Public-sector compensation over the life cycle*

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April 21, 2023

Abstract

The size of the public sector in terms of employment and compensation has a strong life cycle dimension. We establish a quantitative partial-equilibrium life cycle model with incomplete markets, private and public sectors, and risk-averse workers, and use it to (i) calculate three dimensions of public-sector compensation: wage, pension, and job-security premia, and (ii) quantify the effects of harmonizing the compensation in the two sectors. We find that the job-security and pension's premia are important forms of compensation to public-sector workers. Harmonizing the characteristics of public employment with those of the private sector would lower the unemployment rate and reduce government costs.

JEL Classification: J45, E24, H30, H55.

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

*We would like to thank participants at the SAEe meetings, econPol conference, Work, Pensions and Labour Economics Study Group conference, and the EUROFRAME conference and in seminars at Universidad Autonoma de Madrid and Universite Cergy-Pontoise. Felix Wellschmied gratefully acknowledges support from MICIN/ AEI/10.13039/501100011033, grants CEX2021-001181-M and PID2020-117354GB-I00, and Comunidad de Madrid, grants EPUC3M11 (V PRICIT) and H2019/HUM-5891 and thanks the Department of Economics at ITAM for its hospitality.

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1 Introduction

In most developed economies, the public sector accounts for 10 to 30 percent of total employment. Public(-sector) employment has a strong life cycle pattern. As shown in Figure 1 for the United States, United Kingdom, France and Spain, public employment represents a small fraction of total employment for young workers, but progressively grows, peeking at ages 50 to 60.[1] The compensation in the public sector also varies by age. Besides their labour market consequences, both employment and compensation have considerable budgetary implications as first pointed by Buchanan and Tullock (1977).

When examining differences in compensation across sectors, most studies focus on the age-averaged premium of "static" wage differences (the "static" premium). Differences in the "static" premium have been widely documented by the empirical literature using micro-level data that usually finds that most public sectors pay relatively higher wages, particularly to low-educated workers, but that these differentials are not homogeneous by age.[2] However, wages are not the only form of compensation difference between the public and private sectors. Perhaps more relevant for older workers is the fact that retirement benefits are often higher in the public sector. Traditionally, in many countries, public-sector workers have enjoyed separate pensions schemes with larger benefits (see OECD (2017)). A third component of compensation is job security - a distinctive feature of public-sector jobs in many but not all countries. These different forms of compensation interact with each other in a meaningful way. For example, high public-sector retirement benefits will be particularly valuable for a 50-year-old worker, if her job security is high until she retires.

This paper quantifies the total public-sector compensation premium over workers' life cycles. We set up an incomplete markets life cycle model with a public and private sector. The two sectors offer different wage profiles, job-separation rates, and pension benefits. Search markets are separated by age; thereby, age-variations in compensation

[1] Figure 3 shows that the initial increase is also present once we condition on education levels.

[2] 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.

schemes create age-varying labor market outcomes. Additionally, markets are separated by education (college, no college degree), another important dimension of heterogeneity between the two sectors, both in terms of employment and wages (Gomes, 2018). Our framework allows us to express the total compensation premium – wages, job-security, and pensions – over the life cycle in a single number for the two education groups.

The presence of incomplete markets and a savings decision plays two important roles, previously unexplored in the literature. First, sectorial differences in income risk stemming from unemployment, different wage profiles, and different retirement benefits lead to different wealth profiles of private and public sector workers. Second, unemployed workers decide whether to look for work in the private or public sector, and this decision depends on their wealth. The relatively wealthy unemployed search for public-sector jobs because they can afford to queue for longer for jobs that offer better compensation.[3]

We calibrate the model to the four economies shown in Figure 1. We chose these countries for three reasons. First, their public sectors have different sizes, larger in the UK and France (23 and 21 percent of total employment), and smaller in the US and Spain (16 percent of total employment). Second, they have different labour market institutions. The common age profiles of employment means it is a general characteristic of the public sector. Third, these countries represent the variety of different institutional arrangements regarding pensions, as highlighted in the report Pensions at a Glance by OECD (2017). France has an entirely separate system for civil servants. The United States and the United Kingdom have a fully integrated system with top-up components for civil servants beyond the mandatory schemes for private-sector workers. Spain had separate schemes as France, but in 2011 reformed them and now has a fully integrated system between the two sectors. We encapsulate in the model the differences in replacement rates between sectors documented by the aforementioned report.

We find that the total public-sector compensation premia is substantially larger than

[3]While this specific mechanism of selection into the public sector based on wealth has not been studied in the empirical literature, there are several empirical and theoretical papers that establish that unemployed workers with more wealth, find jobs at a slower pace, but these jobs have higher wages, for instance: Stancanelli (1999), Algan et al. (2003), Gladden and Alexopoulos (2004) or Lentz and Tranas (2005).

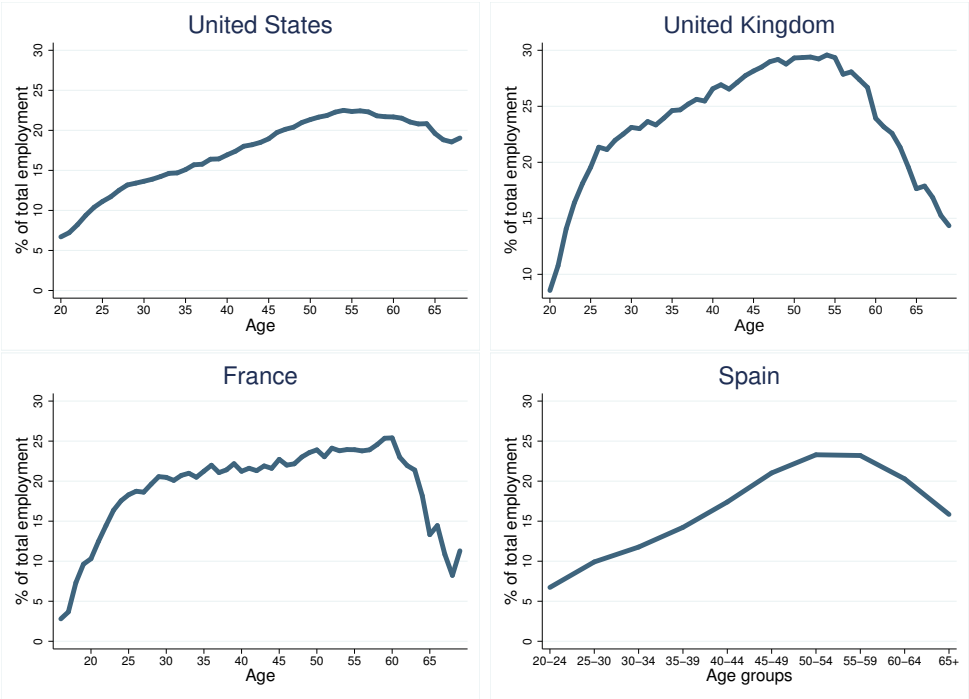

Figure 1: Public Employment Over The Life Cycle,

Note: The figure show public 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 (2005-2071). See for details on the methodology in Fontaine et al. (2020). Appendix A.1 shows that cohort effects and occupational differences across sectors do not explain this life cycle pattern.

the "static" premia particularly for non-college workers. The total premia are as high as 39 and 47 percent in Spain and the UK. The corresponding "static" wage premia are 15 and 10 percent. For college workers, the total premia ranges from 5 percent in France to 8 percent in the US, with a corresponding "static" wage premia of -3 and 2.0 percent. These premia are heavily tilted towards older workers because the pension premia are large and their valuation increases with age.

Next, we study the changes in the unemployment rate resulting from harmonizing the public-sector compensation scheme to that of the private sector. Changes in the unemployment rates result from workers changing their decisions on which sector to search in. As the two compensation schemes are most aligned in France, the unemployment rate changes least. The average unemployment rate of non-college workers drops by 0.5 percentage points and that of college workers rises by 0.7 percentage points. In the UK, the rates drops by 1.6 and 1.5 percentage points, in the US by 2.9 and 1.1 points, and in Spain by 2.7 and 2.6 percentage points, respectively.

Finally, we study the effects that harmonizing the compensation schemes has on the governments' budgets. Harmonization has three effects. First, directly, by lowering public sector pay and pensions, it reduces expenditures. Second, by changing unemployment, it changes expenditures on unemployment benefits. Third, by changing employment, it changes tax revenues, and it changes pension benefit accumulation and, thus, pension expenditures. We find that harmonizing the schemes improves the budget by €9 per person/quarter in France, €93 in Spain, $95 in the US, and £229 in the UK.

Literature We contribute to the growing literature that employs structural search models to calculate the compensation premia in the public- relative to the private-sector and uses counterfactual simulations to understand the aggregate labour market outcomes resulting from said premia (Postel-Vinay and Turon, 2007, Albrecht et al., 2018, Gomes, 2015, Bradley et al., 2017, Dickson et al., 2014). In particular, we explicitly introduce to this literature (a) risk averse workers and precautionary savings that allow us to value the security premium, (b) an explicit life cycle with age-varying premia, and (c) differences in retirement benefits.

Resulting from the additional complexity of having risk-averse workers and incomplete markets, we have to abstract from some of the mechanisms that this previous literature finds to be important when comparing the value of a public- and private-sector job. Most importantly, we abstract from on-the-job search and a feedback from public-sector policies on private-sector wages. This is not to say that these are not important. However, even introducing them to the model should not overturn our main results: the total public-sector compensation premium is substantially larger than the wage premium, this premium varies with age, and harmonizing policies between the two sectors generally reduces unemployment.

The interaction of the life cycle structure with the public sector has been studied in models without search frictions. Cavalcanti and Santos (2020) set up an occupational choice model and argue that higher wages and better pensions in the public sector in Brazil lead to misallocation of resources with a lower entrepreneurship rate. Also focusing on Brazil, Glomm et al. (2009) set up an overlapping generations model where workers

are initially randomly assigned to each sector. They use it to study the effects of early retirement in the public sector.

Hörner et al. (2007) and Reis and Zilberman (2014) also study the private- and public-sector with risk averse workers, where wages in the public sector are less volatile. The former employs a search model to study the affects on unemployment when workers are hand-to-mouth, i.e., they cannot accumulate savings. The latter, similar to us, set-up an incomplete market Aiyagari model to measure the degree of insurance provided by public-sector jobs, yet, they abstract from search frictions and unemployment risk.

Regarding the pension premium, we relate to two empirical studies that calculate the value of public-sector pensions for the UK: Disney et al. (2009) and Danzer and Dolton (2012). Disney et al. (2009) find a higher prevalence of *defined benefits* plans in the public sector as opposed to *defined contributions*. They compute pension accruals for the two sectors considering job tenure and earnings profile, life expectancy, employee contributions and vesting rules. Danzer and Dolton (2012) go one step further and calculate the total reward differentials, including current earnings and pensions, but also hours of work, paid holidays, employer provided health care and probability of unemployment, using survey data from the UK. Our approach is based on a structural model that translates compensation differences into utils and permits us to use counterfactual simulations to study the labour market effects of differences in compensation schemes.

