sector and nonemployment. The individuals employed in the private sector can be laid off, and they may search for a private job on the job. Those employed in the public sector do not search for a job and cannot be laid off. In France, a public servant can indeed not be laid off. A public employee can be fired only in very rare cases, the rules of which greatly differ from private-sector ones (disciplinary sanctions in the public sector). Hence firings in the public sector are neglected. Finally the nonemployed may search either for a public or for a private job.

Agents live infinitely. At each point in time, they can be either nonemployed (denoted by n as non employed that is unemployed or out of the labor force), or employed either in the private sector (denoted by Pr) or in the public sector (denoted by Pu). Unemployment and nonparticipation are assumed to be non distinct labor force states. This assumption is not restrictive since we focus on the choice between the public and the private sector, and the data set is restricted to people under 60 who have a high participation rate, whether male or female. Nonemployed individuals enjoy a real return b and receive job offers at a Poisson rate depending on the sector of research $\lambda_{n,Pr}$ and $\lambda_{n,Pu}$. b may represent non labor incomes. Nonemployed individuals support research costs depending on the type of job they search for: c_{Pr} (resp. c_{Pu}) for private jobs (resp. for public jobs). They can decide to restrict their research to private jobs. Agents who decide to search for a job in the public sector can fail to enter public services although they get a public offer since they have to succeed the entrance exam to become a civil servant. p_S denotes the probability to succeed conditional on searching for a job in this sector, and it implicitly depends on individual covariates.

When employed in the private sector, individuals receive a real wage w, and they continue to receive private job offers at a Poisson rate $\lambda_{Pr,Pr}$. They are assumed to restrict their job research to the private sector and they face search costs c.[14] Existing private jobs are hit by idiosyncratic (productive) shocks that occur at a Poisson rate δ. This assumption implies that an individual cannot transit directly from the private to the public sector, he has to go through an unemployment period. To ease calculations, the instantaneous discount rate is ρ and the horizon is infinite.

Finally, when employed in the public sector, agents cannot search for a private job. We detail later what are the consequences of this assumption.

F_{Pr} denotes the wage distribution in the private sector on $[0, \overline{w}]$, F_{Pu} in the public sector on $[0, \overline{w}]$. We assume that these distributions are different from one another but that they rely on the same finite support for sake of simplicity. Nevertheless the tails of the distributions can be far different (see the empirical part for some illustration, figure 1).

In the sequel V denotes the value function.

– A worker currently employed in the public sector with starting wage w receives net income w and cannot loose his job. We assume that he receives no external nor internal offer. His value function

[14] To search for a public job requires a lot of time since entrance exams need preparation.

is

$$V_{Pu}(w) \quad = \quad \frac{w\Delta t}{1+\rho\Delta t} + \frac{V_{Pu}(w)}{1+\rho\Delta t}, \tag{A.13}$$

which yields

$$V_{Pu}(w) \quad = \quad \frac{w}{\rho}. \tag{A.14}$$

– A worker currently employed in the private sector receives a net income $w - c$ and may be forcibly separated from his job with probability δ. He also receives private job offers at rate $\lambda_{Pr,Pr}$ which are accepted when their value exceeds the expected discounted lifetime utility stream in the current job:

$$\begin{aligned} V_{Pr}(w) \quad &= \quad \frac{(w-c)\Delta t}{1+\rho\Delta t} + \delta\frac{V_n\Delta t}{1+\rho\Delta t} + (1-\delta\Delta t - \lambda_{Pr,Pr}\Delta t)\,\frac{V_{Pr}(w)}{1+\rho\Delta t} \\ &+ \quad \frac{\Delta t\lambda_{Pr,Pr}}{1+\rho\Delta t}\int_0^{\overline{w}} \max\left(V_{Pr}(x), V_{Pr}(w)\right) dF_{Pr}(x), \end{aligned}$$

which can be simplified in

$$\begin{aligned} V_{Pr}(w)\,(\rho+\delta) \quad &= \quad w - c + \delta V_n \\ &+ \quad \lambda_{Pr,Pr}\int_w^{\overline{w}} \left(V_{Pr}(x) - V_{Pr}(w)\right) dF_{Pr}(x). \end{aligned} \tag{A.15}$$

– A currently nonemployed person enjoys a net flow of income $b-c-d_{Pu}c_{Pu}$ depending on her choice to search for a public job ($d_{Pu} = 1$) or not ($d_{Pu} = 0$). We assume that he must search for a private job.

$$\begin{aligned} V_n^{d_{Pu}} \quad = \quad & \frac{(b-c-d_{Pu}c_{Pu})}{1+\rho\Delta t}\Delta t + \frac{\Delta t}{1+\rho\Delta t}\lambda_{n,Pr}\mathbb{E}_{F_{Pr}}\left(\max\left(V_n, V_{Pr}(X)\right)\right) \\ & + \frac{\Delta t}{1+\rho\Delta t}\lambda_{n,Pu}d_{Pu}\mathbb{E}_{F_{Pu}}\left\{\max\left(V_n, p_S V_{Pu}(X) + (1-p_S)V_n\right)\right\} \\ & + \frac{1}{1+\rho\Delta t}\left(1-\lambda_{n,Pr}\Delta t - \lambda_{n,Pu}d_{Pu}\Delta t\right)V_n. \end{aligned} \tag{A.16}$$

For the nonemployed, the optimal acceptance rule consists in accepting the first job, whatever the sector, that pays more than a reservation wage w^* that is specific to the sector: w^*_{Pu} for the public sector and $w^{*,d_{Pu}}_{Pr}$ for the private sector ($w^{*,d_{Pu}=1}_{Pr}$ denotes the reservation wage when the unemployed search for both public and private jobs, $w^{*,d_{Pu}=0}_{Pr}$ when the unemployed search only for private jobs).

$$\begin{aligned} d_{Pu} \in \{0,1\} \quad V_{Pr}(w^{*,d_{Pu}}_{Pr}) \quad &= \quad V_n^{d_{Pu}} \\ V_{Pu}(w^*_{Pu}) \quad &= \quad V_n^{d_{Pu}=1}. \end{aligned}$$

These reservation wages exist and are unique because the private and public value functions are continuous and increasing functions. Therefore the equation (A.16) can be rewritten:[15]

$$\rho V_n^{d_{Pu}} \quad = \quad (b-c-d_{Pu}c_{Pu}) + \lambda_{n,Pr}\int_{w^*_{Pr}}^{\overline{w}} \left(V_{Pr}(x) - V_n\right) dF_{Pr}(x) \tag{A.17}$$

[15]Note that $\max\left(x, zp + (1-p)x\right) = p\max\left(x,z\right) + (1-p)x$ with $p \in]0,1[$

$$+\lambda_{n,Pu} d_{Pu} p \int_{w^*_{Pu}}^{\overline{w}} \left(V_{Pu}(x) - V_n\right) dF_{Pu}(x).$$

