Public-sector employment over the life cycle*

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May 23, 2019

PRELIMINARY AND INCOMPLETE

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Abstract

The size of the public sector in terms of employment and the compensation it pays to its workers have a strong life-cycle dimension in the United States, United Kingdom, France and Spain. We establish a quantitative partial-equilibrium life-cycle model with incomplete markets, with a private and public sectors and risk-averse workers. We analyse the role of public-sector employment in shaping workers labour market outcomes over their life cycle, both in terms of employment choice and savings. We use the model to: (i) calculate the public-sector wage, pension, and job-security premia, and (ii) quantify the effects of harmonizing the public and private sector. We find that the job-security and pension's premia are important forms of compensation to public-sector workers, and are valued differently over the life cycle. Harmonizing the characteristic of the public-sector employment, with those of the private, would lower unemployment rate and reduce government costs.

JEL Classification: J24, J45, E24, H30, O11.

Keywords: public sector employment, public sector wages, life-cycle, unemployment, retirement.

*We would like to thank participants at the SAEe meetings and in seminars at Universidad Autonoma de Madrid and Universite Cergy-Pontoise.

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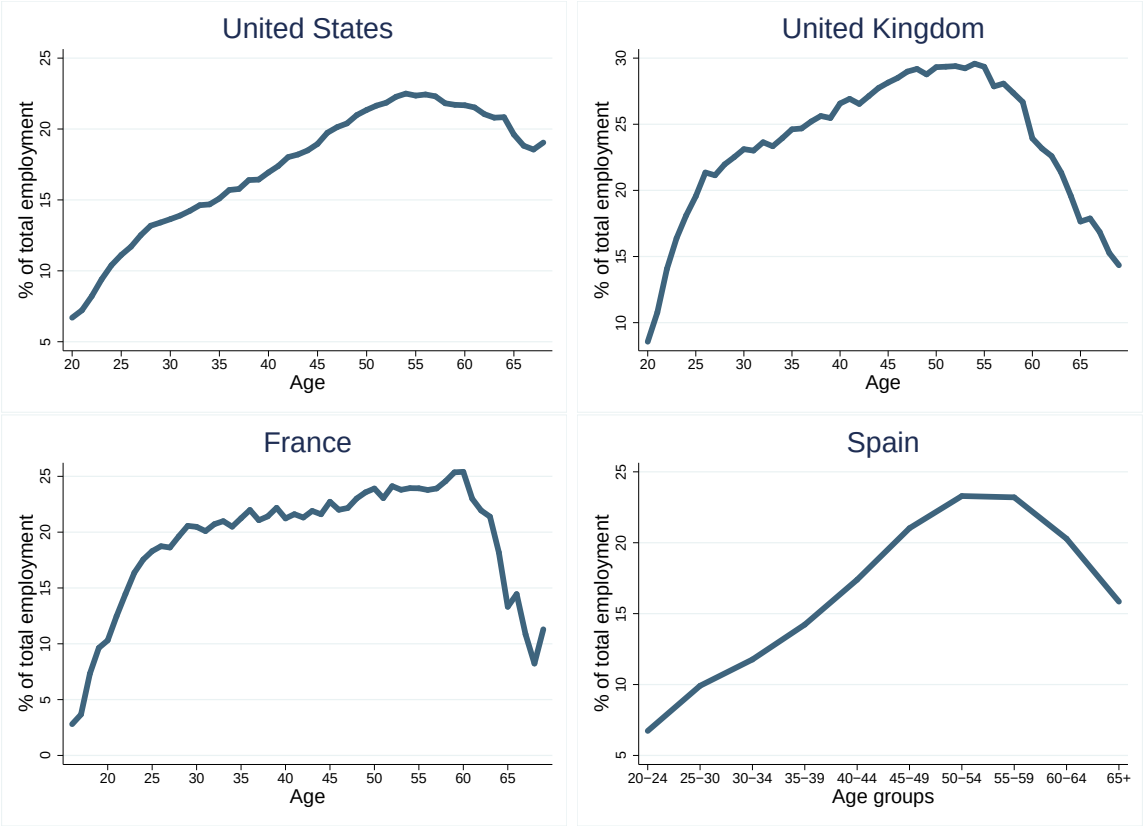
1 Introduction

The public sector is a sizable employer. In most developed economies, the public sector accounts for 15 to 20 percent of total employment. The importance of the public sector in employment and the compensation it pays to workers have a strong life-cycle component. Regarding public-sector employment, Figure 1 shows its percentage out of total employment by age for the United States, United Kingdom, France and Spain. Public-sector employment represents a small fraction of total employment for young workers, but progressively grows, peeking at ages 50 to 60, a feature shared in the four countries.

There is also a life-cycle profile in the compensation of public-sector worker. One form of compensation - public-sector wages - has been widely studied by the empirical literature that uses micro-level data to estimate public-private wage differentials. The literature usually finds that the public-sector pay relatively higher wages, particularly to low educated workers, but that these differentials are not homogeneous by age. Some recent examples include are Christofides and Michael (2013), Castro et al. (2013) for several European countries, and some older examples include Katz and Krueger (1991) for the United States or Disney and Gosling (1998) for the United Kingdom. But wages are not the only form of compensation in the public sector. What is perhaps more relevant for older workers, is that retirement benefits are often higher in the public sector. Traditionally, in many countries, public-sector workers enjoyed separate pensions schemes with earlier retirement age and larger benefits. In recent years, given budgetary pressures many countries implemented reforms to harmonize the two regimes, as described in OECD (2017), but still differences between the two sectors linger. A third component of compensation is the job security offered by the public sector - a distinctive features of public-sector jobs in many countries.

Our objective is to study how employment and compensation schemes in the public sector shape workers' labour market outcomes and savings over their life cycle. To this end, we set up a partial equilibrium, incomplete markets, life cycle model, with a public and private sector. We introduce, search and matching frictions in the labour market - crucial to analyse the precautionary savings behaviour of workers. We use the model to

Figure 1: Public sector employment over the life cycle,



Note: The figure show public sector employment out of total employment by age. For the United States the data is take from CPS (1996-2017), for the United Kingdom from the UK Labour Force Survey (2003-2016), for France for the French Labour Force Survey (2003-2016) and from Spain from the Spanish Labour Force Survey (2005-2007). See for details on the methodology in Fontaine et al (2018).

study the three forms of compensation in the public sector: wages, retirement benefits and job security, and the effects of reforms harmonizing the public and private sectors.

We calibrate the model to the four economies shown in Figure 1. We chose these four countries for two reasons. First, these countries are very heterogeneous in several dimensions. Their public sectors have different sizes, with UK and France having larger public sectors with 23 and 21 percent of total employment, and US and Spain having smaller public sectors (16 percent of total employment). They also have various industry composition of the public sector, different hiring methods and different labour market institutions. The fact that we find a common pattern with respect to the age profile of employment, means that we can consider it to be a general characteristics of the public sector. Second, these countries represent the variety of different institutional arrangement regarding pensions, as highlighted in the report Pensions at a Glance by OECD (2017).

France has an entirely separate system for civil servants. United States and the United Kingdom have a fully integrated system with a top-up components for civil servants beyond the mandatory schemes for private-sector workers. Finally, Spain had different schemes as France, but in 2011 implemented a series of reforms and now has a fully integrated system between the two sectors. However, during the transition, the new scheme only affects new entrants while current workers are kept in the dual scheme. We encapsulate the differences between sectors by the differences in replacement rates, whose estimates for the different countries are provided in the aforementioned report.

In periodic discussions on whether public-sector workers are overpaid or underpaid, alongside with the evidence from the public-private wage differentials, there is often the argument that public-sector worker receive this pension premium, that should be taken in account when setting their pay. It is also argued that government workers are offered more insurance (in terms of lower probability of facing unemployment) and that too should be reflected in lower relative pay. While these two forms of compensation seem to be of extreme relevance for policy makers, up to our knowledge there are few attempts to calculate them. One notable exception is Danzer and Dolton (2012) that calculate the total reward differentials, but including current earnings, pensions, hours of work, paid holidays, employer provided health care and probability of unemployment, using survey data from the UK. We use our quantitative model, calibrated to the four countries, to measure public-sector pensions and job-security premia, by calculating what percentage increase of their wage would be required by public-sector workers to accept its loss, and compare them to the traditional wage premium. Importantly, our model allows us to characterize these premia (wage, pensions and job security) for the entire distribution of workers over the life-cycle.

We find that the job-security and pension's premia are important forms of compensation to public-sector workers, and are valued differently over the life cycle. On average, the total public-sector premium is higher for the United Kingdom and Spain with total premia of between 35 and 47 percent, and lower in France where there are fewer differences between sectors. The total public-sector premia is increasing sharply with age,

mainly driven by the retirement premium. Weighting the values over the life-cycle by the number of public-sector workers by age, we find that in the four countries, the pensions premium accounts for more than half of the total premia.

Finally, we use the model to evaluate the welfare gains of harmonizing pension schemes. We find that when equating wages, replacement rates and job-separation probabilities to those of the private sector, would lower the unemployment rate by between 1 to 2 percentage points in the US, UK and Spain, and would improve the government fiscal position with lower government spending in unemployment and social security benefits.