2 Model

2.1 How is the labour market segmented?

The labour market search literature has used different strategies to model the labour market interaction between public and private sectors. Albrecht et al. (2018) consider 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. This approach mimics the approach of using lotteries to assign workers across sectors in a frictionless labour market. Postel-Vinay and Turon (2007) show that

adding on-the-job search and transitions between the two sectors to a random search model implies additional equilibrium effects through reservation wages. Alternatively to the random search assumption, Gomes (2015) assumes that the two sectors' labor markets are segmented and that workers choose where to search depending on the values offered by the two sectors. As that paper also discusses, an alternative permissible interpretation is that workers decide on their relative intensities for search in the two sectors. A segmented market model is akin to a Roy model, with frictions in the labour market. In this approach, the transmission mechanism of the public sector into the private sector variables do not happen through wages, but through the number of unemployed searching in the private sector.

We opt to model the labour markets as segmented.[4] Analytically, Market segmentation allows us to solve the model by reducing the interaction between public and private sector to scale effects. In particular, it avoids interactions through wages. Moreover, conceptually, market segmentation portrays a realistic mechanism of selection into the public sector in several countries, documented empirically by Krueger (1988) and Nickell and Quintini (2002) or experimentally by Bó et al. (2013), lying at the heart of policy discussions. High public-sector wages attract many unemployed to queue for those jobs. For this mechanism to be relevant, we require that searching in either sector is an option for most workers. We find that even in the US, out of 111 3-digit occupations, 103 (75) have public employment shares of between 1 to 99 (5 to 95) per cent, meaning that only less that 8 (33) per cent of all workers do not have a the opportunities of finding very similar work in both sectors.

A second question is: in which dimensions are markets segmented, beyond the public/private distinction? In job adds, the two most common characteristics specified by employers are educational attainment and prior experience. Therefore, we assume full market segmentation in education and age (as a proxy for experience). We acknowledge that job requirements are usually specified in terms of minimum requirements and

[4]The current state of research does not suggest one approach is superior to the others. Only recently, there have been attempts to distinguish random from directed search in the whole economy (Lentz et al., 2020), let alone for the private-public sector duality.

workers may apply for jobs that require lower qualification, trading off lower wages for a higher probability of being hired, as studied by Garibaldi et al. (2019). Assuming market segmentation provides us with the required model tractability which we consider a worthwhile trade-off for any possible self-selection.[5] In contrast, we do not model markets to be segmented by workers' wealth and accumulated retirement benefits. For one, wealth is unlikely to be observed by the perspective employer. Moreover, job-requirements do not commonly specify these dimensions. Hence, in the model, unemployed workers select into sectors based on these dimensions.[6]

2.2 General setup

Our model has firms, a public sector, and a unit mass of risk-averse workers equally distributed over age $h \in (1, H)$ that discount the future at rate β. Workers differ in their permanent education, e (college vs non-college).[7] During their working life, workers are either unemployed (u) or employed in the public (e^g) or private (e^p) sector.

Workers accumulate assets, a, to insure against the risk of unemployment and for life cycle reasons. Assets pay a risk free return $R = 1 + r$. Workers decide how much to save and consume and, when unemployed, in which sector to search. When employed in the private (public) sector, workers earn $w^P_{h,e}$ ($w^G_{h,e}$) and become unemployed with probability $\delta^P_{h,e}$ ($\delta^G_{h,e}$). Wages are certain and, hence, job destruction is the only source of income risk. When unemployed, they receive unemployment benefits $b_{h,e}$.

All workers retire at age $H_w + 1$.[8] Their retirement benefits depend on their average

[5] In contrast, the documented over-representation of women in the public sector, is very much affected by self-selection of women. As discussed in Gomes and Kuehn (2019), for a given public-sector vacancies, women are more likely to apply for men, perhaps because of better work-life balance, a gender wage gap in the private sector or because of a preference for the public sector.

[6] There exist other differences between public and private sector jobs which we abstract from. For one, countries have tedious and long application processes for at least some public sector jobs. At the same time, the public sector offers often more vacations, better work-life balance and better health benefits. We abstract from these complications.

[7] As we show below, the public sector pays low educated workers relatively well. Hence, by eliminating this unequal treatment, workers might choose to accumulate more education. We take education as exogenous, hence, abstract from this distortion created by the public sector. See Chassamboulli and Gomes (2019) for a model with a public and private sector and endogenous education decisions.

[8] Retirement ages are country-specific. We set these to 68 in the US, 67 in the UK, 63 in France, and 65 in Spain,

life-time earnings in the private and public sector ($\bar{E}_h^P$, $\bar{E}_h^G$). These evolve according to:

$$\bar{E}_{h+1}^P = \begin{cases} \frac{w_h^P + \bar{E}_h^P h}{h+1} & \text{if employed in private} \\ \frac{\bar{E}_h^P h}{h+1} & \text{if unemployed or employed in public} \\ \bar{E}_h^P & \text{if retired.} \end{cases} \tag{1}$$

$$\bar{E}_{h+1}^G = \begin{cases} \frac{w_h^G + \bar{E}_h^G h}{h+1} & \text{if employed in public} \\ \frac{\bar{E}_h^G h}{h+1} & \text{if unemployed or employed in private} \\ \bar{E}_h^G & \text{if retired.} \end{cases} \tag{2}$$

Benefits replace a fraction of these average life-time earnings. There are two replacement rates (rr^P and rr^G), each one applying to the respective careers in each sector: $\bar{E}_h^P$ and $\bar{E}_h^G$. We abstract from institutional details such as minimum contribution lengths, so benefits during retirement are: $ss = rr^P \bar{E}^P + rr^G \bar{E}^G$.

2.3 Search

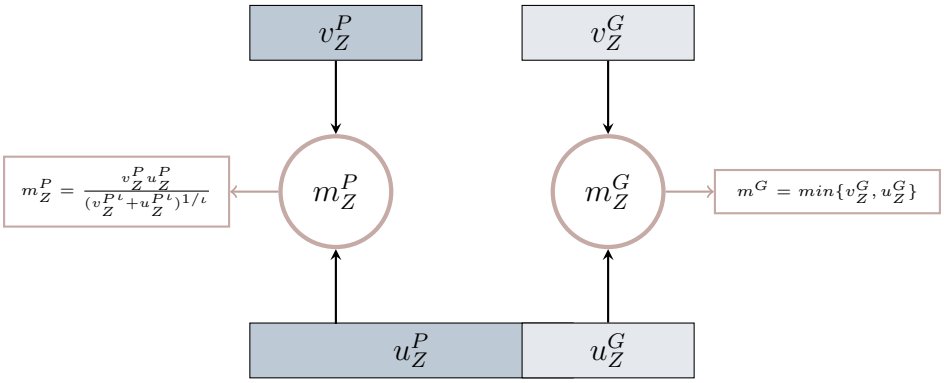

Figure 2: Unemployed's Choice

As discussed above, an unemployed decides to search for a job in either the public or private sector in a given sub-market Z, as depicted in Figure 2. Each sub-market in the two sectors is segmented by age and education $Z = [h, e]$. Let u_Z^P and u_Z^G denote the number of unemployed searching in each of the sectors. Within each sub-market, the unemployed select into either sector based on the remaining state variables

$[a, \bar{E}_h^P, \bar{E}_h^G]$. There are no other sources of heterogeneity. The model abstracts from on-the-job search. Though this might appear restrictive, Appendix A.1 shows that hiring from non-employment is the dominant form of allocating workers into the public sector.

Denote by v_Z^P and v_Z^G the number of vacancies in the two sectors in a given sub-market. The number of new matches that become productive in the following period is given by

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

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

In the private sector, we assume a matching function as in den Haan et al. (2000), so the job-finding and vacancy-filling rates are bounded between 0 and 1. In the public sector, we assume the min function to simplify the computation of the model. This functional form does not imply that matching frictions are absent, simply that they only matter for the unemployed. The absence of frictions for the government is immaterial as we take the job-creation condition in the public sector as exogenous.[9] Also, this assumption has been used previously by Quadrini and Trigari (2007) or Chassamboulli and Gomes (2020a), and there is evidence that the elasticity of matches with respect to the unemployed is much lower in the public than in the private sector (Gomes, 2015).

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:

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

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

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

[9]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 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 the same. This function implies there is a minimum wage in each submarket below which the government cannot recruit its target number of workers.

2.4 Value functions

Workers decide on their savings and search to maximize utility from consumption, c, 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

$$V_Z^{EG}(a, \bar{E}^P, \bar{E}^G) = \max_{a'}\Big\{\frac{c^{1-\gamma}}{1-\gamma} + \beta\Big[(1-\delta_Z^G)\max\{V_{Z+1}^{EG}(a', \bar{E}^{P'}, \bar{E}^{G'}), V_{Z+1}^{U}(a', \bar{E}^{P'}, \bar{E}^{G'})\} + \delta_Z^G V_{Z+1}^{U}(a', \bar{E}^{P'}, \bar{E}^{G'})\Big]\Big\} \tag{8}$$

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

where $V_{Z+1}^{U}(a', \bar{E}^{P'}, \bar{E}^{G'})$ is the value of unemployment in the following period, defined below. With a probability δ_Z^G, workers lose their jobs in the public sector and become unemployed. We do no allow for on-the-job search and direct transitions across sectors, but we allow workers to quit their job to search in another sector.[10] 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

$$V_Z^{EP}(a, \bar{E}^P, \bar{E}^G) = \max_{a'}\Big\{\frac{c^{1-\gamma}}{1-\gamma} + \beta\Big[(1-\delta_Z^P)\max\{V_{Z+1}^{EP}(a', \bar{E}^{P'}, \bar{E}^{G'}), V_{Z+1}^{U}(a', \bar{E}^{P'}, \bar{E}^{G'})\} + \delta_Z^P V_{Z+1}^{U}(a', \bar{E}^{P'}, \bar{E}^{G'})\Big]\Big\} \tag{10}$$

$$c = (1+r)a + w_Z^P(1-\tau(w_Z^P)) - a'. \tag{11}$$

[10] In Appendix we show that only a majority of new hires in the public sector come from non-employment. In Spain, France, UK and US only 11, 15, 27 and 21 percent of new-hires were employed in the private sector in the previous quarter (month in the US).