When does a nonemployed worker decide to search for a public job? Searching for a public job is actually costly and risky since individuals are not sure to succeed to enter public services. This cost of searching for a public job is induced by the fact that individuals have to pick up information, to prepare entrance exams. Hence nonemployed will search for a public job when their expected gains, which may depend on individual characteristics and unobserved ability, exceed the searching cost (see figure 7). So $d_{pu} = 1$ when:[16]

$$c_{Pu} \quad \leq \quad p_S \frac{\lambda_{n,Pu}}{\rho} \int_{h(w^*_{d=0})}^{\overline{w}} \overline{F}_{Pu}(x) dx, \tag{A.18}$$

We denote $\mathcal{U}_{pu} = p_S \frac{\lambda_{n,Pu}}{\rho} \int_{h(w^*_{d=0})}^{\overline{w}} \overline{F}_{Pu}(x) dx$ and $h(w^*_{d=0})$ is a function of $\left(b, \lambda_{n,Pr}, \lambda_{Pr,Pr}, \overline{w}, \rho, \delta, \overline{F}_{Pr}\right)$. $h(w^*_{d=0})$ can also be written as

$$h(w^*_{d=0}) \quad = \quad \frac{\lambda_{n,Pr}}{\lambda_{n,Pr} - \lambda_{Pr,Pr}} w^*_{d=0} - c - \frac{\lambda_{Pr,Pr}}{\lambda_{n,Pr} - \lambda_{Pr,Pr}} b \tag{A.19}$$

The probability to search for a public job is $\mathbb{P}\left(c_{Pu} \leq \mathcal{U}_{pu}\right)$. When the cost of searching for a public job is greater than $\mathcal{U}_{pu}$, the nonemployed had rather searched for a private job only. $\mathcal{U}_{pu}$ depends on individual characteristics, on the probability of passing the exam and finally, on the reservation wage via $h(w^*_{d=0})$.

Equation (A.18) entails that the value of the threshold, determining the search for a public job, is lower when the probability to succeed the entrance exams decreases or when the public arrival rate is lower. $\mathcal{U}_{pu}$ depends on $\lambda_{n,Pu}$ and p_S in a multiplicative way, since $h(w^*_{d=0})$ does not depend on these variables.

Which consequences? First, the higher the probability to pass the exam (p_S), the higher the probability to search for a public job. This feature is empirically illustrated by the fact that the individuals with a higher degree have a higher probability to pass the entrance exams. For instance, in 2006, among individuals who take the "*CAPES*" exam (entrance exam to become a high-school or secondary-school teacher), 53% had a "*licence*" degree (*L3*) and 44% had a "*maîtrise*" (*M1*), this latter degree requires an additional year of studies. Considering those who finally pass the exam, 58% had a maîtrise and only 41% had a licence. Similar features hold for other public-sector exams. The higher the degree, the higher the probability to pass the exam.

Second the unemployment rate is captured by the parameter δ, and $h(w^*_{d=0})$ depends on δ only by the way of $w^*_{d=0}$. It turns that $w^*_{d=0}$ diminishes when δ grows (see Appendix B and equation A.19). Hence the probability to search for a public job increases with δ.

The limits of the model

This model presents several limits: unemployed and nonparticipants are not distinguished. As the sample is composed of people aged between 16 and 59, largely economically active, this assumption is not very restrictive. Furthermore, the model assumes that public workers cannot search for a private job. This assumption is made for the sake of simplicity but if relaxed, our core results would not be modified. The function value associated to the public sector would be larger, since it is more flexible: the French civil servants could work a few years in the private sector and get

[16] Details are in appendix B

their public job back in the public sector. Henceforth they could not suffer from their private-job experience: even if laid off, they could recover a job in public services. In such a case, their wage would be the wage they had when departing for a private experience.

Finally the model does not take into account possible parental or sabbatic leaves for civil servants. Moreover we do not enable direct transitions from the public to the private sector, and vice versa. These limits would modify both the public and the private function values but the core results would not change.

B. Structural model

From (A.15), differentiating this latter equation with respect to w yields:

$$\begin{aligned}\rho V_{Pr}'(x) &= 1 - \delta V_{Pr}'(x) - \lambda_{Pr,Pr} V_{Pr}'(x)\overline{F}(x) \\ \Rightarrow V_{Pr}(x) - V_{Pr}(\overline{w}) &= -\int_x^{\overline{w}_{Pr}} \frac{1}{\rho + \delta + \lambda_{Pr,Pr}\overline{F}_{Pr}(y)} dy\end{aligned}$$

Let us consider both cases.

- Case 1: $d_{Pu} = 0$

  When the individual does not search for a public job, if he receives an offer with a wage w greater than $w^*_{d=0}$, he accepts this offer. The reservation wage $w^*_{d=0}$ checks: $V_n^{d=0} = V_{Pr}(w^*_{d=0})$. Henceforth:

$$\begin{aligned}V_n^{d=0}\rho &= (b-c) + \lambda_{n,Pr}\int_{w^*_{Pr,d=0}}^{\overline{w}} \left(V_{Pr}(x) - V_n\right) dF_{Pr}(x) \\ &= (b-c) + \lambda_{n,Pr}\int_{w^*_{Pr,d=0}}^{\overline{w}} V_{Pr}'(x)\overline{F}_{Pr}(x)dx \\ &\Rightarrow \begin{pmatrix} \rho V_n^{d=0} &= & (b-c) + \lambda_{n,Pr}\int_{w^*_{Pr,d=0}}^{\overline{w}} V_{Pr}'(x)\overline{F}_{Pr}(x)dx \\ \rho V_n^{d=0} &= & w^*_{Pr,d=0} - c + \lambda_{Pr,Pr}\int_{w^*_{Pr,d=0}}^{\overline{w}} V_{Pr}'(x)\overline{F}_{Pr}(x)dx \end{pmatrix}\end{aligned}$$

  And:

$$\begin{aligned}w^*_{Pr,d=0} &= b \\ &+ (\lambda_{n,Pr} - \lambda_{Pr,Pr})\int_{w^*_{Pr,d=0}}^{\overline{w}} \frac{\overline{F}_{Pr}(x)}{\rho + \delta + \lambda_{Pr,Pr}\overline{F}_{Pr}(x)} dx\end{aligned} \tag{B.20}$$