We contribute to a recent labor market search literature that analyzes the role and effects of public-sector employment and wages. Burdett (2012) includes the public sector in a job-ladder framework where firms post wages. Bradley et al. (2017) further introduce on-the-job search and transitions between the two sectors to study the effects of public-sector policies on the distribution of private-sector wages. Albrecht et al. (2017) consider heterogeneous human capital and match specific productivity in a Diamond-Mortensen-Pissarides model. These papers assume that the unemployed randomly search across sectors, and, hence, public-sector policies affect the equilibrium only by affecting the outside option of the unemployed and their reservation wage. Gomes (2015) emphasizes the role of public-sector wage policy in achieving the efficient allocation, while Afonso and Gomes (2014) highlight the interactions between private and public wages. Gomes (2017) explicitly consider heterogeneity in terms of education and examines the effects of a public-sector wage reform that equates the wage of all public-sector workers, to their private-sector counterparts. These papers assume that the two sectors's labor markets are segmented, and that the risk-neutral unemployed choose which of the sectors to search in, depending on the government's hiring, separation and wage policies. We follow this assumption of segmented markets. We think it portrays a realistic mechanism of selection into the public sector in several countries, documented empirically by Nickell and Quintini (2002) or experimentally by Bó et al. (2013), lying at the heart of current policy discussions. High public wages attract many unemployed to queue for public-sector jobs. Conversely, if public wages are too low, few unemployed search in the public sector,

which then faces recruitment problems.

We add to the literature by explicitly introducing a life-cycle dimension and by analysing how wealth interacts differently with the private and public sector in the presence of risk-averse agents. On the one hand, we can examine how the accumulated wealth of an unemployed affects the choice of where to search. Because turnover is lower in the public sector and the conditions offered are better, it takes longer to find a job there so only richer unemployed can afford to queue for the public sector. On the other hand, as job are safer in the public sector, wage profiles different, and pension schemes more generous, public sector workers have different savings' behaviour than their private sector counterpart (both for precautionary, life-cycle and retirement motives). Allowing for savings as an insurance mechanism is important to calculate the insurance value of the public sector jobs. In this sense, our paper is related to Hörner et al. (2007) who present a search model with risk-averse agents to study the effect of wage uncertainty on unemployment when wages in the public sector are insulated from this volatility. We add to them by explicitly considering savings as a self-insurance mechanism, a life-cycle structure and different age-varying job-separation probabilities in the two sectors.

The interaction of the life cycle structure with the public sector has been studied in models without search frictions. Cavalcanti and Santos (2017) set up an occupational choice model and argue that higher wages and better pensions in the public sector might lead to misallocation of resources with a lower entrepreneurship rate. Reis and Zilberman (2014) set up an incomplete markets model to measure the degree of insurance provided by public sector jobs. In their model, job security is modelled in reduced form by a less volatile and more compressed wages schedule.

The paper is structured as follows. Section 2 presents the model economy with search and matching frictions. Section 3 describes the calibration and the fit of the model. Section 4 examines the effects of public-sector employment and wages over the lifecycle, as well as the effects of the social security reforms harmonizing the two sectors. Section 5 concludes.

2 Model

2.1 General setup

We consider a model with private-sector firms and a public sector. There is a unit mass of risk-averse workers, equally distributed over age $h \in (1, H)$ and discount the future at rate β. Workers are heterogeneous with respect to their education type, e (college vs non-college). During their working life, workers are either unemployed (u) or employed in the public (g) or private (p) sector.

Workers may accumulate assets, a, to insure against the risk of unemployment, for life-cycle reasons, or for retirement. Assets pay a risk free return $R = 1 + r$. Workers decide how much to save and consume and, if they are unemployed, which sector to search. When employed in the private sector, workers earn $w^P_{h,e}$ and become unemployed with probability $\delta^P_{h,e}$. Similarly, when working in the public sector, workers earn $w^G_{h,e}$ and become unemployed with probability $\delta^G_{h,e}$. When unemployed, they receive unemployment benefits $b_{h,e}$. We can construct two measures of average life-time earnings, one for each sector ($\bar{E}^P_h$, $\bar{E}^G_h$), which summarize the workers' career and evolve according to:

$$\bar{E}^P_{h+1} = \begin{cases} \frac{w^P_h + \bar{E}^P_h h}{h+1} & \text{if employed private} \\ \frac{\bar{E}^P_h h}{h+1} & \text{if unemployed or employed in public} \\ \bar{E}^P_h & \text{if retired.} \end{cases} \tag{1}$$

$$\bar{E}^G_{h+1} = \begin{cases} \frac{w^G_h + \bar{E}^G_h h}{h+1} & \text{if employed public} \\ \frac{\bar{E}^G_h h}{h+1} & \text{if unemployed or employed private} \\ \bar{E}^G_h & \text{if retired.} \end{cases} \tag{2}$$

Workers retire at age $H_w + 1$ and receive retirement benefits. Benefits replace a fraction of average life-time earnings. There are two different replacement rates (rr^P and rr^G), each one applying to the contributive careers in each sector: ($\bar{E}^P_h$ and $\bar{E}^G_h$). Hence, the social security benefits in retirement are given by $ss = rr^P \bar{E}^P + rr^G \bar{E}^G$.

2.2 Search

An unemployed decide to search for a job in the public or private sector in a given sub-market Z, as depicted in Figure 2. Each sub-market in the private and public sectors is segmented by age and education $Z = [h, e]$. Let u_Z^P and u_Z^G denote the amount of unemployed workers search in the private and public sector, respectively. Within each sub-market, the unemployed select into one or the other sector based on the remaining state variables $[a, \bar{E}_h^P, \bar{E}_h^G]$.

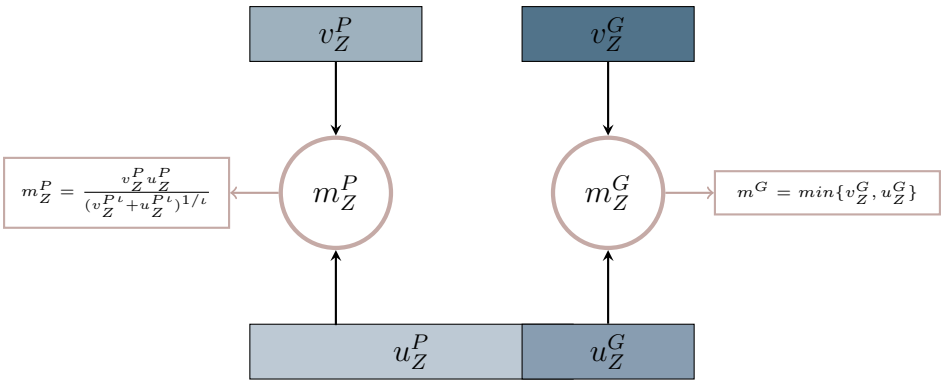
Denote by v_Z^P and v_Z^G the number of private- and public-sector vacancies in given sub-market. The number of new matches that become productive in the next period is given by

$$m_Z^P = \frac{v_Z^P u_Z^P}{(v_Z^{P\iota} + u_Z^{P\iota})^{1/\iota}}. \tag{3}$$

$$m_Z^G = min\{v_Z^G, u_Z^G\} \tag{4}$$

We assume the matching function in the public sector for simplicity. The assumption has been used previously by Quadrini and Trigari (2007) or Chassamboulli and Gomes (2018), and there is evidence that the elasticity of matches with respect to unemployed is much lower in the public sector than in the private (Gomes (2015)). This assumption is not crucial and it does not imply that there are no matching frictions, only that they are one-sided. Nothing substantial would change in the model if the matching function in the public sector was equal to that of the private sector. In such case, the vacancy filling probability of the government would no longer be 1, and it would need to set

Figure 2: Unemployed choice,



endogenously the vacancies such that the total number of matches would equate exactly the number of workers that it wanted to hire, but the job-finding rate of the unemployed would be exactly the same.