Private-sector workers face different wage and job-separation profile. When unemployed, individuals decide to search in one of the two sectors, with the values given by:

$$V_Z^{UG}(a,\bar{E}^P,\bar{E}^G) = \max_{a'}\Big\{\frac{c^{1-\gamma}}{1-\gamma} + \beta\Big[\theta_Z^G \max\{V_{Z+1}^{EG}(a',\bar{E}^{P'},\bar{E}^{G'}), V_{Z+1}^{U}(a',\bar{E}^{P'},\bar{E}^{G'})\} + (1-\theta_Z^G)V_{Z+1}^{U}(a',\bar{E}^{P'},\bar{E}^{G'})\Big]\Big\} \tag{12}$$

$$V_Z^{UP}(a,\bar{E}^P,\bar{E}^G) = \max_{a'}\Big\{\frac{c^{1-\gamma}}{1-\gamma} + \beta\Big[p^P(\theta_{h,e}^P) \max\{V_{Z+1}^{EP}(a',\bar{E}^{P'},\bar{E}^{G'}), V_{Z+1}^{U}(a',\bar{E}^{P'},\bar{E}^{G'})\} + (1-p^P(\theta_Z^P))V_{Z+1}^{U}(a',\bar{E}^{P'},\bar{E}^{G'})\Big]\Big\} \tag{13}$$

$$c = (1+r)a + b_Z - a'.$$

The unemployed earn b_Z net of taxes. They face different job-finding rates in the two sectors. Furthermore, the values depend on their assets and average lifetime earnings. 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 choose to search in the sector with the highest value so that the value of unemployment solves

$$V_Z^{U}(a,\bar{E}^P,\bar{E}^G) = \max\Big\{V_Z^{UP}(a,\bar{E}^P,\bar{E}^G), V_Z^{UG}(a,\bar{E}^P,\bar{E}^G)\Big\} \tag{14}$$

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

$$V_Z^{R}(a,\bar{E}^P,\bar{E}^G) = \max_{a'}\Big\{\frac{c^{1-\gamma}}{1-\gamma} + \beta V_{Z+1}^{R}(a',\bar{E}^{P'},\bar{E}^{G'})\Big\} \tag{15}$$

$$c = (1+r)a + ss(1-\tau(ss)) - a'.$$

with $\bar{E}^{X'} = \bar{E}^X$, and 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.

2.5 Equilibrium tightness

As typically in the recent literature on public employment, we do not model why governments follow certain policies. These could be due to preferences for the production of goods and services, for redistribution, union pressure, or political economy considerations. That is, we take the wage profile and separation rates in the public sector as given. Moreover, we also take the public-sector hiring policies as exogenous from data, i.e., we exogenously set government vacancies in each sub-market, v_Z^G, to target public employment as a fraction of total employment by age and education. This means the public employment profile is demand driven (by the government) rather than by (self)selection. More people searching in for public sector jobs does not increase the number of jobs, only queues.

Given the number of vacancies in each age/education sub-market, we have to determine which unemployed workers search in the public and which search in the private sectors (Equation (14)). As we discuss below, each private sector sub-market features a unique job-finding probability, $p^P(\theta_Z^P)$. Each unemployed worker values public- and private-sector jobs differently because of their individual assets and life-time earnings, $[a, \bar{E}^P, \bar{E}^G]$. Each unemployed in a sub-market has a unique job-finding probability in the public-sector that would make her indifferent between searching in the two sectors, $\theta_Z^{G*}(a, \bar{E}^P, \bar{E}^G)$. When deciding in which sector to search, an unemployed compares the actual job-finding probability common to all the unemployed to the rate that would make her indifferent. Hence, there exists a marginal worker who at the realized θ_Z^G is indifferent between searching in the two sectors and all unemployed with a higher (lower) $\theta_Z^{G*}(a, \bar{E}^P, \bar{E}^G)$ search in the private (public) sector. This marginal worker pins down the equilibrium job-finding probability in the public sector and, thus, the type of unemployed searching in each sector.[11] Denote the resulting density of unemployed workers searching

[11] To compare the values of searching in the private and public sector, workers do not only need to know today's job-finding probabilities, but also the probabilities they will face in the future. To make the model computationally 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 calendar year. Using as measure R^2, the approximation explains 99% of the realized variation.

in the private sector by $\Lambda_Z^{UP}(a', \bar{E}^{P'}, \bar{E}^{G'})$.

Turning to the equilibrium finding rates in the private sector, we model firms in a simplified way. When matched with a firm, workers produce output y_Z and receive a constant share, $w_Z^P = \lambda y_Z$. Thus, flow profits are given by $\pi_Z = (1-\lambda)y_Z$. This simplification would not be coherent with a random search approach (as the effects of policies occurs through wage spillovers), but is consistent with the framework of segmented markets in which the effects work through the length of queues and the scale of the private sector, as shown by Chassamboulli and Gomes (2020b). The value of a matched worker depends on her education and age, because productivity and the job destruction rate vary with the education and on the age of the worker, and because retirement terminates the match. Moreover, because of endogenous quitting, it depends on the remaining worker states. We assume firms are risk neutral; thus, the resulting firm value is

$$V_Z^F(a, \bar{E}^P, \bar{E}^G) = \pi_Z + (1 - \delta_Z^P)\mathbf{I}_{Z+1}^P(a', \bar{E}^{P'}, \bar{E}^{G'})\beta V_{Z+1}^F(a', \bar{E}^{P'}, \bar{E}^{G'}), \tag{16}$$

where $\mathbf{I}^P$ is an indicator variable that is one when the worker does not quit into non-employment. When posting a vacancy, the entrepreneur pays flow costs that depend on the required education level, $\kappa(e)$. There is free entry into each vacancy sub-market:

$$0 = -\kappa(e) + \beta q^P(\theta_Z^P) \int \int \int V_{Z+1}^F d\Lambda_Z^{UP}(a', \bar{E}^{P'}, \bar{E}^{G'}). \tag{17}$$

Hence, equation (17) pins down the vacancy-filling probability in each private-sector sub-market, $q^P(\theta_Z^P)$, and, conversely, the job-finding probability in each sub-market, $p^P(\theta_Z^P)$.

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* $\{\theta_Z^P, \theta_Z^G\}$*, stocks of public- and private-sector employment and unemployed searching in the two sectors* $\{e_Z^P, e_Z^G, u_Z^P, u_Z^G\}$*, private-sector wages* $\{w_Z^P\}$ *and densities of assets and lifetime earnings* $\{\Lambda_Z^P, \Lambda_Z^G, \Lambda_Z^{UP}, \Lambda_Z^{UG}, \Lambda_Z^R\}$ *such*

that, given some exogenous government policy $\{v_Z^G, \delta_Z^G, w_Z^G\}$*:*[12]

1. *Workers choose assets and make decisions about employment according to conditions (8), (10), (12), (13) and (15).*
2. *Unemployed decide optimally the sector to search (14).*
3. *The average lifetime earnings evolve according to (1) and (2).*
4. *Private-sector firms satisfy the free-entry condition (17).*
5. *Job-finding rates in the two sectors and vacancy-filling rates are given by (5), (6) and (7).*

3 Calibration

We calibrate the model to 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. We show in Appendix A.2 the comparison of the key variables of the two surveys. For the European countries, we use their Labour Force Surveys: the UK LFS (2003-2016), the French LFS (2003-2016) and the Spanish LFS (2005-2017), that were extracted by Fontaine et al. (2020). We complement it with 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 and the UK Household Assets Survey for 2006. Finally, for government programs, we rely on data from the OECD.

We calibrate exogenously all parameters pertaining to the welfare state, earnings in the public sector, output, the private sector's wage share in output, vacancy posting costs, workers' risk aversion, and the interest rate. All remaining parameters are calibrated endogenously to match moments in the data. Table 1 summarizes the calibration.

[12] We solve for the steady state numerically. Appendix A.4 outlines the algorithm.

Parameter	Value				Target/Source
	US	UK	F	S	
	Exogenous				
γ	1.5				Attanasio and Weber (1995)
r	0.01				Siegel (2002)
w_Z^G	Age-specific, see Table 3				Wages public sector
y_Z	Age-specific, see Table 3				Wages private sector
λ	0.63	0.65	0.64	0.62	Wage share private sector
$\kappa(e)$	638/829	451/597	594/863	398/553	Hagedorn and Manovskii (2008)
	Endogenous				
$\iota(e)$	0.27/0.27	0.27/0.31	0.24/0.24	0.25/0.27	Mean unemployment rate
$(1-\beta)$*100	1.1	1.05	1.15	0.94	Median wealth to income ratio
v_Z^G	Age-specific				Share public employment
δ_Z^G	Age-specific, see Figure 3				EU rate public
δ_Z^P	Age-specific, see Figure 3				EU rate private

Table 1: Calibration

The table summarizes the calibration. The left column displays the calibrated parameter. The middle column shows for the calibrated parameter for the four countries (US, UK, (F)rance, (S)pain). The right column describes the data target. We separate the table into those parameters that we calibrate exogenously to a specific data moment and those that we calibrate inside of the model.

3.1 Public- and private-sector policies

Figure 3 shows the size of the public sector relative to total employment over worker's age. In all four countries, the public sector is particularly prevalent for workers with a college degree. The share of workers in the public sector is increasing until age 55 and decreases slightly thereafter. Except in Spain, the share of non-college workers in the public sector rises from 10 percent at age 20 to around 20 percent at age 55. In Spain, it rises from 5 to 15 percent. The increase is yet more pronounced for college-educated workers. It is about 10 percent at age 20 and rises to 30 to 45 percent at age 55 depending on the country. Notice that our objective is to evaluate the effects of time-varying compensation in the public sector, taking as exogenous this age-profile of employment. Thus, we calibrate the number of public-sector vacancies in each sub market, v_Z^G, to match these age-employment profiles.[13] The figure shows that the model traces the data perfectly until age 55 but fails to match the decline in the public share after age 55. We think this fact, visible mainly in

[13]In Appendix A.1, we show that the age differences between the sectors are unlikely to result from cohort effects or occupational differences between teh sectors. Instead, we show that new hires from unemployment tend to be older in the public sector.