- Case 2: $d_{Pu} = 1$

  Let us proceed the same way thus we get:

$$\begin{aligned}\rho V_n^{d=1} &= (b - c - c_{Pu}) + \lambda_{n,Pr}\int_{w^*_{Pr,d=1}}^{\overline{w}} V_{Pr}'(x)\overline{F}_{Pr}(x)dx\lambda_{n,Pr} \\ &+ p\lambda_{n,Pu}\int_{w^*_{Pu}}^{\overline{w}} V_{Pu}'(x)\overline{F}_{Pu}(x)dx\end{aligned}$$

$$\rho V_n^{d=1} = w^*_{Pr,d=1} - c + \lambda_{Pr,Pr}\int_{w^*_{Pr,d=1}}^{\overline{w}} V'_{Pr}(x)\overline{F}_{Pr}(x)dx$$
$$V_n^{d=1} = V_{Pr}(w^*_{Pr,d=1}) = V_{Pu}(w^*_{Pu}) = \frac{w^*_{Pu}}{\rho}$$

Hence:

$$w^*_{Pu} = w^*_{Pr,d=1} - c + \lambda_{Pr,Pr}\int_{w^*_{Pr,d=1}}^{\overline{w}} \frac{\overline{F}_{Pr}}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}_{Pr}(x)}(x)dx$$
$$w^*_{Pr,d=1} = (b - c_{Pu}) + (\lambda_{n,Pr} - \lambda_{Pr,Pr})\int_{w^*_{Pr,d=1}}^{\overline{w}} \frac{\overline{F}_{Pr}(x)}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}_{Pr}(x)}dx + \frac{\lambda_{n,Pu}p}{\rho}\int_{w^*_{Pu}}^{\overline{w}} \overline{F}_{Pu}(x)dx$$

The values we have to compare to determine whether the individual searches for a public job, are $V_n^{d=0}$ and $V_n^{d=1}$, i.e. $V_{Pr}(w^*_{Pr,d=0})$ and $V_{Pr}(w^*_{Pr,d=1})$:

$$V_{Pr}(w^*_{Pr,d=1}) - V_{Pr}(w^*_{Pr,d=0}) = \int_{w^*_{Pr,d=0}}^{\overline{w}} \frac{1}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}(x)}dx - \int_{w^*_{Pr,d=1}}^{\overline{w}} \frac{1}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}(x)}dx$$

$$V_{Pr}(w^*_{Pr,d=1}) = V_{Pr}(w^*_{Pr,d=0}) \Leftrightarrow w^*_{Pr,d=1} = w^*_{Pr,d=0}$$
and
$$V_{Pr}(w^*_{Pr,d=1}) \geq V_{Pr}(w^*_{Pr,d=0}) \Leftrightarrow w^*_{Pr,d=1} \geq w^*_{Pr,d=0}$$

The nonemployed person searches for both public and private jobs when $w^*_{Pr,d=1} \geq w^*_{Pr,d=0}$.

From equations ($w^*_{Pr,d=0}$), ($w^*_{Pr,d=1}$) and (w^*_{Pu}), we get:

$$w^*_{Pr,d=0} = f(w^*_{Pr,d=0})$$
$$w^*_{Pr,d=1} = f(w^*_{Pr,d=1}) + g(w^*_{Pr,d=1})$$

with

$$f(x) = b + (\lambda_{n,Pr} - \lambda_{Pr,Pr})\int_{x}^{\overline{w}} \frac{\overline{F}_{Pr}(x)}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}_{Pr}(x)}dx$$
and
$$g(x) = -c_{Pu} + \frac{\lambda_{n,Pu}p}{\rho}\int_{h(x)}^{\overline{w}} \overline{F}_{Pu}(x)dx$$
and
$$h(x) = x - c + \lambda_{Pr,Pr}\int_{x}^{\overline{w}} \frac{\overline{F}_{Pr}(x)}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}_{Pr}(x)}dx$$

h is an increasing and bounded function with first derivative:

$$h'(x) = \frac{\rho+\delta}{\rho+\delta+\lambda_{Pr,Pr}\overline{F}_{Pr}(x)}$$

Hence g is a decreasing and bounded function and three different cases are possible. Indeed, $\forall x \in [0,\overline{w}]$, $0 \geq f'(x) \geq f'(x) + g'(x)$.

- $f(0)+g(0) \leq f(0)$: it means that a nonemployed person never searches for a public job for $w^*_{d=0} > w^*_{d=1}$.
- $f(0)+g(0) \geq f(0)$ and $f(\overline{w})+g(\overline{w}) \geq f(\overline{w})$: it means that a nonemployed person always searches for both public and private jobs.
- $f(0)+g(0) \geq f(0)$ and $f(\overline{w})+g(\overline{w}) < f(\overline{w})$: it means that a nonemployed person may search for a public job depending on $g(w^*_{d=0})$. If $g(w^*_{d=0}) \geq 0$ the nonemployed person will search for a public job, whereas she won't.
  We show that

$$w^*_{d=0} \leq w^*_{d=1} \quad \Leftrightarrow \quad g(w^*_{d=0}) \geq 0$$

  Indeed,

  ♢ On one hand,

$$\begin{array}{rl} & w^*_{d=0} \leq w^*_{d=1} \Rightarrow f(w^*_{d=0}) + g(w^*_{d=0}) \geq f(w^*_{d=1}) + g(w^*_{d=1}) \\ \text{And} & w^*_{d=0} \leq w^*_{d=1} \Rightarrow f(w^*_{d=0}) \leq f(w^*_{d=1}) + g(w^*_{d=1}) \\ \text{Thus} & f(w^*_{d=0}) \leq f(w^*_{d=0}) + g(w^*_{d=0}) \Rightarrow g(w^*_{d=0}) \geq 0 \end{array}$$

  ♢ On the other hand

$$\begin{array}{rl} & g(w^*_{d=0}) \geq 0 \Rightarrow f(w^*_{d=0}) \leq f(w^*_{d=0}) + g(w^*_{d=0}) \\ \text{Thus} & w^*_{d=0} \leq f(w^*_{d=0}) + g(w^*_{d=0}) \\ \text{And} & f(x)+g(x)-x \text{ is a decreasing function such as} \\ & \left\{ \begin{array}{l} f(w^*_{d=1}) + g(w^*_{d=1}) - w^*_{d=1} = 0 \\ f(w^*_{d=0}) + g(w^*_{d=0}) - w^*_{d=0} \geq 0 \end{array} \right\} \\ \Rightarrow & w^*_{d=1} \geq w^*_{d=0} \end{array}$$

Proposition B.1 *Search for a public job*
The nonemployed agent decides to search for both public and private jobs when:

$$\begin{array}{rcl} c_{Pu} & \leq & p_S \dfrac{\lambda_{n,Pu}}{\rho} \displaystyle\int_{h(w^*_{d=0})}^{\overline{w}} \overline{F}_{Pu}(x)dx \\ & & \textit{where} \quad h(w^*_{d=0}) \textit{is a function of } \left(b, \lambda_{n,Pr}, \lambda_{Pr,Pr}, \overline{w}, \rho, \delta, \overline{F}_{Pr}\right) \end{array}$$

with:

- c_{Pu} *the cost to search for a public job*
- $\lambda_{n,Pu}$ *the public job offer arrival rate*
- p_S *the individual probability to succeed public entrance exam*
- $h(w^*_{d=0}) = \frac{\lambda_{n,Pr}}{\lambda_{n,Pr}-\lambda_{Pr,Pr}} w^*_{d=0} - c - \frac{\lambda_{Pr,Pr}}{\lambda_{n,Pr}-\lambda_{Pr,Pr}} b$

He only searches for private jobs when:

$$c_{Pu} \quad > \quad p_S \frac{\lambda_{n,Pu}}{\rho} \int_{h(w^*_{d=0})}^{\overline{w}} \overline{F}_{Pu}(x)dx$$

C. Descriptive Statistics

see figure 8.