Denote by $\theta_Z^X = \frac{v_Z^X}{u_Z^X}$ the labor market tightness in a specific sub-market. The job finding probabilities and the vacancy filling rate in the private sector are given by

$$p^G(\theta_Z^G) = \frac{m_Z^G}{u_Z^G} = \theta_Z^G \tag{5}$$

$$p^P(\theta_Z^P) = \frac{m_Z^P}{u_Z^P} = \frac{1}{(1+\theta_Z^{P-\iota})^{1/\iota}} \tag{6}$$

$$q^P(\theta_Z^P) = \frac{m_Z^P}{v_Z^P} = \frac{1}{(1+\theta_Z^{P\iota})^{1/\iota}} \tag{7}$$

2.3 Value functions

Workers make their savings and search decisions to maximize utility, given by

$$U = \frac{c^{1-\gamma}}{1-\gamma},$$

In the value functions, we denote the pre-determined or deterministic state variables that define a sub-market - education and age - as a subscript. The remaining state variables that reflect choices - assets and average lifetime earnings in the two sectors - are expressed in brackets. The values of working in the private and public sectors are different. The value of employment in the public sector reads

$$VE_{h,e}^G(a, \bar{E}^P, \bar{E}^G) = \max_{a'}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \beta[(1-\delta_{h,e}^G)VE_{h+1,e}^G(a', \bar{E}^{P'}, \bar{E}^{G'}) + \delta_{h,e}^G VU_{h+1,e}(a', \bar{E}^{P'}, \bar{E}^{G'})]\right\} \tag{8}$$

$$c = (1+r)a + w_{h,e}^G(1-\tau(w_{h,e}^G)) - a', \tag{9}$$

where $VU_{h+1,e}(a', \bar{E}^{P'}, \bar{E}^{G'})$ is the value of unemployment in the following period, defined below. With a probability $\delta_{h,e}^G$, workers lose their jobs in the public sector and become

unemployed. Workers face a tax schedule $\tau(.)$ that depend on their level of income. They choose how much to consume c and to save a' to maximize their per-period utility plus the continuation value. Similarly, the value of employment in the private sector reads

$$VE^P_{h,e}(a,\bar{E}^P,\bar{E}^G) = \max_{a'}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \beta[(1-\delta^P_{h,e})VE^P_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'}) + \delta^P_{h,e}VU_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'})]\right\} \tag{10}$$

$$c = (1+r)a + w^P_{h,e}(1-\tau(w^P_{h,e})) - a'. \tag{11}$$

Private-sector workers face different wage and job-separation profile. When unemployed, individuals have to decide to search either for public or private sector jobs. The values of searching in the public sector or the private sector are given by:

$$VU^G_{h,e}(a,\bar{E}^P,\bar{E}^G) = \max_{a'}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \beta[\theta^G_{h,e}max\{VE^G_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'}), VU_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'})\}\right. \tag{12}$$

$$\left. + (1-\theta^G_{h,e})VU_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'})]\right\}$$

$$VU^P_{h,e}(a,\bar{E}^P,\bar{E}^G) = \max_{a'}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \beta[p^P(\theta^P_{h,e})max\{VE^P_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'}), VU_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'})\}\right. \tag{13}$$

$$\left. + (1-p^P(\theta^P_{h,e}))VU_{h+1,e}(a',\bar{E}^{P'},\bar{E}^{G'})]\right\} \tag{14}$$

$$c = (1+r)a + b_{h,e} - a'.$$

Unemployed individuals earn $b_{h,e}$ net of taxes. When searching in each of the sectors, the unemployed face different job-finding rates. Furthermore, the values will be different depending on their assets and average lifetime earning. If they found a job in a particular sector, they might decide not to take it, if the value of a job is lower than remaining unemployed. The unemployed chooses to search in the sector with highest value, so t the

value of unemployment solves

$$VU_{h,e}(a, \bar{E}^P, \bar{E}^G) = max\{VU^P_{h,e}(a, \bar{E}^P, \bar{E}^G), VU^G_{h,e}(a, \bar{E}^P, \bar{E}^G)\} \tag{15}$$

Finally, the value of retirement, $VR_{h,e}(a, \bar{E}^P, \bar{E}^G)$, is given by

$$VR_{h,e}(a, \bar{E}^P, \bar{E}^G) = \underset{a'}{max}\left\{\frac{c^{1-\gamma}}{1-\gamma} + \beta VR_{h+1,e}(a', \bar{E}^{P'}, \bar{E}^{G'})\right\} \tag{16}$$

$$c = (1+r)a + ss(1-\tau(ss)) - a'. \tag{17}$$

where gross social security benefit are given by $ss = rr^P \bar{E}^P + rr^G \bar{E}^G$. Retired individuals face the same tax schedule $\tau(.)$ that depend on their level of income. Once retired, the agents only decide how fast they deplete their savings.

2.4 Private-sector wages and job creation

We model the firm side of the model in a simplified way. When employed in the private sector, workers produce output $y(h, e)$ and receive wages that are a constant share of output $w^P_{h,e} = \lambda y_{h,e}$. Thus, profits are given by $\pi_{h,e} = (1-\lambda)y_{h,e}$. We assume entrepreneurs are risk neutral; thus, the resulting firm value is

$$VF_{h,e} = \pi_{h,e} + (1-\delta^P_{h,e})\beta VF_{h+1,e}. \tag{18}$$

When posting a vacancy, the entrepreneur pays flow costs κ. There is free entry into each vacancy sub-market, driving the value of a vacancy to zero and pinning down $\theta^P_{h,e}$)

$$0 = -\kappa + \beta q^P(\theta^P_{h,e}) \int\int\int \mathbf{I}^U_{h+1,e}(a', \bar{E}^{P'}, \bar{E}^{G'}) VF_{h+1,e} d\Lambda^{U^P}_{h,e}(a', \bar{E}^{P'}, \bar{E}^{G'}). \tag{19}$$

where $\mathbf{I}^U_{h+1,e}(a', \bar{E}^{P'}, \bar{E}^{G'})$ is an index whether a non-employed worker meeting a private sector job would accept it and $\Lambda^U_{h,e}(a, \bar{E}^{P'}, \bar{E}^{G'})$ is the pdf of the end of period stationary distribution of unemployed workers searching in the private sector at age h and education e. To make the model computational tractable, we assume workers are bounded rational

in predicting labor market tightness in the government sector. Instead of having rational expectations over θ_Z^G at each quarter, they have only rational expectations about tightness in the first quarter of each year and use cubic splines to approximate the labor market tightness within a calender year. Using as measure R^2, the approximation explains 99% of the realized variation.

2.5 Government

As typically in the recent literature on public-sector employment, we do not try to model why governments follow certain policies. We take them as exogenous from data and analyse its implications and the effects of policy changes. We exogenously set government vacancies $v_{h,e}^G$ in each sub-market to target public-sector employment as a fraction of total employment by age and education. The separation rates $\delta_{h,e}^G$ and wages $w_{h,e}^g$ are also exogenously set to match the data, as described in Section 3. Finally, we set exogenously the tax system $\tau(.)$, that incorporates progressive taxes and social contributions.

2.6 Definition of equilibrium

Definition 1 *A steady-state equilibrium in our economy is defined by a set of tightness in the two sectors by age and education* $\{\theta_{h,e}^P, \theta_{h,e}^G\}$*, stocks of public- and private-sector employment and unemployed searching in the two sectors* $\{e_{h,e}^P, e_{h,e}^G, u_{h,e}^P, u_{h,e}^G\}$*, private-sector wages* $\{w_{h,e}^P\}$ *and the distribution of assets and lifetime earnings* $\{\Lambda_{h,e}^P, \Lambda_{h,e}^G, \Lambda_{h,e}^{U^P}, \Lambda_{h,e}^{U^G}, \Lambda_{h,e}^R\}$ *such that, given some exogenous government policy* $\{V_{h,e}^G, \delta_{h,e}^G, w_{h,e}^G\}$*:*

1. *Workers choose consumption and assets according to conditions 9, 11, 13, 14, 17.*
2. *Unemployed decide optimally the sector to search (15).*
3. *The average lifetime earnings evolve according to 1 and 2.*
4. *Private-sector firms satisfy the free-entry condition 19.*
5. *Job-finding rates in the two sectors and vacancy-filling rates are given by 5, 6 and 7*