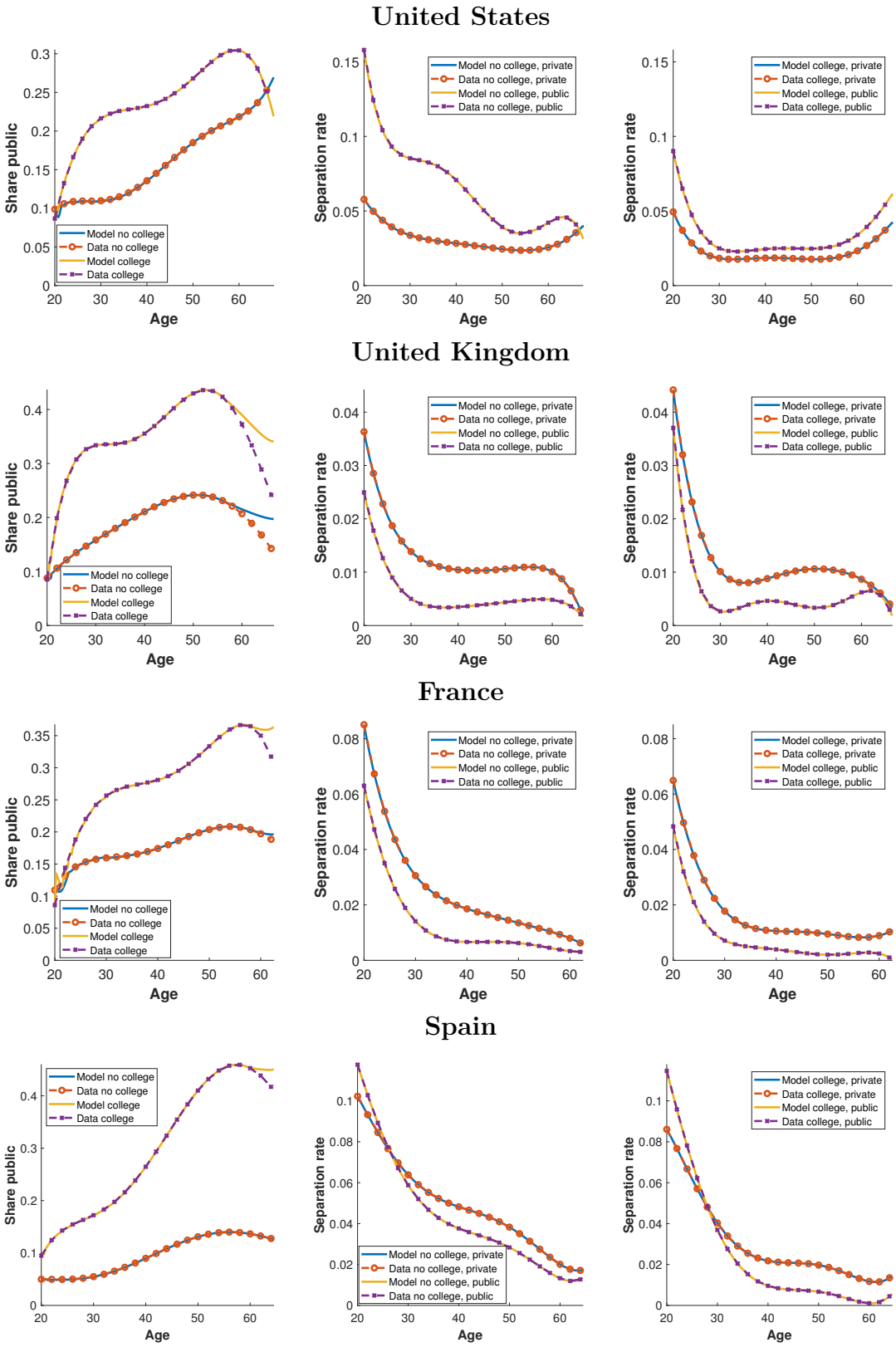

Figure 3: Labour Market Stocks And Flows By Education And Age

Note: The figure show public employment out of total employment and the job-separation rates in the two sectors, by age and education. The data is taken from SIPP (1996-2017), UK Labour Force Survey (2003-2016), French Labour Force Survey (2003-2016) and Spanish Labour Force Survey (2005-2017).

	United States		United Kingdom		France		Spain	
Age	Private	Public	Private	Public	Private	Public	Private	Public
No college								
20-29	1.00	1.10	1.00	1.14	1.00	1.01	1.00	1.15
30-39	1.15	1.26	1.15	1.27	1.14	1.14	1.09	1.29
40-49	1.23	1.40	1.19	1.28	1.21	1.22	1.16	1.36
50-59	1.29	1.42	1.16	1.27	1.27	1.29	1.23	1.41
60+	1.26	1.30	1.11	1.22	1.35	1.32	1.27	1.41
Average	–	1.09	–	1.10	–	1.01	–	1.15
College								
20-29	1.30	1.37	1.31	1.41	1.38	1.34	1.31	1.42
30-39	1.57	1.58	1.53	1.58	1.61	1.55	1.51	1.62
40-49	1.62	1.65	1.59	1.64	1.80	1.72	1.68	1.75
50-59	1.63	1.66	1.55	1.65	1.90	1.86	1.81	1.84
60+	1.58	1.62	1.45	1.59	2.02	1.93	1.87	1.87
Average	–	1.02	–	1.06	–	0.97	–	1.06

Table 2: Estimated Wage Profiles

SIPP (2005-2017), SES (pooled 2002, 2006, 2010, 2014). Estimation by regressing the log of average gross hourly earnings 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 (US: \$5208, UK: £3961, France: €4980, Spain: €3369).

the UK, is due to the possibility of early retirement that is more prevalent in the public sector - something that we do not take into account in the model.

Next, consider the differences in the job-security between the two sectors shown in the remaining graphs of Figure 3. We target these rates with the exogenous job-separation rates, δ_Z^P, δ_Z^G.[14] In the three European countries, the public sector has generally lower separation rates than the private sector, and the differences are particularly pronounced in France. In contrast, in the US, the job-separation rates are higher in the public sector.[15]

Turning to wage differences in the two sectors, we regress, separately for workers with and without a college degree, the log of average hourly gross hourly earnings on age bracket dummies, age bracket dummies interacted with a public-sector dummy, as well as regions (NUTS I), occupations (2-digit), gender, manager, part-time, and year dummies. We estimate the education premium for private-sector workers aged 20-29. Table 2 shows the resulting wage profiles. In the model, we match gross wages in the public sector,

[14]Endogenous quitting is almost zero in the model. Hence, The exogenous job destruction rates in the model almost coincide with the observed flow rates in the data.

[15]Fontaine et al. (2020) also find for the US that the unconditional job-separation rate in the private sector was double the one in the public sector. However, the difference reduces to 36 percent once they control for additional worker observables.

w_Z^G, directly to this profile. In the private sector, we set the share of wages in output, λ, to the labor share of the four economies. We than match the private-sector wages, w_Z^P, by adjusting worker's output in the model, y_Z. To make countries more readily comparable, the table also displays the wage premium of the average public employee, i.e., the wage premium at each age weight by the density of public employment over age. As we have discussed above, this wage premium is different from the average wage difference between public- and private-sector employees because it puts higher weights on older workers that, on average, have higher wages. Comparing the wage premia across countries, some common features stand out. In all countries but France, the public sector pays higher wages than the private sector. Also, as commonly found in the literature, there is a higher premium for workers without a college degree. Spain stands out with an average premium of 15 percent. For college-educated workers, Spain and the UK pay the highest premia of about 6 percent. Finally, except in the US, the public-sector wage premium is higher for younger workers, that is, wages grow more steeply in the private sector.

For retired workers, the compensation difference between the two sectors also results from their retirement replacement rates. The top panel of Table 3 compares the estimates of replacement rates in the two sectors. The original graphs from the report are shown in Figures A5-A8 in the Appendix. The differences in the retirement replacement rates are the highest in the UK, with private-sector pensions replacing 50 percent of wages, while public-sector pensions replace more than 100 percent. In the US and Spain, the replacement rates are 20 percentage points higher in the public sector. Despite having entirely separated pension schemes, France has the lowest asymmetry between sectors, with a difference of only 8 percentage points.

Finally, the government provides two insurance schemes against income risk. First, it runs an unemployment insurance scheme. The bottom panel of Table 3 shows that, on average, the replacement rates are higher in France and Spain compared to the UK and US, and they are also higher for non-college educated workers. Second, the government uses a progressive income tax system, $\tau(.)$, that follows the statutory tax schedule (com-

	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

Table 3: Unemployment And Retirement Benefits

Note: Retirement benefits from OECD (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.

prising both income tax and social security contributions) detailed in Appendix A.3. The progressivity of the system reduces the difference between the net income of workers.

3.2 Remaining parameters

Following Attanasio and Weber (1995), we use a risk aversion coefficient of 1.5. We set $r = 0.01$ and calibrate β to match the median net wealth to income ratio over age groups.[16] Workers start with zero wealth at age 20. Following Hagedorn and Manovskii (2008), we set the vacancy posting costs, $\kappa(e)$ to 4.5 percent of quarterly output and 3.67 percent of quarterly wages in the private sector. We use the matching efficiency in the private sector, $\iota(e)$, to calibrate the average unemployment rate of low- and high-educated workers. Moreover, we match the unemployment rate and the share of employed workers in the private and public sector by education at age 20, assigning the status randomly across individuals.

3.3 Analysis of the baseline economies

The calibration targets the initial and average unemployment rate and the median wealth to income ratio but not their life cycle behaviors. Still, we replicate these well, as shown Figure 4. The left panels display the unemployment rate for college and non-college workers. In all countries but the US, unemployment rates are declining in age, and we

[16]We choose to target the median instead of the mean as the model features no mechanisms that allows it to match the fat right tail of the wealth distribution in the data.

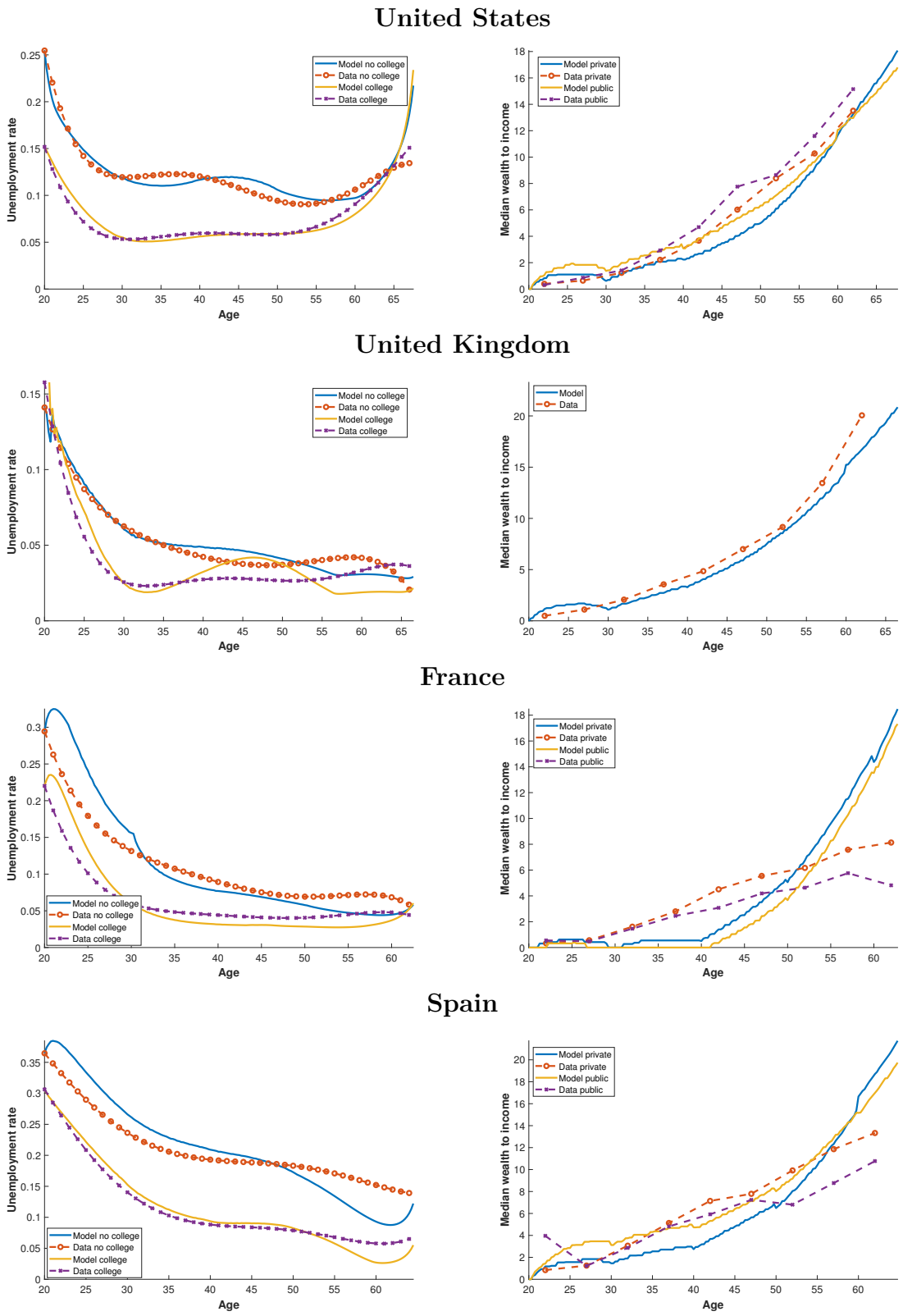

Figure 4: Unemployment Rates, Median Wealth To Income Ratio By Age

Note: The left graphs show the unemployment rate of college and no-college workers, in the model and in the data by age. Only the initial unemployment rate at age 20 and the average unemployment rate across educations were model targets. The graphs on the right show the median wealth to income ratios of public- and private-sector workers, with and without college. For the UK, the wealth data is not available by sector.

replicate the relatively quick decline early in life. In the US, the relationship is U-shaped in age, with the model overstating slightly the increase late in life.