D. Implementation

D.1. M-step

In the M-step, we maximize the expected completed log likelihood:

$$\sum_{i=1}^{N}\sum_{k=1}^{K}\pi_{ik}^{(n)}\ln l\left(\underline{y}_i,\underline{z}_i,\underline{w}_i|T_i=k,\beta,\sigma_{Pu}^2,\sigma_{Pr}^2,(\pi_k)_{k=1}^K,(\theta_k)_{k=1}^K\right) \tag{D.21}$$

with $\beta=\left(\beta^Y,\beta^Z,\beta^{Pr},\beta^{Pu}\right)$.

$$\begin{aligned}
& l\left(\underline{y}_i,\underline{z}_i,\underline{w}_i|T_i=k,\beta,\sigma_{Pu}^2,\sigma_{Pr}^2,(\pi_k)_{k=1}^K,(\theta_k)_{k=1}^K\right)\\
= & \prod_{t=1}^{T}\left(\mathbb{P}\left(y_{it}=0|T_i=k,(\theta_k^Y)_k,\beta^Y\right)\right)^{y_{it}=0}\\
& \left(\mathbb{P}\left(y_{it}=1,z_{it}=1,w_{it}^{Pr}|T_i=k,\beta,\sigma_{Pu}^2,\sigma_{Pr}^2,(\pi_k)_{k=1}^K,(\theta_k)_{k=1}^K\right)\right)^{y_{it}=1,z_{it}=1}\\
& \left(\mathbb{P}\left(y_{it}=1,z_{it}=0,w_{it}^{Pu}|T_i=k,\beta,\sigma_{Pu}^2,\sigma_{Pr}^2,(\pi_k)_{k=1}^K,(\theta_k)_{k=1}^K\right)\right)^{y_{it}=1,z_{it}=0}
\end{aligned}$$

Since, given the individual type, for a given date, residuals are independent, we have:

$$\begin{aligned}
& l\left(\underline{y}_i,\underline{z}_i,\underline{w}_i|T_i=k\right)\\
= & \prod_{t=1}^{T}\left(\mathbb{P}\left(y_{it}=0|T_i=k,(\theta_k^Y)_k,\beta^Y\right)\right)^{y_{it}=0}\left(\mathbb{P}\left(y_{it}=1|T_i=k,(\theta_k^Y)_k,\beta^Y\right)\right)^{y_{it}=1}\\
& \prod_{t=1}^{T}\left(\mathbb{P}\left(z_{it}=1|T_i=k,(\theta_k^Z)_k,\beta^Z,\gamma,(\theta_k^{Pr})_k,\beta^{Pr},(\theta_k^{Pu})_k,\beta^{Pu},\right)\right)^{y_{it}=1,z_{it}=1}\\
& \prod_{t=1}^{T}\left(\mathbb{P}\left(z_{it}=0|T_i=k,(\theta_k^Z)_k,\beta^Z,\gamma,(\theta_k^{Pr})_k,\beta^{Pr},(\theta_k^{Pu})_k,\beta^{Pu}\right)\right)^{y_{it}=1,z_{it}=0}\\
& \prod_{t=1}^{T}\left(\mathbb{P}\left(w_{it}^{Pu}|T_i=k,(\theta_k^{Pu})_k,\beta^{Pu},\sigma_{Pu}^2\right)\right)^{y_{it}=1,z_{it}=0}\\
& \prod_{t=1}^{T}\left(\mathbb{P}\left(w_{it}^{Pr}|T_i=k,(\theta_k^{Pr})_k,\beta^{Pr},\sigma_{Pr}^2\right)\right)^{y_{it}=1,z_{it}=1}
\end{aligned}$$

We hence get four sequential optimization problems:

1. Optimization on the employment equation parameters

$$\begin{aligned}
\max_{\beta^Y,(\theta_k^Y)_{k=1}^K}\sum_{k=1}^{K}\sum_{i=1}^{N}\sum_{t=1}^{T} \quad & \pi_{ik}^{(n)}\mathbb{I}_{y_{it}=0}\ln\Phi\left(-X_{it}^Y\beta_Y-\theta_k^Y\right)\\
+ \quad & \pi_{ik}^{(n)}\mathbb{I}_{y_{it}=1}\ln\Phi\left(X_{it}^Y\beta_Y+\theta_k^Y\right),
\end{aligned}$$

   where Φ denotes the cumulative distribution function of a standardized gaussian.

2. Optimization on the wage equations parameters

$$\min_{\beta^{Pr},\sigma_{Pr},(\theta_k^{Pr})_{k=1}^K} \sum_{k=1}^K\sum_{i=1}^N\sum_{t=1}^T \quad \pi_{ik}^{(n)}\mathbb{I}_{y_{it}=1,z_{it}=1}\ln(\sigma_{Pr}) + \frac{\pi_{ik}^{(n)}}{2\sigma_{Pr}^2}\mathbb{I}_{y_{it}=1,z_{it}=1}(w_{it}^{Pr}-X_{it}^{Pr}\beta_{Pr}-\theta_k^{Pr})^2,$$

and

$$\min_{\beta^{Pu},\sigma_{Pu},(\theta_k^{Pu})_{k=1}^K} \sum_{k=1}^K\sum_{i=1}^N\sum_{t=1}^T \quad \pi_{ik}^{(n)}\mathbb{I}_{y_{it}=1,z_{it}=0}\ln(\sigma_{Pu}) + \frac{\pi_{ik}^{(n)}}{2\sigma_{Pu}^2}\mathbb{I}_{y_{it}=1,z_{it}=1}(w_{it}^{Pu}-X_{it}^{Pu}\beta_{Pu}-\theta_k^{Pu})^2.$$