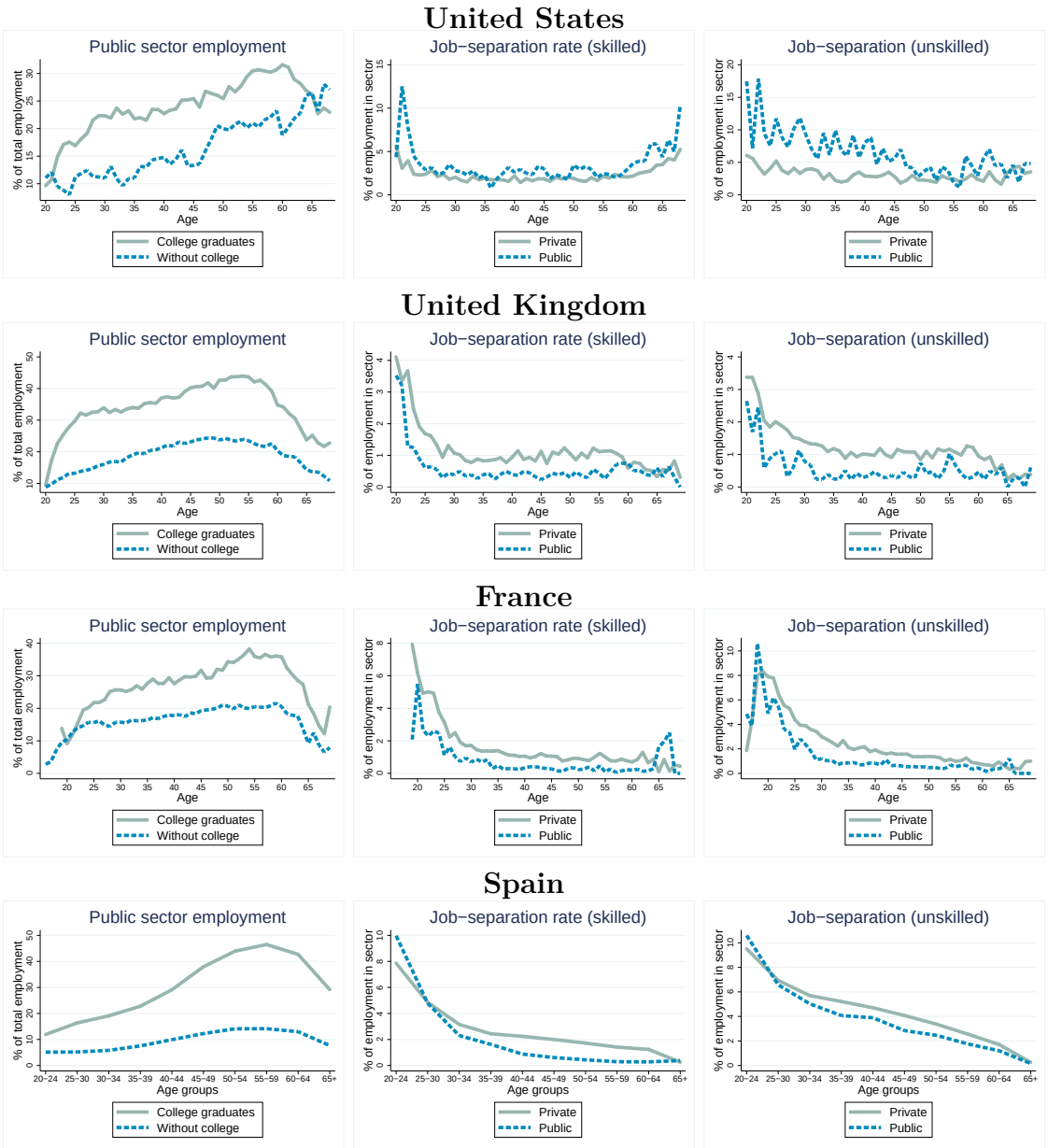
3 Calibration

We calibrate our model to data from the four countries: US, UK, France and Spain. For the US, we use data from the Survey of Income and Program Participation (SIPP) for the period 2005-2017. We prefer the SIPP to the CPS as it has more comprehensive data on wages and wealth. For the European countries we use data from the Labour Force Surveys: the UK LFS (2003-2016), the French LFS (2003-2016) and the Spanish LFS (2005-2007), and complement it with data from wage data from the Structure of Earning Survey (SES) for the years 2002, 2006, 2010 and 2014, and wealth data from the Household Finance and Consumption Survey (HFCS) for 2010.

Figure 3 shows the profile of public-sector employment out of total employment by age for college and non-college workers, together with the job-separation rates in the two sectors. The profile of job-separations, $\delta^P_{h,e}$, $\delta^G_{h,e}$, is set exogenously to match the employment to unemployment flows in the data. The profile of public-sector vacancies, $v^G_{h,e}$, is set to target the level of public-sector employment. Notice that the increasing weight of public-sector employment by age exists also for both college and non-college workers, even if the average weight of the public sector is much higher for college. In the three European countries, the public sector has lower separation rates than the private sector, with the exception for the younger workers. However, in our sample, for the United States the job-separation rates are higher in the public sector, particularly for unskilled workers. In Appendix, we show a comparison between the SIPP and the CPS data, and the profiles are similar.

Regarding policy parameters, we set $w^P_{h,e}, w^G_{h,e}$ to those observed in the data. We use the SIPP and the SES data and regress the log of hourly wage on age bracket dummies, and age bracket dummies interacted with public sector, separately for college graduates (skilled) and bellow college graduates (unskilled), controlling for regions (NUTS I), occupation (2-digit), gender, manager, part-time and year dummies. Education premium is estimated for private sector 20-29 years old. The estimated wage profiles are shown in Table 1. Despite being different across countries, the wage profiles have some common features. As commonly found in the literature, there is a higher public sector premium for

Figure 3: Labour market stocks and flows by education and age



Note: The figure show public sector employment out of total employment by age. The data is taken from CPS (1996-2017), UK Labour Force Survey (2003-2016), French Labour Force Survey (2003-2016) and Spanish Labour Force Survey (2005-2007). See for details on the methodology in Fontaine et al (2018).

Table 1: Estimated wage profile

	United States		United Kingdom		France		Spain	
Age	Private	Public	Private	Public	Private	Public	Private	Public
No college								
20-29	1.00	1.08	1.00	1.10	1.00	1.02	1.00	1.13
30-39	1.27	1.28	1.11	1.18	1.11	1.12	1.04	1.20
40-49	1.32	1.36	1.12	1.17	1.14	1.17	1.06	1.20
50-59	1.33	1.36	1.08	1.14	1.16	1.21	1.08	1.18
60+	1.28	1.32	1.02	1.10	1.25	1.22	1.09	1.15
College								
20-29	1.33	1.43	1.38	1.44	1.43	1.43	1.38	1.48
30-39	1.48	1.59	1.56	1.58	1.64	1.62	1.53	1.64
40-49	1.56	1.73	1.60	1.61	1.81	1.77	1.64	1.68
50-59	1.62	1.75	1.56	1.62	1.89	1.89	1.73	1.71
60+	1.59	1.63	1.48	1.58	2.02	1.97	1.78	1.73

SIPP (2005-2017), SES (pooled 2002, 2006, 2010, 2014). Estimation by regressing the log of hourly wage on age bracket dummies, and age bracket dummies interacted with public sector, separately for college graduates (skilled) and bellow college graduates (unskilled), controlling for regions, occupation, gender, manager, part-time and year dummies. Education premium is estimated for private sector 20-29 years old. Wages of the unskilled, 20-29 old private sector worker normalized to 1.

workers without college degree and is also higher for younger workers. The wage profile is steeper for private sector workers.

We set $r = 0.04$ and calibrate β to a median wealth holding for those aged 60. We use the matching efficiency in the private sector, $\iota(e)$, to calibrate the average unemployment rate of low and high skilled workers. Moreover, we calibrate the unemployment rate, private and public employment by education at age 20, assigning the status randomly across individuals. We also calibrate the wealth distribution at initial age to match the distribution of assets of workers younger than 25, assigning randomly across all agents. Following Attanasio and Weber (1995), we use a risk aversion coefficient of 1.5. Following Hagedorn and Manovskii (2008), we set the vacancy posting costs, $\kappa(e)$ to 4.5% of quarterly output and 3.67% of quarterly wages in the private sector.

The Table 2 shows the unemployment and retirement rate replacement rates. The features of the retirement schemes follow the estimates in the report Pensions at a Glance by OECD (2017) (the original graphs from the report are shown in Figures A3-A5 in Appendix). In the United Kingdom the differences is the retirement replacement rates are higher, with private-sector workers pensions replacing 50 percent of their wage while

Table 2: Unemployment and retirement benefits

	United States	**United Kingdom**	**France**	**Spain**
Retirement replacement rate				
Private	67.8	51.4	55.4	81.2
Public	86.8	106.0	63.4	100
Unemployment replacement rate				
No college	42.5	41.8	59.8	49.8
College	29.0	24.8	47.4	33.1

Note:OECD Pensions Outlook 2016. Unemployment benefits calculated from OECD as the simple average of the net Replacement Rates for six family types, on the initial phase of unemployment and long term unemployment, for a family that does not qualify for cash housing assistance or social assistance "top ups", earning 67 percent of the average wage (no college) or 150 percent of the average wage (college) in 2006.