The right panels display median wealth to income ratios over the life cycle. In the data, the median household holds almost no net wealth in its early twenties, and the median wealth to income ratio is increasing throughout working life afterward. The model replicates this basic pattern as workers accumulate savings to finance consumption during retirement when average earnings are below those of their working life. The model overstates the increase for France and Spain but matches it well in the UK and the US. This might suggest other forms of insurance, either from the government or the family, in continental Europe.

The model features three mechanisms driving differences in wealth to income ratios between the two sectors. First, job security differs leading to lower precautionary savings in the public-sector, except in the US. Second, as we will explain below, workers with high wealth tend to search in the public sector because their wealth permits them to wait longer for a relatively attractive job offer. By this mechanism, high-wealth workers tend to sort themselves into the public sector. Third, higher replacement rates in the public-sector reduce the need for life-cycle savings of their workers. Consistent with this, we observe higher wealth to income ratios in the private relative to the public sector in both Spain and France late in life. France is particularly interesting in this respect because the only institution markedly different between the two sectors is the higher retirement replacement rate in the public sector.

Next, we turn to the search decisions of unemployed workers that lead to these unemployment and wealth outcomes. Figure 5 show the job finding rate in the public relative to the private sector. In general, college workers in France being the exception, search is more efficient in the private than in the public sector (the ratio of job finding rates is below one). Put differently, workers prefer having a public rather than a private sector job and this is particularly true for non-college workers. The differences in search efficiencies is relatively small early in life when workers have relatively little wealth and, thus, cannot afford to wait too long to find the most desirable job. As workers come closer

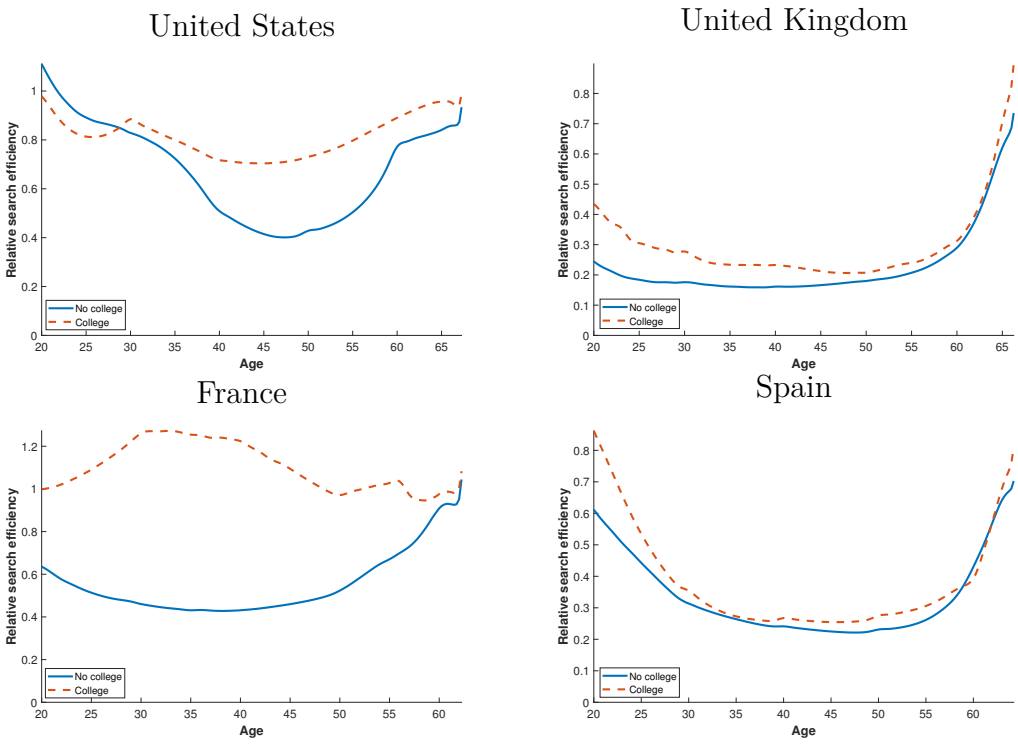

Figure 5: Attractiveness Of The Public Sector, By Age And Education

Note: The graphs show the ratio of search efficiency in the public sector relative to the private sector for college and no-college workers.

to retirement, the relative discounted present values of working in the different sectors converge. Hence, relative search efficiencies start converging again

4 Results

4.1 Public-sector premia

Often in policy discussions, there is the argument that public-sector jobs offer extra-compensation besides wages. Two of these compensations are job-security and better pensions. However, there are few attempts to quantify these job-security and pensions premia. Furthermore, the average wage premia reported in Table 2 give only an incomplete view about the economic value of average public- sector wage premia and the variation of this premia over the life cycle. Assessing the true economic value of the wage premium together with the economic value of higher pensions and job security is extremely important from a policy perspective. According to Gomes (2015), the government should offer wages that equalize the value between the public and the private sector

	United States		United Kingdom		France		Spain	
	No college	College	No college	College	No college	College	No college	College
Total premium								
20	-0.81	0.83	26.57	14.03	5.59	0.21	13.94	6.36
30	2.44	1.86	25.52	13.82	5.28	-1.08	26.59	17.04
40	7.03	4.01	28.33	20.11	5.99	0.09	33.36	19.38
50	10.80	6.48	39.34	32.64	7.77	3.65	35.80	23.37
60	14.59	15.65	77.35	70.53	18.59	16.11	50.01	56.93
Avg	10.05	8.27	46.97	38.03	9.36	4.82	38.75	34.59
Wage premium								
20	9.69	4.90	11.53	5.77	0.59	-3.25	15.34	8.94
30	9.27	1.24	9.31	4.31	0.34	-3.68	16.83	6.33
40	12.69	1.88	8.31	5.01	0.82	-3.60	16.48	4.12
50	9.28	2.05	8.91	7.31	1.15	-2.77	14.05	4.69
60	3.35	2.72	9.31	9.31	-2.20	-4.52	11.32	15.68
Avg	7.04	2.30	9.13	6.83	0.07	-3.61	13.86	9.33
Retirement premium								
20	0.45	0.90	4.11	3.31	0.68	0.65	1.73	1.98
30	1.94	1.78	6.81	5.50	1.38	1.28	3.56	3.58
40	4.05	3.61	11.34	9.84	2.36	2.21	6.72	5.33
50	6.53	7.11	20.73	17.95	4.37	4.28	11.87	8.85
60	16.65	18.47	56.45	54.25	19.86	18.81	30.66	27.64
Avg	9.95	9.38	27.69	25.20	6.78	6.73	16.68	14.78
Security premium								
20	-10.44	-3.90	8.96	4.68	4.25	3.07	-2.22	-3.11
30	-8.77	-0.91	7.44	3.62	5.54	1.84	3.14	5.99
40	-7.92	-1.16	5.85	3.77	2.62	1.60	5.64	8.58
50	-3.60	-1.95	4.47	3.32	1.71	1.81	5.16	7.98
60	-3.40	-3.21	1.99	0.26	0.72	1.92	2.31	4.95
Avg	-5.43	-2.20	4.68	2.53	2.25	1.65	3.59	6.22

Table 4: Public-Sector Premia By Age

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.

taking the entire economic value of the jobs into account.

Our model offers a laboratory to calculate the retirement and the job-security premia, as well as the wage premium. We express these as the percentage increase in public wages (at all ages) required to compensate a public-sector worker for having the same wage schedule, pension scheme, or job-destruction rates as the private sector. We study these compensations jointly, as well as separately, across stationary equilibria holding all other model parameters fixed.

The second panel of Table 4 displays the wage premia for different ages for public-sector workers. That is, we ask by what percentage wages at all ages need to rise over the private-sector wage schedule to accept it over their own, i.e., $\tilde{w}^G_{h,e} = (1+\omega)w^P_{h,e}$, where $\tilde{w}^G_{h,e}$ is the resulting public-sector wage and ω is the wage premium. Hence, the

measure eliminates any difference in the age-schedule of wage compensation between the two sectors. We calculate this premium for workers who are employed in the public sector at different ages, as well as the average wage premium where we weight the age-specific premia by the density of public employment. These are similar (within one percentage point) to the average wage premia in Table 2, with two exceptions. College workers in Spain require a higher average wage premium by 9 percent, instead of 6 percent suggested by the "naive" wage premium. The reason is that public-sector wages are front-loaded relative to the private sector for college workers in Spain. For a young public-sector worker, receiving the high wage premium of older workers is uncertain due to the high separation rate as young. Hence, she requires a relatively higher compensation to be willing to give up her high wages when young. The reverse is true for non-college educated workers in the US where the public-sector wage premium is back-loaded. For these workers, the average measure is 9 percent, whereas the model suggests only 7 percent.

The third panel shows the retirement premium, i.e., the rise in the public-sector wage that makes a worker indifferent when the pension schemes are equalized across sectors. We express the premium relative to the existing public-sector wage: $\tilde{w}^G_{h,e} = (1+\omega)w^G_{h,e}$, so the wage profiles are again different between the two sectors. Looking at the age average, strikingly, in all countries, the retirement premium is larger than the wage premium. It ranges from 6.7 percent in France, to above 25 percent in the UK, with little differences between education groups. Yet, there is large heterogeneity by age. At age 20, workers only value the better pension regime at between 0.5 to 4.1 percent of their wages. Young workers heavily discount the higher pension benefits because of time discounting and the probability of changing sector during the working life. The premium reaches between 16.7 percent and 56.5 percent for workers at age 60, which suggests how much older public-sector workers would oppose any reform equalizing the pension schemes without large indemnities.

The last panel shows the job-security premium, again measured relative to the public-sector wage: $\tilde{w}^G_{h,e} = (1+\omega)w^G_{h,e}$. In the European countries, the average premium ranges

from around 2 percent in France to 6.2 percent for college workers in Spain. Resulting from high job-destruction rates for young Spanish public-sector workers, the security premium is actually negative at these ages. This, however, is compensated by highly stable jobs at older ages. The premia are always higher for low-educated workers, as they face a higher risk of unemployment. In the US, public-sector jobs have higher separation rates leading to a negative premium.