3. Optimization on the sector choice equation parameters

$$\max_{\gamma,\beta^Z,(\theta_k^Z)_{k=1}^K} \sum_{k=1}^K\sum_{i=1}^N\sum_{t=1}^T \quad \pi_{ik}^{(n)}\mathbb{I}_{y_{it}=1,z_{it}=0}\ln\Phi\left(-X_{it}^Z\beta_Z-\theta_k^Z-\gamma\left(X_{it}^{Pr}\beta_{Pr}+\theta_k^{Pr}-X_{it}^{Pr}\beta_{Pu}-\theta_k^{Pu}\right)\right) + \pi_{ik}^{(n)}\mathbb{I}_{y_{it}=1,z_{it}=1}\ln\Phi\left(X_{it}^Z\beta_Z+\theta_k^Z+\gamma\left(X_{it}^{Pr}\beta_{Pr}+\theta_k^{Pr}-X_{it}^{Pr}\beta_{Pu}-\theta_k^{Pu}\right)\right),$$

D.2. Monte Carlo Simulation

In order to be sure no mistake were left in the Gauss Code, we run a monte carlo simulation. We simulate 100 samples made up of 700 individuals observed over 3 time periods according to:

$$y_{it} = \mathbf{1}\left(X_{it}^Y\beta^Y+\theta_{k(i)}^Y+u_{it}^Y>0\right) \tag{D.22}$$

And if $y_{it}=1$,

$$z_{it} = \mathbf{1}\left(X_{it}^Z\beta^Z+\gamma\mathbb{E}\left(w_{it}^{Pr}-w_{it}^{Pu}|k(i)\right)+\theta_{k(i)}^Z+u_{it}^Z>0\right) \tag{D.23}$$

$$w_{it}^{Pr} = z_{it}\left(X_{it}^{Pr}\beta^{Pr}+\theta_{k(i)}^{Pr}+u_{it}^{Pr}\right) \tag{D.24}$$

$$w_{it}^{Pu} = (1-z_{it})\left(X_{it}^{Pu}\beta^{Pu}+\theta_{k(i)}^{Pu}+u_{it}^{Pu}\right) \tag{D.25}$$

where

$\theta = \left(\theta^Y,\theta^Z,\theta^{Pr},\theta^{Pu}\right)$ denotes the vector of the unobserved heterogeneity components. We use 4 types of unobserved heterogeneity.

$k(i)$ denotes the type of the individual k,

$X = \left(X^Y,X^Z,X^{Pr},X^{Pu}\right)$ denotes the vector of the observable characteristics. Each equation has 3 observed explanatory variables, normally distributed.

$\beta = \left(\beta^Y,\beta^Z,\beta^{Pr},\beta^{Pu}\right)$ denotes the vector of parameters,

$u = \left(u^Y,u^Z,u^{Pr},u^{Pu}\right)$ denotes the vector of residuals, which are assumed to be independent and normally distributed across time and individuals, with variance σ_{Pr}^2 (resp. σ_{Pu}^2).

Table D.2 reports the original values and the estimates of the parameters. The results confirm the absence of fatal error in the code.

Parameters	Estimates	Original Values
β_1^Y	-2.716	-2.672
β_2^Y	0.069	0.065
β_3^Y	-2.967	-2.914
β_1^Z	2.166	2.152
β_2^Z	-3.315	-3.264
β_3^Z	1.130	1.121
β_1^{Pr}	-5.218	-5.218
β_2^{Pr}	3.758	3.755
β_3^{Pr}	1.146	1.141
$\sigma^{2,Pr}$	0.672	0.607
β_1^{Pu}	8.930	8.931
β_2^{Pu}	-0.160	-0.157
β_3^{Pu}	5.656	5.658
$\sigma^{2,Pu}$	1.137	1.105
π_1	0.398	0.400
π_2	0.095	0.100
π_3	0.207	0.200
π_4	0.300	0.300
Y *equation*		
$\theta_{k=1}^Y$	2.042	2.000
$\theta_{k=2}^Y$	-5.029	-5.000
$\theta_{k=3}^Y$	3.914	4.000
$\theta_{k=4}^Y$	5.110	5.000
Z *equation*		
$\theta_{k=1}^Z$	-1.022	-1.000
$\theta_{k=2}^Z$	-3.010	-3.000
$\theta_{k=3}^Z$	1.656	2.000
$\theta_{k=4}^Z$	-2.778	-3.000
W^{Pr} *equation*		
$\theta_{k=1}^{W^{Pr}}$	-3.015	-3.000
$\theta_{k=2}^{W^{Pr}}$	-0.872	-1.000
$\theta_{k=3}^{W^{Pr}}$	3.729	4.000
$\theta_{k=4}^{W^{Pr}}$	2.092	2.000
W^{Pu} *equation*		
$\theta_{k=1}^{W^{Pu}}$	4.975	5.000
$\theta_{k=2}^{W^{Pu}}$	-1.682	-2.000
$\theta_{k=3}^{W^{Pu}}$	-1.797	-2.000
$\theta_{k=4}^{W^{Pu}}$	2.757	3.000

E. Quantile differences between the public log of wage distributions and the counterfactual distribution

Table 9. Quantile differences between the public log of wage and the counterfactual distributions.

	1994	1995	1996	1997	1998	1999	2000	2001
Quantiles				*Estimates*				
				Standard Errors				
0.050	0.157	0.170	0.158	0.154	0.155	0.157	0.157	0.168
	0.035	0.031	0.036	0.033	0.032	0.033	0.034	0.036
0.100	0.148	0.161	0.159	0.154	0.157	0.155	0.153	0.158
	0.030	0.029	0.030	0.029	0.027	0.029	0.029	0.031
0.150	0.135	0.147	0.147	0.144	0.148	0.146	0.143	0.145
	0.028	0.027	0.028	0.027	0.026	0.027	0.027	0.028
0.200	0.123	0.133	0.135	0.131	0.137	0.135	0.133	0.134
	0.027	0.026	0.027	0.026	0.025	0.025	0.025	0.026
0.250	0.113	0.121	0.124	0.120	0.126	0.126	0.124	0.123
	0.026	0.025	0.025	0.025	0.024	0.024	0.024	0.025
0.300	0.105	0.111	0.113	0.111	0.116	0.116	0.114	0.114
	0.025	0.025	0.024	0.024	0.024	0.024	0.023	0.024
0.350	0.096	0.102	0.104	0.102	0.107	0.106	0.107	0.105
	0.024	0.024	0.023	0.023	0.023	0.023	0.023	0.023
0.400	0.089	0.093	0.095	0.094	0.099	0.098	0.098	0.097
	0.024	0.023	0.023	0.023	0.023	0.023	0.022	0.022
0.450	0.082	0.085	0.087	0.087	0.090	0.089	0.090	0.089
	0.023	0.023	0.023	0.022	0.023	0.022	0.022	0.022
0.500	0.075	0.078	0.080	0.080	0.082	0.082	0.082	0.082
	0.023	0.022	0.022	0.022	0.023	0.022	0.022	0.022
0.550	0.069	0.071	0.073	0.074	0.075	0.075	0.074	0.075
	0.023	0.022	0.023	0.022	0.023	0.022	0.022	0.021
0.600	0.062	0.065	0.066	0.067	0.067	0.067	0.066	0.068
	0.023	0.022	0.022	0.022	0.023	0.022	0.022	0.021
0.650	0.056	0.058	0.059	0.060	0.060	0.060	0.058	0.060
	0.024	0.022	0.023	0.021	0.023	0.023	0.022	0.022
0.700	0.048	0.050	0.051	0.052	0.051	0.051	0.050	0.052
	0.024	0.023	0.022	0.022	0.023	0.023	0.022	0.022
0.750	0.040	0.042	0.042	0.043	0.041	0.042	0.039	0.042
	0.024	0.023	0.023	0.022	0.023	0.023	0.022	0.022
0.800	0.029	0.031	0.030	0.032	0.030	0.031	0.028	0.031
	0.024	0.023	0.023	0.023	0.024	0.023	0.023	0.023
0.850	0.016	0.017	0.017	0.018	0.016	0.017	0.015	0.017
	0.024	0.024	0.024	0.023	0.025	0.023	0.023	0.024
0.900	-0.003	-0.003	-0.004	-0.001	-0.002	0.000	-0.004	-0.003
	0.024	0.025	0.025	0.024	0.026	0.023	0.024	0.024
0.950	-0.037	-0.040	-0.039	-0.035	-0.033	-0.030	-0.032	-0.032
	0.023	0.025	0.026	0.025	0.027	0.025	0.026	0.025