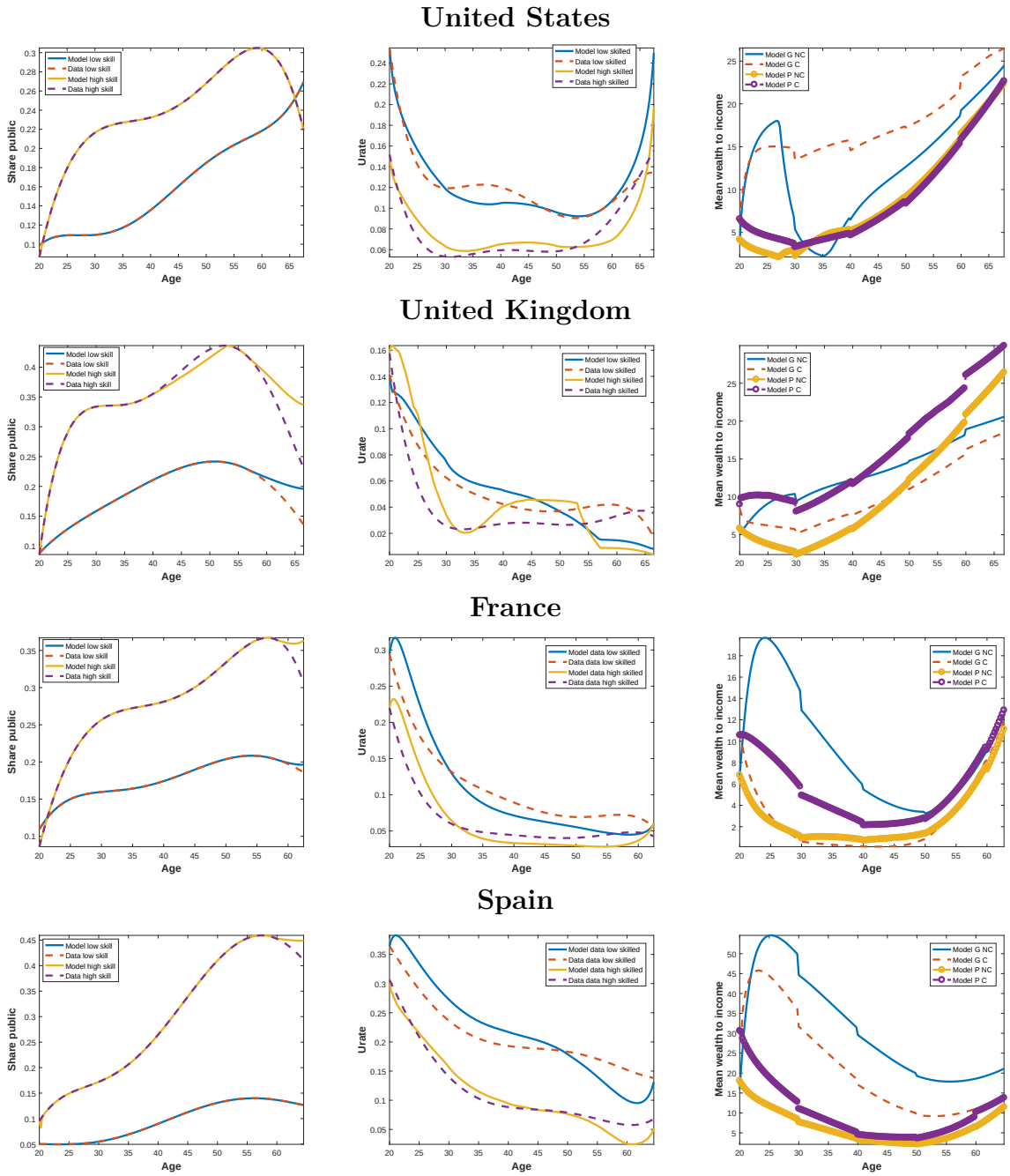
public-sector pensions replace more than 100 percent. In the United States and Spain the replacement rates are 20 percentage points higher in the public sector. France has the lowest asymmetry between sectors with a difference of only 8 percentage points. The table also shows the unemployment replacement rates, that are higher in France and Spain compared to the UK and US. They are also higher unemployed with no college. The tax system, $\tau(.)$, follows the statutory tax schedule (comprising both income tax and social security contributions), taken from OECD, detailed in Appendix.

3.1 Analysis of the baseline economies

The left graphs of Figure 4 show the share of public-sector employment over the life-cycle, that was a target in the calibration for the four countries. The model is able to fit perfectly the shares, except for the last years in the working life. We think this fact, visible mainly in the United Kingdom and France, is due to the possibility of early retirement that is more prevalent in the public sector - something that we do not take in account in the model. The second panel of Figure 4 shows the unemployment rate over the life-cycle for college and non-college graduates. For the calibration we fix unemployment rate at age 20 and target the average unemployment rate for college and non college. Although not targeted, the model matches well the life-cycle profile of the unemployment rates.

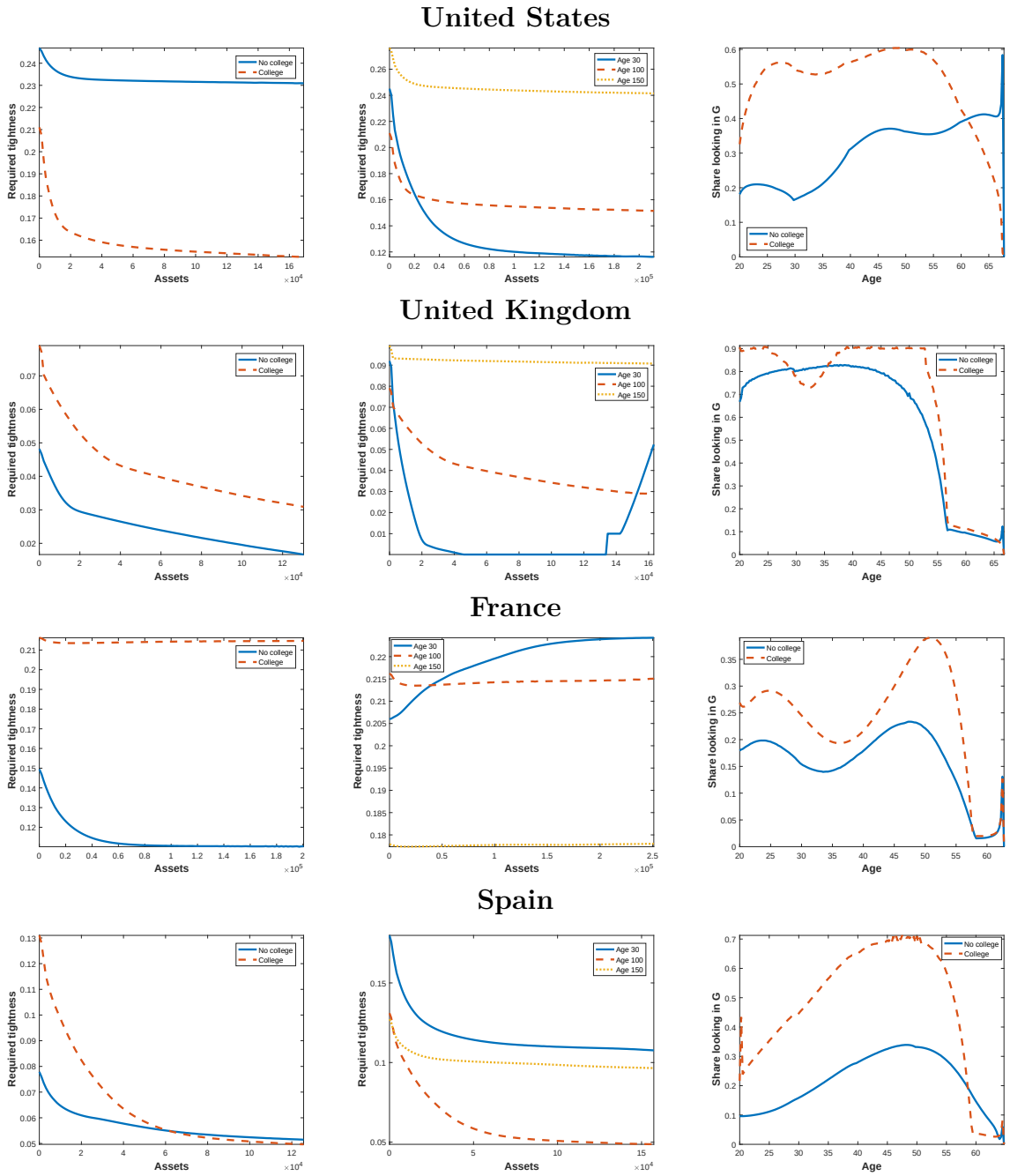
The graphs on the right of Figure 4, show the wealth to income ratios of private- and public-sector workers, with and without college over their life cycle. The initial point at age 20, public and private sector workers have the same level of wealth, as the initial

Figure 4: Targeted and non-targeted moments by age and education: public-sector shares, unemployment rates, mean wealth to income ratio



Note: The left graphs show the model fit of the targeted life-cycle profile of public-sector employment as a fraction of total employment. The middle graphs show the unemployment rate of college and no-college workers, in the model and in the data. The initial unemployment rate at age 20 and the average unemployment rate across educations were model targets. The graphs on the right show the mean wealth to income ratios of public and private sector workers with and without college.

Figure 5: Policy function and share of unemployed searching in public sector, by age and education



Note: The left graphs show the tightness in the public sector required by an unemployed with particular assets to search there, for college and no-college workers. The middle graphs show the tightness in the public sector required by an unemployed with particular assets to search there, workers we different ages: 27.5, 45 and 57.5. The graphs on the right show the fraction of the unemployed searching for public-sector jobs, for college and no-college workers.

distribution of labour market status and wealth distribution were assigned randomly across workers. After that, the evolution of the wealth to income ratio is endogenous. We observe that public-sector workers have higher wealth to income ratios, particularly at younger ages. One reason for this, is that the initial selection as unemployed of which sector to search is driven solely on wealth, meaning that the government hires the wealthiest unemployed. At the end of the working life, public sector workers accumulate higher wealth in the US and Spain, lower wealth in the UK, and very similar levels in France.

Figure 5 shows the tightness in the public sector required to attract unemployed with different level of assets. In all cases it depends negatively on wealth. This means that unemployed with more assets accept a lower job-finding rate in the public sector. In each sub-market, this means that the unemployed with more assets search for public-sector jobs. We can see in the figures how they are different by sub-markets by education and age. College graduates require a higher tightness to apply for public sector jobs, while there is no clear ranking by age.

The right graphs of Figure 5 show the fraction of unemployed looking for a public-sector job. College graduates search more for the public sector jobs than non-college graduates. This is so because there are relatively more jobs available in the public sector for college graduates than for no college workers. Furthermore, we see that in the beginning of their career few unemployed search for public-sector jobs and that this fraction increases over the lifecycle, falling sharply after age 50 when fewer public-sector jobs become available.