The first panel shows the total premia, i.e., when all three compensation schemes are equalized to the private sector. Considering the age-averaged premia, they are higher for workers without college. Also, the total public-sector compensation is substantially larger than suggested by the average wage premia from static reduced-form estimations. For college workers, the premia range from 4.8 percent in France to 8.3 percent in the US. The corresponding "static" wage premia are -3.0 percent and 2.0 percent, respectively. For non-college workers, the premia are as high as 38.8 and 47.0 percent in Spain and the UK, respectively. The corresponding "static" wage premia are 15 and 10 percent. Resulting from the retirement premium, these premia are heavily tilted towards older workers.

4.2 Reforms

The substantial premium from having a public-sector job implies that many workers queue for these (fixed number of) jobs, reducing job creation of firms. As a result, the unemployment rate is higher. Moreover, the age variation in these premia implies that this queuing of unemployed workers also has an age dimension. We now examine the effects that reforms harmonizing the public-sector wages, pension scheme and job-security with those of the private sector have on life cycle unemployment and government expenditures. The harmonization of human resource practices and policies in the public sector with those in the private has been a trend in many countries in the past years, and has many supporters. We think this is a more realistic and policy-relevant experiment, rather than calculating jointly the wage, retirement benefits, and job security optimal policy that maximizes efficiency. Importantly, harmonizing the policy mitigates the search

distortions created by the asymmetry in compensations.Across all experiments, we keep the size of public employment by age constant. Given the partial equilibrium nature of the model, wages also remain constant.

Equalizing the compensation schemes lowers the age-averaged unemployment rate, except in France. Resulting from the proximity of the public sector with the private sector, in France, the average unemployment rate of non-college workers drops by only 0.5 percentage points and that of college workers rises by 0.7 percentage points. In the UK, the rate drops by 1.6 and 1.5 percentage points, in the US by 2.9 and 1.1 points, and in Spain by 2.7 and 2.6 percentage points, respectively.

Figure 6 shows the effects on the unemployment rate when equalizing each compensation scheme one-by-one. In the US, UK, and Spain, equalizing wages alone reduces the unemployment rate by about one percentage point, as shown in the left graphs. The effect is more pronounced around the age of 45 to 50 when the share of workers searching in the public sector is at its peak. Eliminating the pension premium, shown in the middle graphs, leads to a reduction in the unemployment rate by about half a percentage points in most countries and education groups. Finally, eliminating the additional security that European public sectors provide has a theoretically ambiguous effect on the unemployment rate. On the one hand, it reduces the attractiveness of these jobs leading to fewer workers queuing for them. On the other hand, it increases the frictional unemployment rate because the inflow into unemployment becomes larger. We find that the second effect dominates, i.e., increasing public-sector job-separation rates leads to more unemployment.

By changing the unemployment rate and the payments to public-sector workers, the reforms also have fiscal effects, as shown in Table 5. Take the US as an example. Equating the wages lowers the government's wage bill. Moreover, resulting from the fall in the unemployment rate, the costs with unemployment benefits also fall. The effect on retirement benefits is theoretically ambiguous. On the one hand, lower wages lead to lower public-sector pensions. On the other hand, higher private-sector employment implies higher private-sector retirement benefits. We find that the latter effect dominates

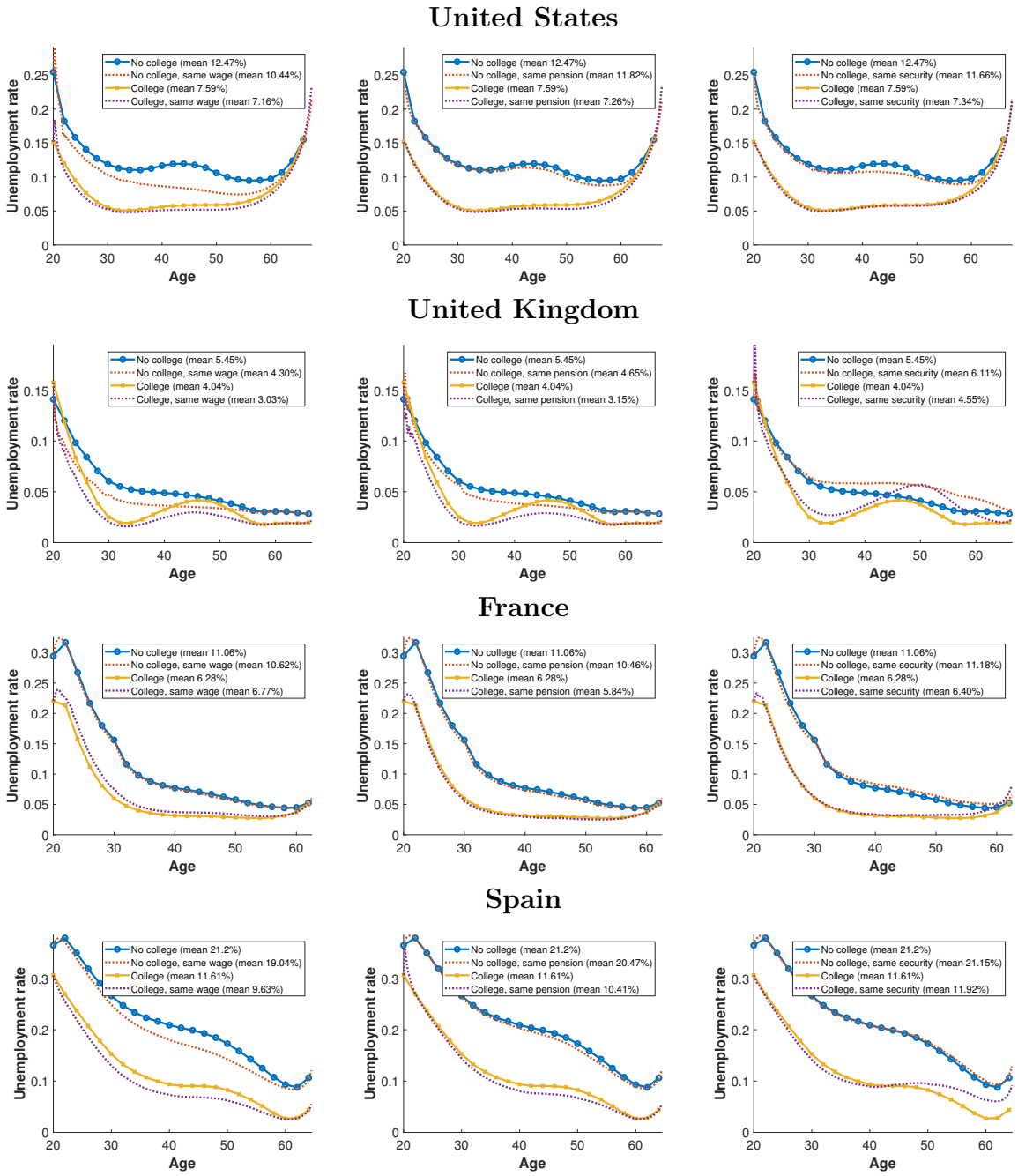

Figure 6: Effects Of Three Reforms On Unemployment

Note: The left graphs show the effect of equating the wage profile of the public sector to that of the private. The middle graphs show the effect of equating the replacement rates of the public sector to that of the private. The right graphs show the effect of equating the job-separation rate profile of the public sector to that of the private.

marginally for the US, Spain, and France, but not in the UK. Similarly, the effect on government revenue is ambiguous. On the one hand, higher employment increases tax revenue. On the other hand, lower wages and retirement benefits decrease tax revenue. Here, we find that the former effect dominates slightly, so there is an increase in revenue in all four countries. In total, we find that by equating wages to those of the private

sector, the net government budget improves by $46 per person/quarter in the economy. The gains are yet larger in the UK and Spain with £63 and €50, respectively. In France, given the closer alignment of the two sectors, the effects are close to zero.

When equating the replacement rates, the overall cost of pensions decreases, and the unemployment decreases which lowers the costs with unemployment benefits. Again, the effect on tax revenues is ambiguous, and we find that these decrease slightly. The total improvement in the government's budget ranges from €28 per person/quarter in France to £177 in the UK, that has the largest difference in replacement rates. Equalizing the job destruction rates has again heterogeneous effects across countries. The unemployment rate falls in the US leading to an improvement in the budget, but it increases in the other three countries leading to a worsening in the budget.

Finally, the first column shows the overall budgetary effects when making equating the three compensation schemes. The government's budget improves by €9 per person/quarter in France, €93 in Spain, $95 in the US, and £229 in the UK.

	Baseline	Total	Same wage	Same rr	Same destruction
US					
Unemployment rate %	9.38	7.67	8.38	8.97	8.95
Costs benefits	172	140	153	164	164
Costs wage	842	813	813	842	843
Costs pension	776	737	782	727	779
Revenues	1458	1453	1462	1445	1465
UK					
Unemployment rate %	4.62	3.23	3.71	3.96	5.41
Costs benefits	56	40	45	48	66
Costs wage	887	833	833	887	887
Costs pension	708	507	696	510	701
Revenues	736	694	722	707	730
France					
Unemployment rate %	9.2	9.35	9.33	8.93	9.6
Costs benefits	205	211	209	199	216
Costs wages	708	717	717	709	709
Costs pension	845	815	844	816	842
Revenue	1050	1044	1054	1044	1045
Spain					
Unemployment rate %	17.9	15.51	16.03	17.26	18.20
Costs benefits	225	194	201	217	230
Costs wages	398	368	368	398	398
Costs pension	592	540	595	533	590
Revenue	764	744	763	743	760

Table 5: Program Costs Per Person/Quarter (In Dollars, Pounds, And Euros)

5 Conclusion

Public employment is not driven by the same objectives as private employment. As such, the two labour markets function differently. Amongst several of the differences, this paper is motivated by the substantial asymmetries in the size of the public sector in total employment, as well as the differences in compensation over the life cycle.

We set up an equilibrium life cycle model with a public and private sector. The two sectors differ in their age-specific wages, retirement benefits, and job security. The model features search and matching frictions in the labour market together with incomplete markets and risk-averse workers. Our key findings from the model are that (a) the total public-sector compensation premium is substantially larger than the wage premium, (b) this premium varies with age, and (c) harmonizing policies between the two sectors generally reduces unemployment and improves governments' budgets.

While the purpose of the model is quantitative – to calculate the public-sector job-security and pension's premia and the effects of different reforms – we should interpret the results with caution. Our calibration 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 policies, in some cases reducing the asymmetries and in other cases increasing them. We interpret the finding of large quantitative effects of reforms on the unemployment rate and in fiscal variables, as a call for more research on how to improve wage and employment policies in the public sector. This is even more important now, in a time where government debts are at historically high levels, and more is being asked from the government.

We see our paper as first step in better understanding the differences between private- and public-sector jobs, in the presence of risk-averse workers. Several other dimensions are still absent from the model and call for future research: early retirement, different exposures to the business cycle, differences in job amenities (such as vacations and flexible hours), differences in wage volatility, differences in the transferability of accumulated skills, and the joint decisions of couples of which sectors to join.