Source: French European Household Survey.

F. Figures

Figure 1 Density of the log of wages in 1994.

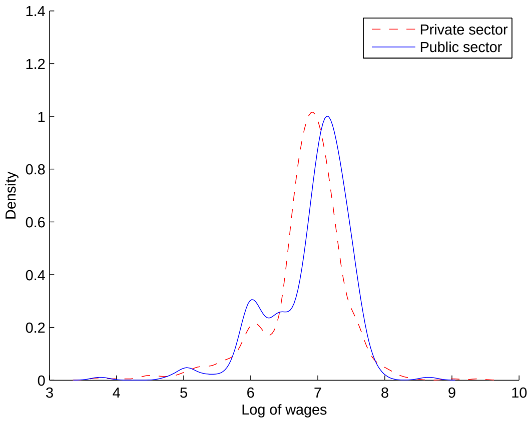

Figure 2 Predicted log of monthly wages - 1994

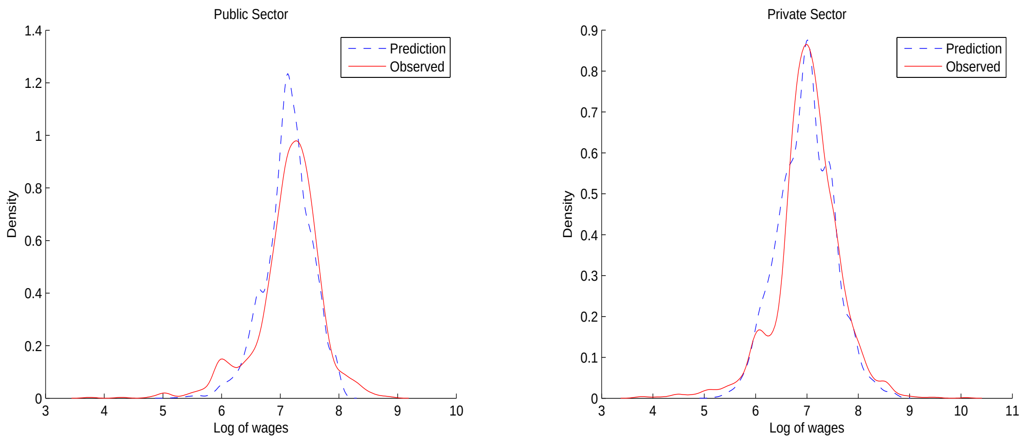

Figure 3 Counterfactual log of monthly wages for civil servants - 1994

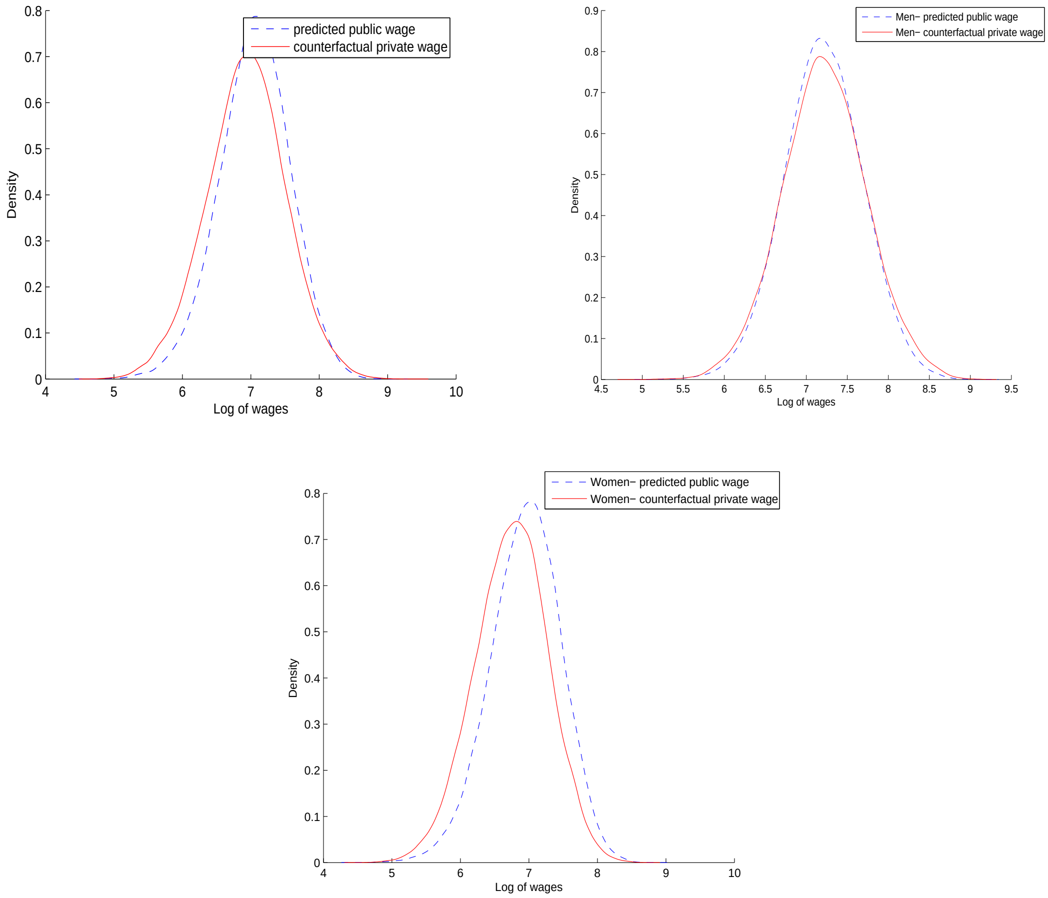