4 Results

4.1 Public sector premia

Often in policy discussions over public-sector wages, there is the argument that public-sector jobs has particular features that offer extra-compensation to workers. Two of these features are job-security and better pensions. However there are few attempts to

quantify this job-security and pensions premia. This is extremely important from a policy perspective. According to Gomes (2015), the optimal design of the public-sector wage schedule should take job security into account. Safer jobs raise a job's expected duration of a job and reduce the expected time spent in unemployment. Thus, the government should offer lower wages in order to keep the value of a public-sector job in line with that of the private-sector job. One could make a similar argument for pensions.

Our model offer a good laboratory to calculate the retirement and the job security premia, as well as the wage premium. In the perspective of a public-sector worker at a given wage, we ask how much public sector wages need to be raised perceptually to compensate him for having the same pension schemes or job-destruction rates as the private sector. As a way to summarize the different profile of public-sector wages, we also calculate the wage premium, as the permanent percentage increase over private-sector wages, required to accept that particular wage schedule by age.

Table 3 shows the overall public-sector premia, together with the disaggregated wage, job security and pension's premia. There is a large heterogeneity across countries on the size of and form of compensation of public-sector worker. On average, it is higher for the United Kingdom and Spain with total premia of between 35 and 47 percent, and lower in the United States and France with total premia of between 5 and 12 percent. For all countries except the US, the premium is higher for workers without a college degree.

The total public-sector premia is increasing sharply with age. This is mainly driven by the retirement premium. At age 20, workers only value the better pension regime in the public sector at between 0.5 to 4 percent of their wage. The value at retirement is heavily discounted by the discount factor and the probability to loose the public sector job during working life. However, these numbers rises over the lifecycle. Weighting the values over the life-cycle by the number of public-sector workers by age, we find that in the four countries, the pensions premium accounts for more than half of the total premia.

In the European countries the job-security premium is around four percent for workers without college. Workers with college in France and the UK have a job-security premia of two percent and in Spain of 6 percent. In the US public-sector jobs have higher separation

Table 3: Public sector premia by age

	United States		United Kingdom		France		Spain	
	No college	College	No college	College	No college	College	No college	College
Total premium								
20	-2.20	3.50	26.22	13.36	8.36	1.74	13.00	6.10
30	-2.15	7.65	24.87	13.31	7.61	0.24	26.50	17.20
40	0.87	10.71	27.42	19.56	7.26	1.04	32.90	19.50
50	5.72	11.26	38.62	32.76	8.46	4.42	35.65	23.65
60	14.17	16.91	77.67	71.81	19.03	16.97	50.50	57.40
Avg	7.25	12.22	46.80	38.47	10.54	5.89	38.73	34.86
Wage premium								
20	6.75	7.85	11.31	5.55	0.66	-3.36	14.85	8.25
30	1.55	8.25	9.36	4.36	0.41	-3.71	15.55	5.95
40	2.30	9.80	8.41	5.01	0.81	-3.61	15.55	4.45
50	2.30	7.80	8.91	7.31	1.16	-2.76	14.00	4.80
60	3.10	3.14	9.31	9.31	-2.14	-4.46	11.30	15.70
Avg	2.86	6.48	9.15	6.84	0.11	-3.61	13.49	9.35
Retirement premium								
20	0.45	0.95	4.40	3.14	0.58	0.52	1.30	1.30
30	1.51	1.79	6.89	5.43	1.18	1.02	3.40	3.40
40	3.86	3.34	11.45	9.85	2.18	2.12	6.25	5.45
50	7.21	6.79	20.98	18.60	4.31	4.27	11.45	9.15
60	17.01	18.59	57.71	55.71	19.68	18.82	30.80	28.10
Avg	10.03	9.41	28.43	26.03	6.61	6.66	16.48	15.01
Security premium								
20	-9.20	-4.60	8.66	4.24	7.02	4.80	-2.70	-3.30
30	-5.35	-1.85	6.90	3.20	5.57	3.17	3.80	6.00
40	-5.05	-2.15	5.10	3.26	3.92	2.82	6.00	8.40
50	-3.02	-2.30	3.73	2.76	2.47	2.57	5.50	7.90
60	-3.57	-2.75	1.42	0.17	1.17	2.57	2.55	4.85
Avg	-4.36	-2.51	4.03	2.15	3.43	2.87	3.89	6.11

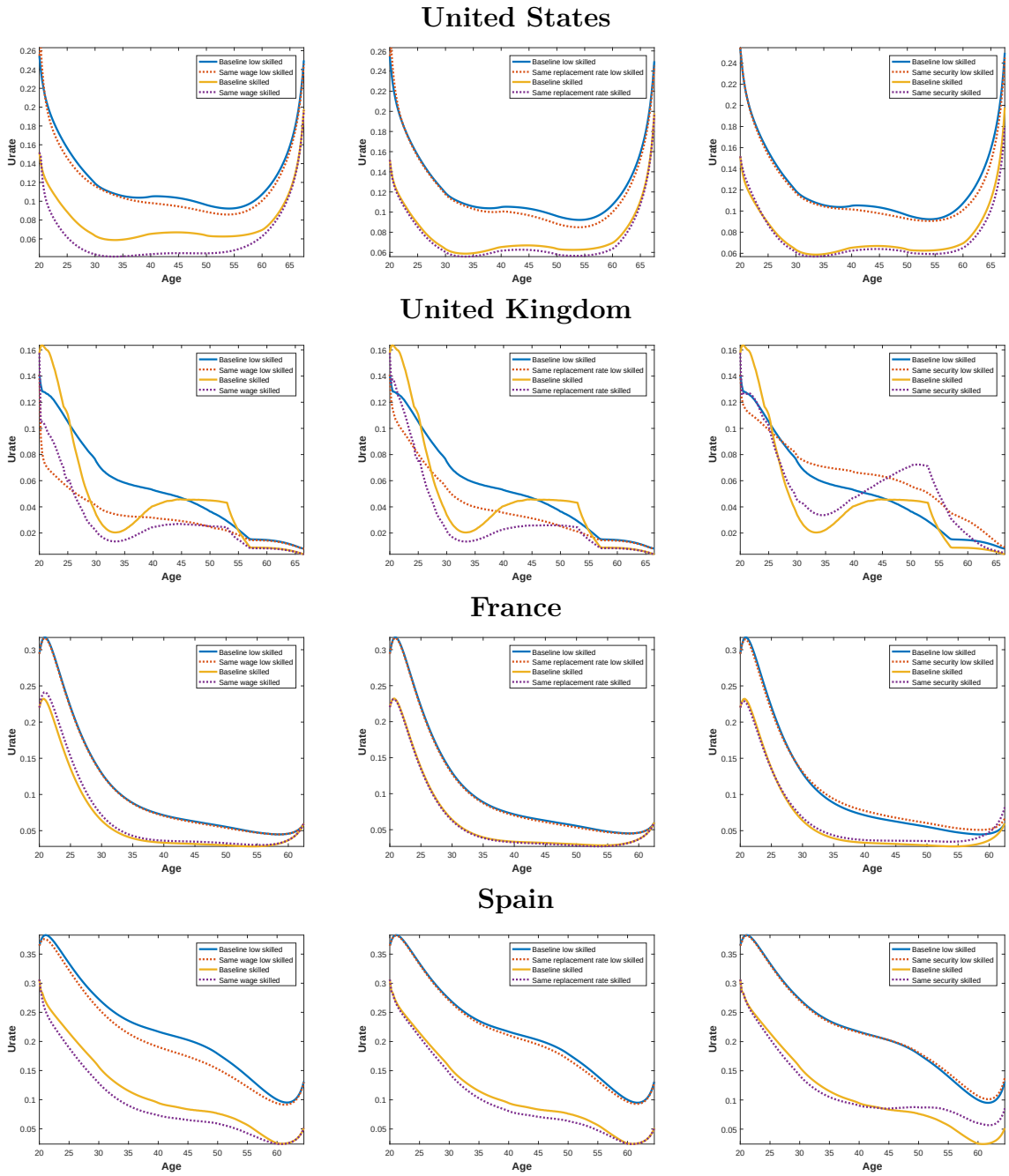
Note: The premia are calculated as the permanent increase as percentage of income that public-sector workers would require to accept the same: i) profile of private sector wage, ii) retirement replacement rate of the private sector, iii) the profile of job-separation of the private sector, iv) or all three together.

rates so it contributed to a negative premia.

4.2 Reforms

We now implement reforms harmonizing the public-sector wages, pension scheme and job-security with those of the private sector. Across all experiments, we keep the number of public-sector employment constant. The effects on unemployment rate are shown in Figure 6. France is the country where the reforms would have the smallest effect. This

Figure 6: Effects of three reforms on unemployment



is the consequence of a more proximity of the public sector with the private sector, both in terms of wages and replacement rates.

For the other three countries, the effects of the reforms on unemployment rate are significant. Equating the retirement replacement rate to the private sector would reduce unemployment rate by 0.5 percentage point in the United States, 0.7 percentage points in Spain and above 1 percentage points in the UK. We can see from the graphs in the second column that the fall of the unemployment rate is larger for older workers.