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A Appendix

A.1 Public employment by Age

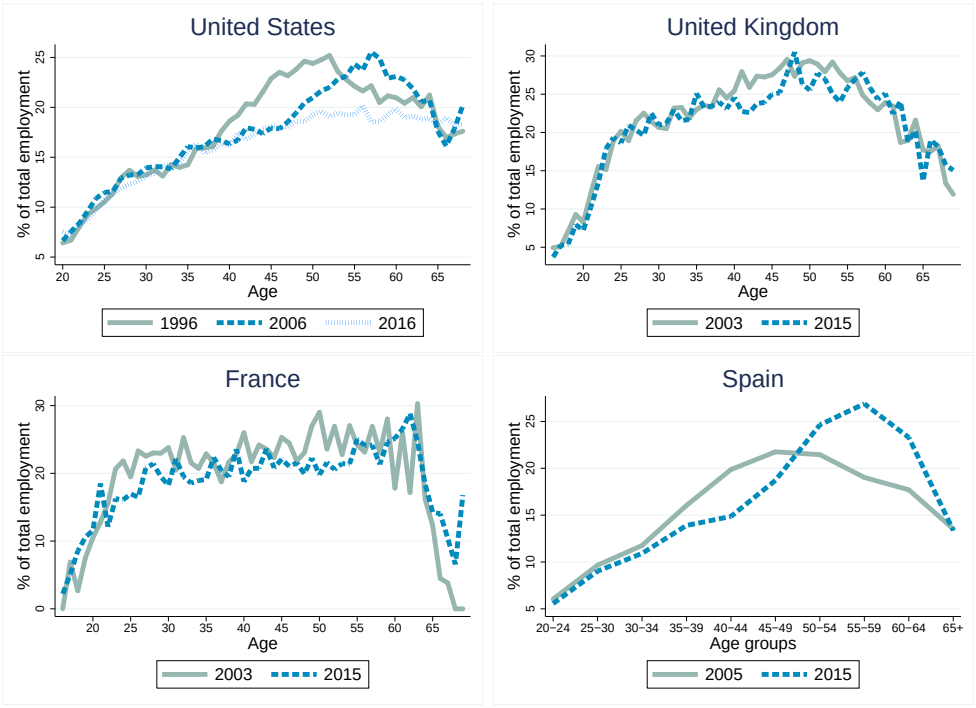


Figure A1: Public Employment Over The Life Cycle, Different Cohorts

Note: The figure show public 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 (2005-2017). See for details on the methodology in Fontaine et al. (2020).

The paper shows that the public sector employs relatively older workers. Moreover, it highlights that this labor demand policy, together with age-varying compensation differences between the public and private sector, affects unemployment rates of workers over their life cycle by affects their search decisions. This appendix establishes four facts relevant for these mechanisms. First, it shows that the age profile we observe in the data is not driven by cohort effects. Second, it shows that occupational differences between the two sectors cannot explain this age profile. Third, it shows that new hires are indeed older in the public sector. Fourth, it shows that job-to-job transitions are not the dominant driver behind the reallocation of elderly workers towards the public sector.

One possible explanation that contributes to the pattern are cohort effects. The size and the composition of public employment depend, to a large extent, on past decisions. As argued by Rose (1985), "to understand the level of public employment today, we must understand how past program commitments have gradually caused some groups of workers to increase in number, whilst others remain constant or decrease." Governments have control over changes of public employment through the hiring of workers, but when analyzing the stocks, they might be driven by historical episodes. Suppose that the government hired many workers in the 1970s. These workers would now be close to retirement age, and have a disproportionate weight on the average age of the sector. To understand the importance of such cohort effects, Figure A1 shows the age profile for

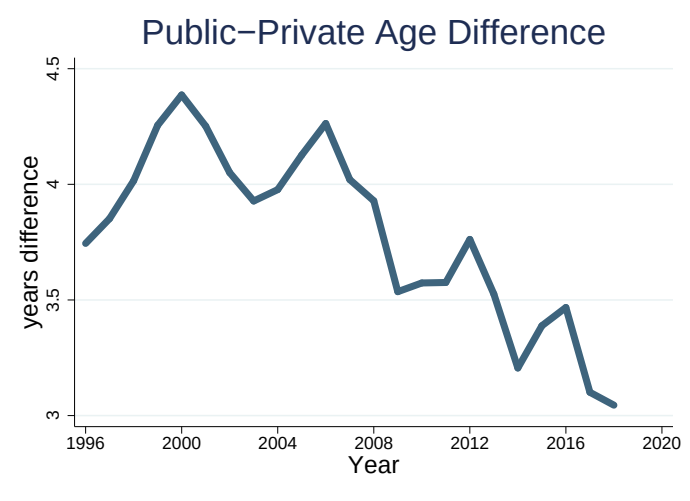


Figure A2: Evolution of Age difference Between Public and Private Sector Worker

Note: The figure shows the average age difference between workers in the public and private sector, based of regression of unweighed data from CPS-IPUMS (1996-2018).

several specific years separated by a decade. If there are cohort effects, these could be seen as humps that evolve from decade to decade. We do observe such patterns in the US and Spain, but again they don't justify the pattern.

Another way to confirm the relative unimportance of a shrinking public sector in driving the age profile is to look at average public sector relative to private sector age over time. The relatively long time series allows us to do this for the US. Figure A2 shows the difference in average age across the two sectors over time. The average age has declined by less than one year.

Differences in the age profile may also result from the underlying job characteristics being different across sectors. For example, the public sector may hire particularly many physicians and this occupation requires long work experience. In our context, this would be problematic, if some workers had preferences for particular occupations. In that case, they would not face a true choice between searching for work in the private or public sector but would always search in the public sector once they reach the required age. For the US, we can use occupation data from the CPS to understand the importance of occupations on the age profile of the public sector. To that end, we regress the age of employed workers on a public-sector dummy to capture the difference in average age. These are shown in column (1) of Table A1. The average workers in the public sector is 3.8 years older than the private sector. In column (2) we include dummy variables for about 458 4-digit occupation dummies, as well as year dummies. These are very precise occupations like "Water Wastewater Treatment Plant and System Operators" or "Speech Language Pathologists", so they will filter the effects of different jobs in the public sector. The size of the coefficient reduces to 3.3, meaning that for the United States, about 13 percent of the age difference can be accounted by the composition of jobs. We re-run regressions for worker with and without college separately, with similar result. The average age difference is bigger for workers without college, 4.7 years, compared to worker with college, about 2.3.

Another explanation for workers being older in the public sector relates to a longer tenure in that sector arising from lower separation rates. Notice that lower job-separations per se do not necessarily raise the average age of workers relative to the private sector.

	All workers		College		No College	
	(1)	(2)	(1)	(2)	(1)	(2)
Public-sector	3.783***	3.290***	2.328***	2.339***	4.704***	4.191***
	(152.56)	(112.11)	(62.46)	(62.91)	(117.72)	(93.49)
Controls						
Occupation dummies		X		X		X
Year dummies		X		X		X
Observations	1,673,743	1,673,743	702,218	702,218	971,525	971,525
R-squared	0.0137	0.098	0.007	0.049	0.014	0.116

Table A1: Average Age Difference, United States

Note: CPS-IPUMS data between 1996 and 2018, unweighed. Regression of age of employed worker on the sector of employment. Include 458 4-digit occupations dummies.

Imagine a person losing the job in the private sector and finding another job quickly. This would reduce the job tenure, but would not affect the average age of employment in the private sector. Still, we could inspect this mechanism indirectly by looking at the difference of the average age of a worker in the two sectors, and compare it to the average age of a new hire. We use weighted data from the French, Spanish, UK Labour Force Surveys and the CPS (2003-2018), used by Fontaine et al. (2020). In the US and UK, the difference in the average age of workers and new hires are aligned. For instance in the UK, public-sector workers are 3 years older that their private sector counterparts, and the new hires in the public sector are also 3 years older. In the US the age difference is about 5 years, for both workers and new hires, (slightly higher that reported in Table A1 because we use the population-weighted data). In contrast, in France, there is no difference in the age of the new hires across sectors, but there is still a difference of 1.5 years in the average age across sectors. Spain is in between. The average age difference is about 4, but the average age difference of new hires, is only 2.

Our model generates the age pattern in public sector employment by using the fact that new hires tend to be older. An alternative explanation are sector-to-sector transitions through on-the-job search. Figure A3, shows new hires in the public sector that come from the private sector without a (measured) spell of unemployment as a fraction of total public sector hires. As a fraction of total hires, these transitions represent a minority. In Spain and France, they represent 11 and 15 percent. They are slightly bigger in the US and UK with 21 and 27 percent, but still small. The smaller share of sector-to-sector transitions in new hires from the public sector was also been documented by Chassamboulli et al. (2020). Moreover, this fraction is likely to be an upper bound for the importance of on-the-job search as some of these job-to-job transitions may represent reallocation to avoid unemployment. Finally, the life cycle profile is such that hiring from the private sector is relatively unimportant after age 40. As such, given the complexity of modeling additionally on-the-job search and sector to sector transitions, we consider only transitions through non-employment.

	United States		United Kingdom		France		Spain	
	Stock	Hires	Stock	Hires	Stock	Hires	Stock	Hires
Stocks								
All workers	5.05	5.38	3.12	3.29	1.66	-0.14	4.13	1.86

Table A2: Average Age Difference in Public Sector: Stock Vs. Hires

Note: French, Spanish, UK Labour Force Surveys and the CPS (2003-2018). Weighted data.

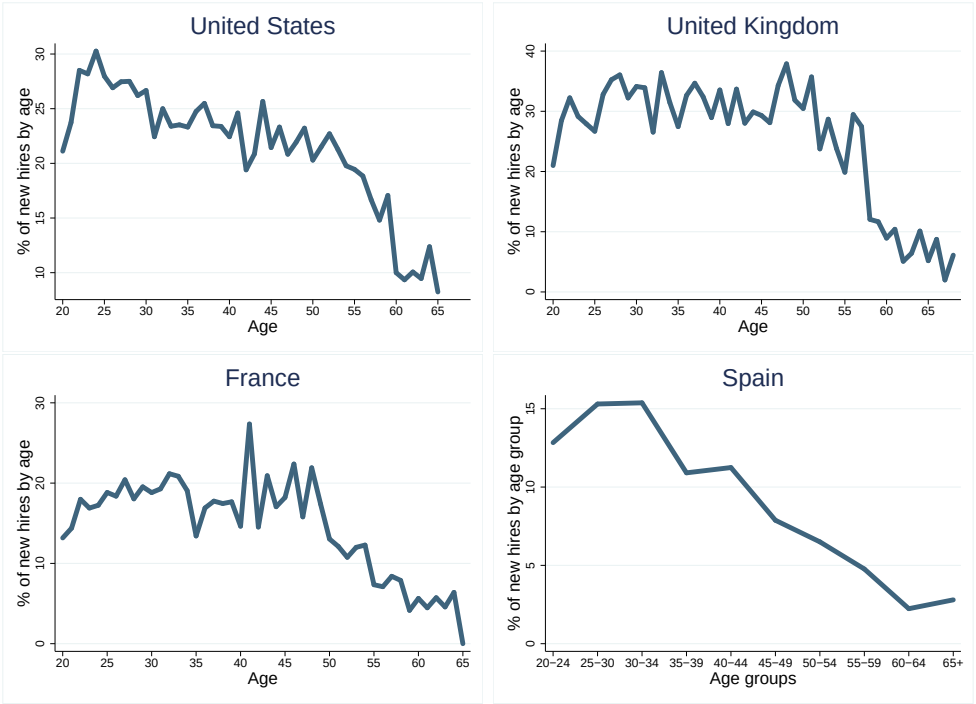


Figure A3: Hires in the Public Sector, Unemployment and Job-to-Job

Note: The figure show public sector hires from the private sector as a percentage of total public sector hires 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 (2005-2017).