Figure 4 Counterfactual log of monthly wages according to degrees

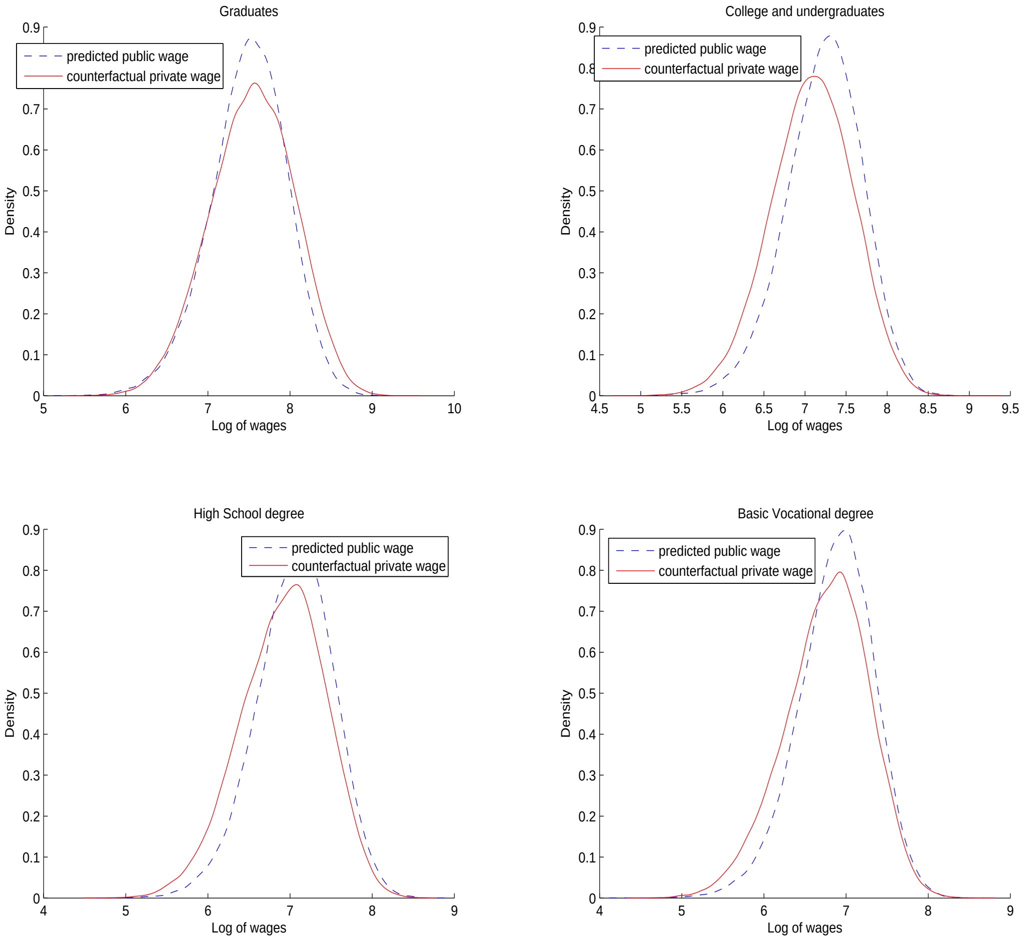

Figure 5 Quantile differences between counterfactual and public log of wage distribution from 1994 to 2001.

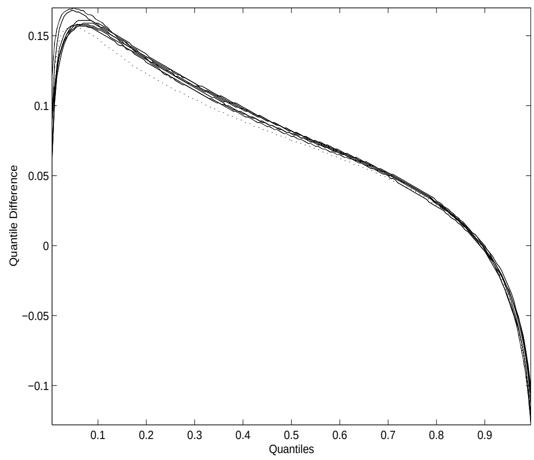

Figure 6 Quantile differences between the public log of wage and the counterfactual distributions given sex and degrees.