Table 4: Output and program costs per worker (in dollars, pounds, and euros)

	Baseline	total	wage same	rr^G same	destruct same
US					
Urate %	9.96	8.13	8.83	9.54	9.61
Output	6790	6885	6825	6826	6821
Costs b	207	175	190	198	200
Costs wage	708	675	675	708	708
Costs pension	731	694	731	686	737
Revenues	1351	1345	1350	1339	1358
UK					
Urate %	4.83	1.56	2.97	3.47	5.77
Output	4791	4899	4825	4863	4736
Costs b	93	31	57	67	112
Costs wage	794	743	743	794	794
Costs pension	684	498	678	497	677
Revenues	699	675	691	680	692
France					
Urate %	8.27	8.73	8.48	8.13	8.67
Output	5766	5752	5771	5775	5736
Costs b	147	154	149	144	155
Costs wages	709	718	718	709	709
Costs pension	844	815	845	815	841
Revenue	1051	1044	1056	1044	1046
Spain					
Urate %	16.23	13.91	14.45	15.54	16.54
Output	3735	3800	3777	3766	3719
Costs b	209	183	188	202	213
Costs wages	404	374	374	404	404
Costs pension	598	540	599	537	596
Revenue	768	746	767	747	765

Equating the wage profile to those of the private sector have even larger effects in reducing unemployment. In the UK and Spain, equating the wage profile lowers unemployment rate by 2 percentage points, while in the US the reduction is of 1 percentage point. In the three countries, the reform affects both skilled and unskilled workers alike. The third reform - equating the job-separation rate - tends to raise unemployment rate, except for the US where job-separations were higher in the public sector.

Beside a significant effect on unemployment, the reforms have large fiscal effects, as shown in Table 4. When equating the replacement rates the overall cost of pensions reduced by 6 percent in the US, 10 percent in Spain, 27 percent in the UK and 3 percent in France. The reform equating the wages would reduce the wage bill by 5 to 6 percent

in all countries with the exception of France. Finally, eliminating the public-sector job security would raise costs for the government in the form of unemployment benefits in all countries with the exception of the US. Overall, when taken together the reforms would lower per capita private output by 1.4, 2.3 and 1.7 percent in the US, UK and Spain and a negligible effect in France. There would be a substantial reduction in spending with wages, unemployment benefits and pensions.

5 Conclusion

Public-sector employment is driven by the same objectives as private-sector employment. As such, the two labour markets function differently. Amongst several of the differences, this paper is motivated by the substantial asymmetries on the size of public sector in total employment, as well as the differences in job security and compensation over the life-cycle. We study how public-sector employment and compensation policies shape workers' labour market outcomes and savings over their life cycle, as well as analyse the effect of a different pension regime in the public sector.

We set up a partial equilibrium life cycle model with a public and private sector. The model simplifies the problem along several dimensions, but it has the key features that we think are essential. The model features two sectors and search and matching frictions in the labour market, necessary to capture a distinctive features in many public sectors - the more job security. The model also features incomplete markets and finitely-lived risk- averse workers that self-insure against the risk of loosing their current job. While one can think about many interesting dimensions that are absent from the model: joint decision of the couple of the sectors to join; job-to-job transitions; early retirement or the presence of business cycles; we think that including them in the model, while relevant to study other questions on public-sector employment, it would complicate much the analysis without bringing relevant insights.

While the purpose of the model is quantitative – to calculate the public-sector job-security and pension's premia and the effects of different public-sector reforms – we should

interpret the results with caution. The calibration of the model is based on average policies in the 2000s. However, when we look at the government policies in the different countries, in particular the wage premia, there have been sharp changes in polices, in some cases reducing the asymmetries and in other cases increasing them. We should interpret the results, that find large quantitative effects of reforms on unemployment rate and in fiscal variables, as a call to increase the research on how to improve wage and employment policies.

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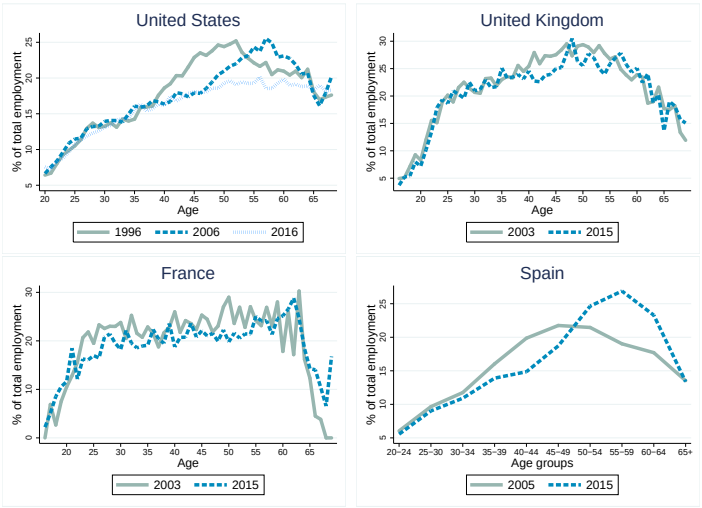
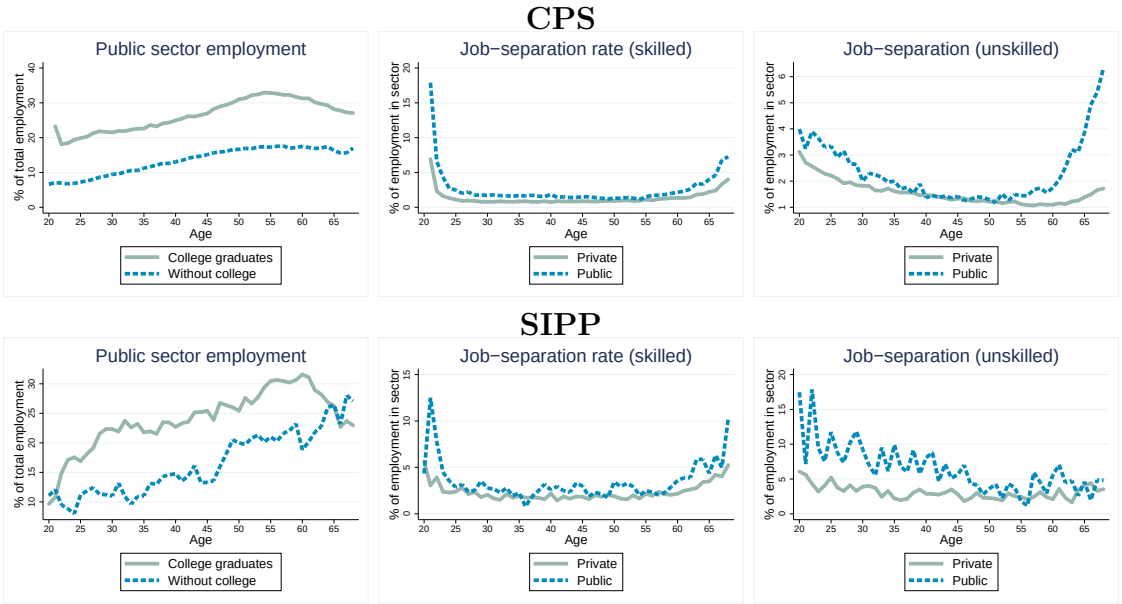
6 Appendix

Figure A1: Public sector employment over the life cycle, different cohorts



Note: The figure show public sector employment out of total employment by age for different cohorts. For the United States the data is take from CPS (1996-2017), for the United Kingdom from the UK Labour Force Survey (2003-2016), for France for the French Labour Force Survey (2003-2016) and from Spain from the Spanish Labour Force Survey (2005-2007). See for details on the methodology in Fontaine et al (2018).

Figure A0: Comparison between SIPP and CPS: stocks and flows by education and age



Note: The figure show public sector employment out of total employment and job-separation rates by sector by age. The data in the top panel is taken from CPS (1996-2017) while from the bottom panel is take from SIPP (2005-2017).

All numbers are yearly.

$$\tau(E) = \tau^{i}(E) + \tau^{ss}(E)$$

Table A1: Comparison between SIPP and CPS: Estimated wage profile

	No college		College		No college		College	
Age	Private	Public	Private	Public	Private	Public	Private	Public
CPS					**SIPP**			
20-29	1.00	1.01	1.55	1.57	1.00	1.08	1.33	1.43
30-39	1.29	1.32	1.91	1.91	1.27	1.28	1.48	1.59
40-49	1.38	1.44	2.03	2.01	1.32	1.36	1.56	1.73
50-59	1.41	1.50	2.03	2.08	1.33	1.36	1.62	1.75
60+	1.36	1.42	1.95	2.02	1.28	1.32	1.59	1.63

Note: The data in the left panel is estimated from CPS (1996-2017) while from the right panel is estimated from SIPP (2005-2017). Estimation by regressing the log of hourly wage on age bracket dummies, and age bracket dummies interacted with public sector, separately for college graduates (skill) and bellow college graduates (unskill), controlling for regions (nuts), occupation, manager, year dummies. Education premium is estimated for private sector 20-29 years old. Wages of the unskilled, 20-29 old private sector worker normalized to 1.