A.2 CPS and SIPP comparison

The main part of the paper relies for the US on micro data from the SIPP. The reason is that the SIPP, other than the CPS, has information on household wealth, and we prefer to have a single unified data set. However, because of its smaller sample and the longer recollection period compared to the CPS, it is relatively inferior for the purpose of calculating worker flows and average earnings. Regarding the latter, Table A3 shows that the life cycle earnings profiles are very similar across the two data sets. Regarding the former, Figure A4 shows that average worker flows are higher in the CPS compared to the SIPP. However, the relative magnitudes between the public and private sector are very similar, and the age profiles have the same shapes in both data sets.

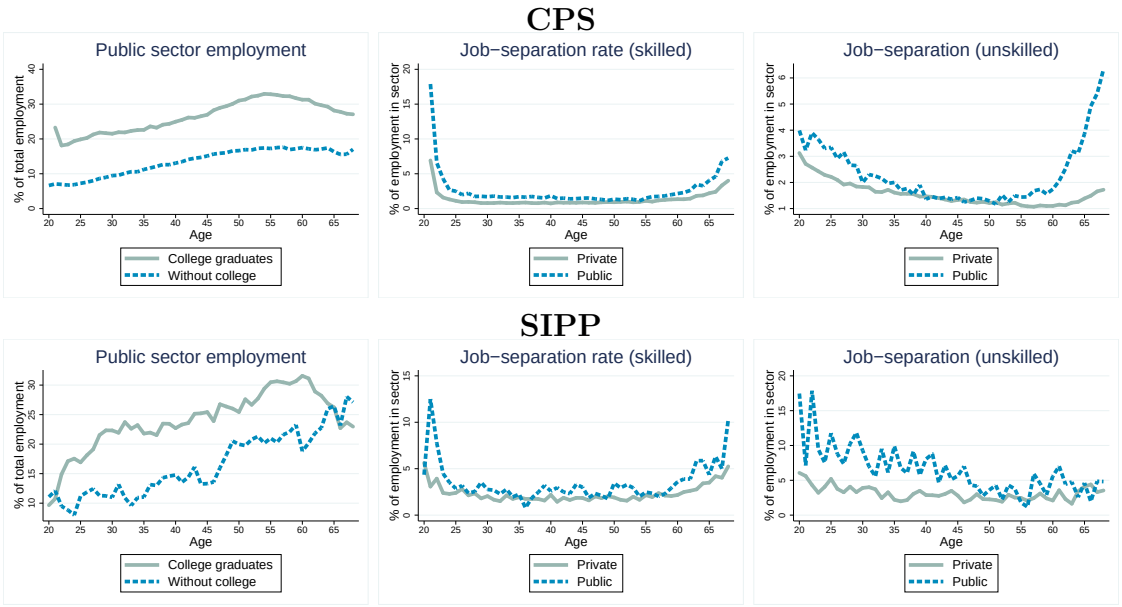


Figure A4: CPS and SIPP Comparison: Stocks And Flows By Education And Age

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).

	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

Table A3: CPS and SIPP Comparison: Estimated Wage Profile

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.

A.3 Tax schedule and calibration

All numbers are yearly.

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

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

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

A.4 Numerical Algorithm

The numerical solution employs a discretization of the state space. For the asset grid, we use 200 equally spaced grid points as states. The algorithm allows for off-grid asset choices, where we employ 900 equally spaced grid points. To compute the value function at off-grid choices, we use linear interpolation between the adjacent on-grid points. Similarly, we discretize the grids for accumulated lifetime earnings in the private- and public-sector allowing for 10 grid points for each. Moreover, we use again linear interpolation to compute the next period value functions given today's earnings in the private- and public-sector. Given the discretized state space, we solve over the life cycle for a sequence of public-sector labour market tightness, a sequence of employment decisions, and a sequence of distributions of unemployed searching in the private-sector. The algorithm proceeds in the following steps:

1. Guess for each education group and age the sequences of labour market tightness in the public-sector, θ_Z^G, the employment decisions, $\mathbf{I}_{Z+1}^P$, and the distribution of unemployed workers searching in the private sector Λ_Z^{UP}.

2. Solve backwards in time the value function of retired households. As this value function is differentiable everywhere, we employ an EGM algorithm for optimal consumption choices instead of a finite grid method.

3. Solve backwards in time the value functions of workers. Within each period:

   (a) Compute the equilibrium vacancy filling rate in the private-sector from Equation (17).

   (b) Compute the job finding rates in the public and private sector using Equations (5) and (6).

   (c) Compute the value of search in unemployment in the two sectors, employment choices, and the asset accumulation using Equations (12) and (13).

   (d) For each state, find the labour market tightness in the public-sector that makes workers indifferent between searching in the two sectors, $\theta_Z^{G*}(a, \bar{E}^P, \bar{E}^G)$. We

do so by slowly updating an initial guess of $\theta_Z^{G*}(a, \bar{E}^P, \bar{E}^G)$ until the value of search in the private- and public-sector are equal.

(e) Compute the expected values of employment, employment choices, and asset accumulation in the two sectors using (8) and (10).

4. Compute the realized sequences of labour market tightness in the public-sector and the distribution of unemployed workers searching in the private sector by iterating forward a density of workers over their life cycle.

   (a) Apply the law of motion for lifetime earnings using today's earnings.

   (b) Apply the law of motion for assets using optimal policies.

   (c) Find the share of workers searching in the private sector and the number of public sector vacancies:

   - For an initial guess for the share of workers searching in the private sector, compute the total number of unemployed finding a private sector job by Equation (6).
   - Using the law of motion for the employed in the public-sector, compute the number of public-sector vacancies such that the share of employment in the public-sector in the next period is equal to its data target.
   - Obtain tightness in the public-sector using (5) and the number of unemployed workers searching in the public-sector by using their optimal policy, $\theta_Z^{G*}(a, \bar{E}^P, \bar{E}^G)$.
   - Update the share share of workers searching in the private sector.

5. Store the tightness in the public-sector at a yearly level and obtain the tightness between yearly points by using spline interpolation.

6. Slowly update θ_Z^G. The optimal employment policies and the distribution of unemployed workers searching in the private sector can be updated fully.

	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

Table A4: Calibration of Taxes Schedule

A.5 Pensions replacement rate in private and public sectors

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.

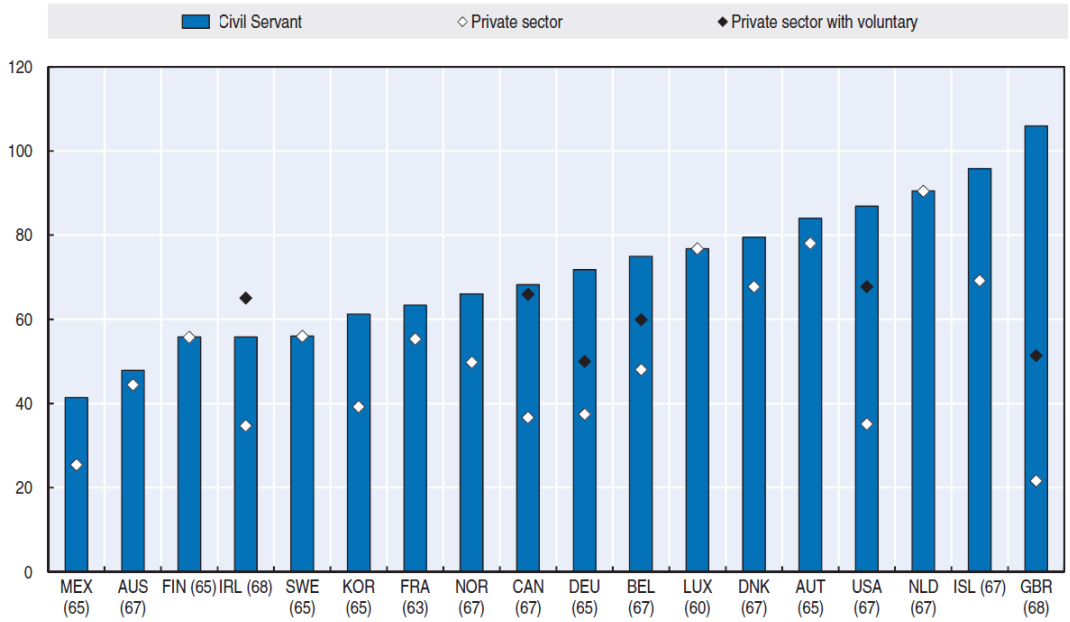
Figure A5: Heterogeneous Retirement Schemes In OECD Countries, Pensions in a Glance

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 A6: Recent Reforms Of Public-Sector Retirement Schemes In OECD Countries, Pensions in a Glance

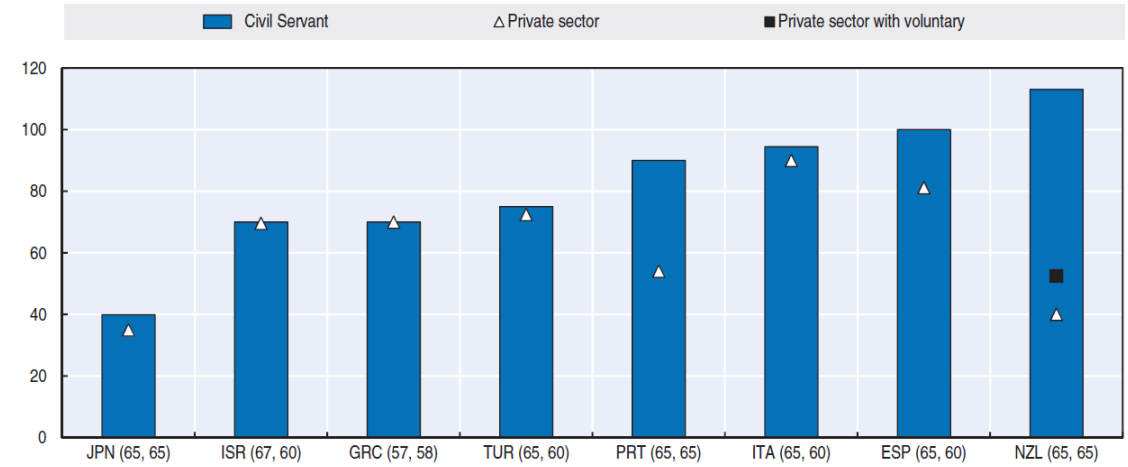
Figure 6.2. **Long-term gross replacement rates for civil service and private sector average earners, entering at age 20 in 2014, %**



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

Figure A7: Summary Of Replacement Rates And Retirement Age, 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.

StatLink http://dx.doi.org/10.1787/888933426827

Figure A8: Summary Of Replacement Rates And Retirement Age cont., Pensions in a Glance

Declarations of interest: none