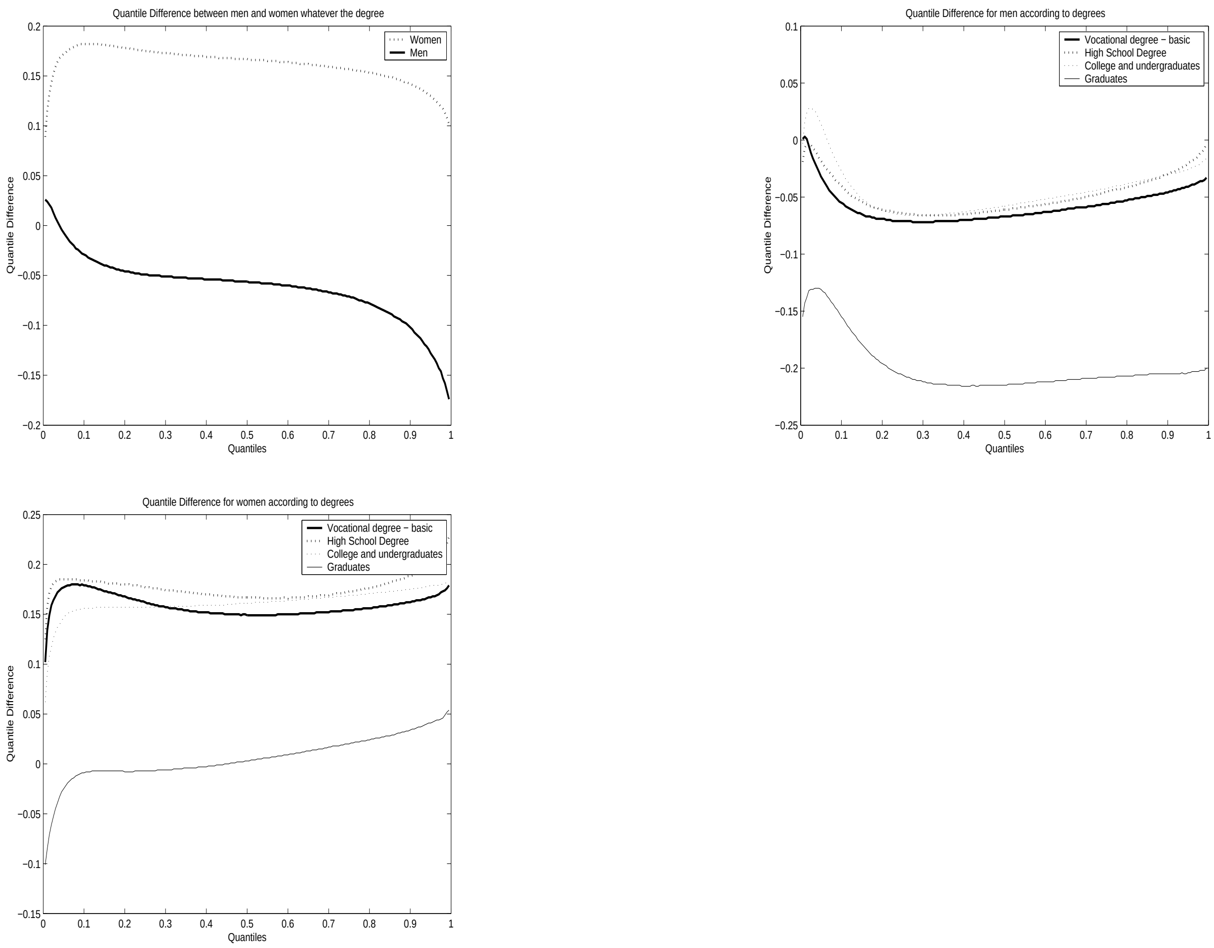

Figure 7 Value function comparison

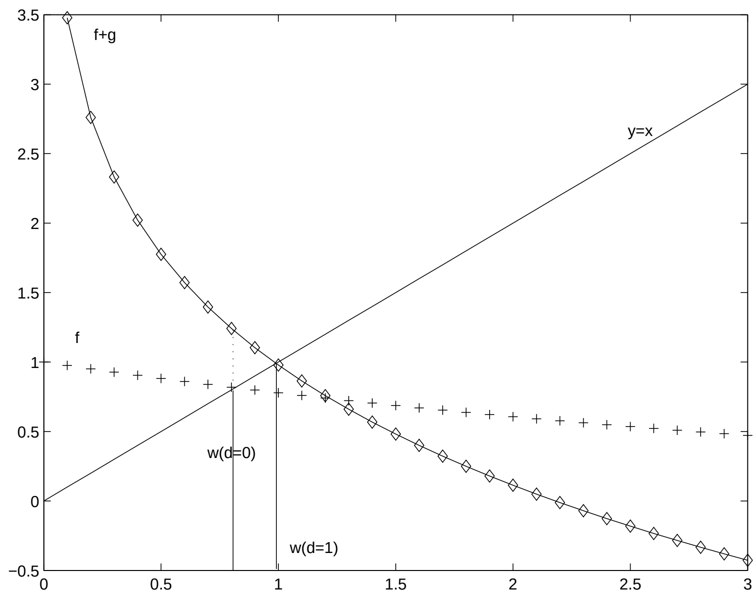

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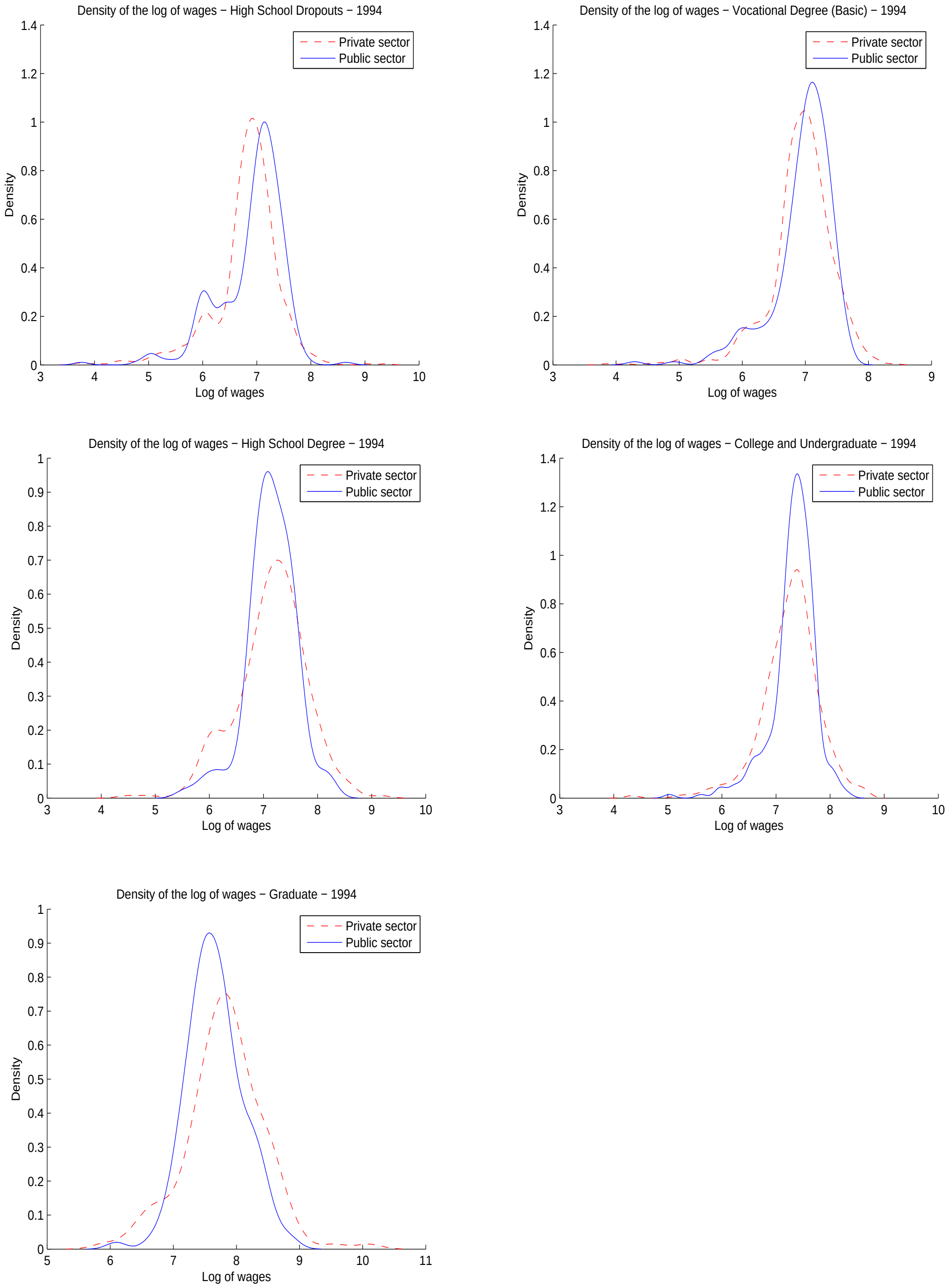
Figure 8 Wages according to degrees



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