Table A2: Taxes

	US	UK	Spain	France
τ_1^{ss}	0.153	0	0.0635	0.137
τ_2^{ss}	0	0.12	0	0.137
τ_3^{ss}	0	0.02	0	0.137
d_1^{ss}	94200	8359	34772	∞
d_2^{ss}	94200	46027	34772	∞
allow	5150	5035	3400	0
τ_1^i	0.1	0.1	0.15	0
τ_2^i	0.15	0.22	0.24	0.055
τ_3^i	0.25	0.4	0.28	0.14
τ_4^i	0.28	0.4	0.37	0.30
τ_5^i	0.33	0.4	0.45	0.40
d_1^i	7550	2150	4162	5614
d_2^i	30650	33300	14358	11198
d_3^i	74200	33300	28842	24872
d_4^i	154800	33300	46818	66679

$$\tau^{ss}(E) = \begin{cases} \tau_1^{ss} E & \text{if } E \leq d_1^{ss} \\ \tau_1^{ss} d_1^{ss} + \tau_2^{ss}(E - d_1^{ss}) & \text{if } d_1^{ss} < E \leq d_2^{ss} \\ \tau_1^{ss} d_1^{ss} + \tau_2^{ss}(d_2^{ss} - d_1^{ss}) + \tau_3^{ss}(E - d_2^{ss}) & \text{if } E > d_2^{ss}, \end{cases}$$

$$\tau^{i}(E) = \begin{cases} \tau_1^{i} \tilde{E} & \text{if } \tilde{E} \leq d_1^i \\ \tau_1^{i} d_1^{i} + \tau_2^{i}(\tilde{E} - d_1^{i}) & \text{if } d_1^i < \tilde{E} \leq d_2^i \\ \tau_1^{i} d_1^{i} + \tau_2^{i}(d_2^{i} - d_1^{i}) + \tau_3^{i}(\tilde{E} - d_2^{i}) & \text{if } d_2^i < \tilde{E} \leq d_3^i \\ \tau_1^{i} d_1^{i} + \tau_2^{i}(d_2^{i} - d_1^{i}) + \tau_3^{i}(d_3^{i} - d_2^{i}) + \tau_4^{i}(\tilde{E} - d_3^{i}) & \text{if } d_3^i < \tilde{E} \leq d_4^i \\ \tau_1^{i} d_1^{i} + \tau_2^{i}(d_2^{i} - d_1^{i}) + \tau_3^{i}(d_3^{i} - d_2^{i}) + \tau_4^{i}(d_4^{i} - d_3^{i}) + \tau_5^{i}(\tilde{E} - d_4^{i}) & \text{if } \tilde{E} > d_4^i \end{cases}$$

Figure A3: Heterogeneous retirement schemes in OECD countries, Pensions in a Glance

Table 6.1. **Institutional arrangements for pensions covering civil servants vs. private sector workers**

Fully integrated	Separate but similar benefits	Fully integrated with top-up	Entirely separate
Chile (1981)	Finland (1995)	Australia	Belgium
Czech Republic	Luxembourg (1999)	Austria (2004, 2009)	France
Estonia	Netherlands	Canada	Germany
Greece (2011)	Sweden	Denmark	Korea
Hungary		Iceland	
Israel (2002)		Ireland (1995)	
Italy (1995/2008)		Mexico (2007)	
Japan (2015)		Norway	
Latvia		United Kingdom	
New Zealand (2007)		United States (1984)	
Poland			
Portugal (2006)			
Slovak Republic			
Slovenia			
Spain (2011)			
Switzerland			
Turkey (2006)			

Note: The years in brackets refer to the date from which newly hired civil servants are no longer covered by an entirely separate scheme, but are rather in the fully integrated private sector scheme or have a top-up. For Italy new civil servants were covered by the private sector scheme from 1995 onwards, while in 2008 future contributions for all civil servants were under the private sector rules. For Austria the pension was fully integrated from 2004 but an additional top-up was introduced in 2009. For Finland the unifying process began in 1995, before which there was more of a top-up element to the system. All countries without a date have been in that particular category for at least the last 35 years.

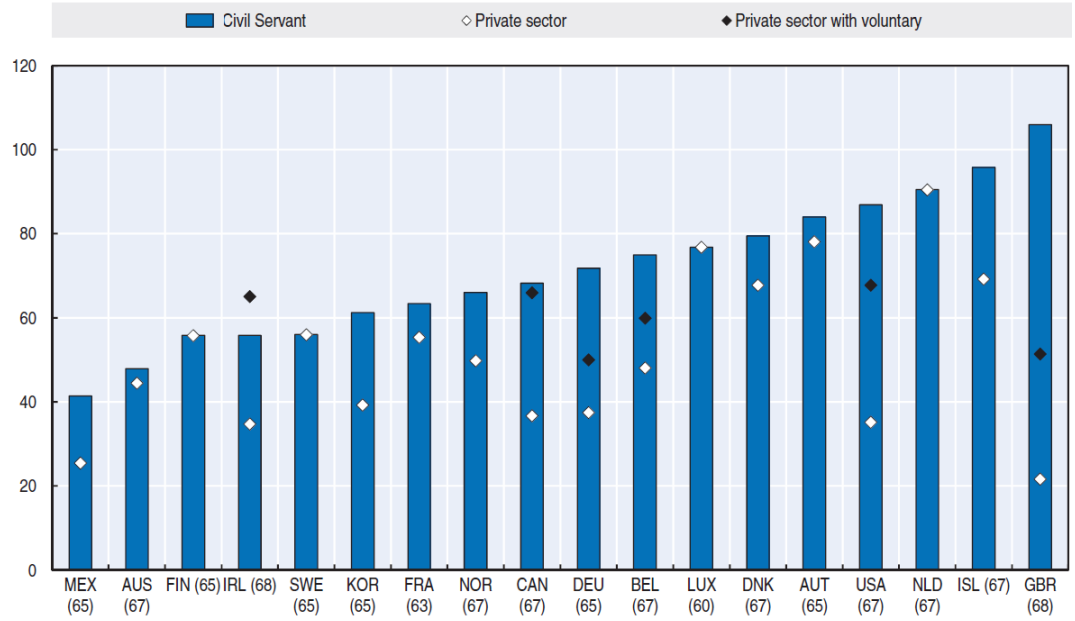
Figure A4: Recent reforms of public-sector retirement schemes in OECD countries, Pensions in a Glance

Table 6.3. **Reforms to civil service pension schemes over the last 25 years**

Reform	Country
Increase in pension age	Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Portugal, Spain, Sweden, United Kingdom
Restriction of early retirement	Austria, Australia, Belgium, Canada, Finland, Germany, Italy, Korea, Portugal, Spain, Sweden, United Kingdom
Reduction of pension generosity or increase in career length	Austria, Finland, France, Germany, Greece, Iceland, Korea, Norway, Portugal, Spain, United Kingdom
Increase in contributions	Austria, Canada, Finland, France, Greece, Israel, Italy, Japan, Korea, Netherlands, Portugal, Sweden, United Kingdom
Integration/alignment of civil service with the general state scheme	Austria, Canada, Greece, Israel, Italy, Japan, Luxembourg, New Zealand, Portugal, Spain, Turkey

Figure A5: Summary of replacement rates and retirement age, Pensions in a Glance

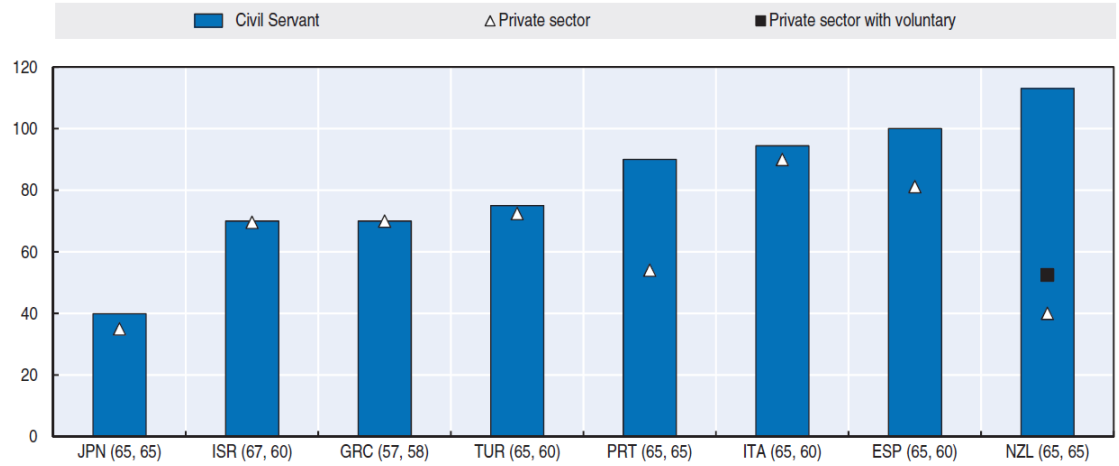
Figure 6.2. **Long-term gross replacement rates for civil service and private sector average earners, entering at age 20 in 2014, %**



Note: Retirement age (in brackets) is the same for both civil servants and private sector workers.
Source: OECD pension models.

Figure A6: Summary of replacement rates and retirement age cont., Pensions in a Glance

Figure 6.3. **Long-term replacement rates for civil servants and private sector average earners, before the civil service reform**



Note: Retirement ages are given in brackets, with private sector first.

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