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## ABSTRACT

### **From Dual to Unified Employment Protection: Transition and Steady State\***

This paper analyses the optimal design of a single open-ended contract (SOEC) and studies the political economy of moving towards such a SOEC in a labour market where employment protection is highly discontinuous. We develop a computationally tractable approach to compare two economic environments: one with a large employment protection gap after a short tenure, and another one with a SOEC featuring a smooth tenure profile. For illustrative purposes, we specialise the discussion of such choices to Spain, a country often considered as an epitome of a labour market with dual employment protection. We show that a SOEC has the potential of bringing substantial improvements in equilibrium allocations and welfare. We provide estimates for the eligibility rule and tenure profile of the optimal SOEC, defined as the contract maximising the steady-state lifetime utility of new labour-market entrants. Finally, we use the model to identify winners and losers among younger and older workers in the transitional path of such a reform, and evaluate its political support.

JEL Classification: H29, J33, J65

Keywords: single contract, employment protection, dualism, labour market reform

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# 1 Background and Introduction

Employment protection legislation (EPL) has been rationalized on several grounds. These range from strengthening workers' bargaining power in wage negotiations to avoid moral hazard by employers or increasing employer-sponsored training.<sup>1</sup> In addition, a very important rationale is that, absent perfect capital markets, EPL could insure risk-averse workers against job losses by increasing job stability (Pissarides, 2001). This role of EPL is especially relevant in countries with so-called dual labour markets, where similar workers in otherwise identical jobs, but under different contracts, are subject to large differences in redundancy pay. Indeed, what really defines a dual labour market is not the existence of open-ended/permanent contracts (henceforth PC) and fixed-term/temporary contracts (TC), which co-exist in all labour markets. Rather, their main characteristic is the operation of a two-tier EPL system (hereafter labeled EPL *gap*) whereby workers under PC are entitled to stringent EPL, while those under TC enjoy virtually none. In particular, PC bear mandated severance payments that increase with tenure, typically subject to a cap. Compensation is usually determined in terms of days of wages per years of service (d.w.y.s.), being lower for dismissals due to fair (e.g., economic) reasons than those deemed unfair. By contrast, despite being hardly ever destroyed before their end dates due to their short-term duration (typically up to two or three years within the same firm), TC are sometimes subject to a fixed termination cost (again in terms of d.w.y.s.) which is typically much lower than redundancy pay for workers under PC with similar tenure (see Cahuc et al., 2012).

As pointed out by Saint-Paul (1996), high EPL gaps originate in some countries – typically in Southern Europe and France – where overall employment protection regulations were very stringent to start with, and governments faced strong opposition to lower it when unemployment increased. As a result, the only politically feasible policies were two-tier labour market reforms, which introduced flexibility at the margin, lowering severance pay for new entrants (outsiders) while keeping it high for longer-tenured workers (insiders). Blanchard and Landier (2002) note that, lacking enough wage flexibility, a large discontinuity in dismissal costs makes employers reluctant to transform TC into PC. The EPL gap therefore creates a “revolving door” through which workers rotate between short-term jobs and unemployment. Excessive job turnover has been found to have negative consequences for unemployment, human capital and innovation (see, e.g., Bentolila et al., 2012) embodied in inefficient turnover (Blanchard and Landier, 2002), high wage pressure (Bentolila and Dolado, 1994), low investment in employer-sponsored training schemes (Cabrales et al., 2014), and the adoption of mature rather than innovative technologies (Saint-Paul, 2002).

This has triggered a heated debate on how to redesign dual employment protection, leading to policy initiatives which advocate removing the discontinuity in firing costs once and for all in the countries aforementioned.<sup>2</sup> To achieve this goal, a key policy advice in most of these proposals is to replace two-tier EPL systems by a universal severance pay schedule that would depend on tenure and apply to all workers. This policy has been termed the Single/Unified Open-Ended Contract (henceforth SOEC) for new hires.<sup>3</sup> The key feature of a SOEC is that it has no *ex ante* time limit and that mandatory sev-

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<sup>1</sup> See Booth and Chatterji (1989, 1998).

<sup>2</sup> Inspired by Blanchard and Tirole (2003), among these proposals one could find Cahuc and Kramarz (2004) and Cahuc (2012) for France, Boeri and Garibaldi (2008) and Ichino et al. (2009) for Italy, and Andrés et al. (2009) for Spain.

<sup>3</sup> In some of these proposals TC and PC remain available as separate contracts (e.g., Cahuc, 2012). In others (e.g., Andrés et al., 2009) TC are abolished but replacement contracts remain for maternity or sickness/disability leaves.

erance pay increases smoothly with seniority. In sum, a SOEC would provide a sufficiently long entry phase and a smooth increase in protection as job tenure lengthens, in stark contrast with the extant EPL discontinuity. The rationale for the gradually increasing redundancy pay could be that the longer a worker stays in a given firm, the larger is her/his loss of specific human capital and the psychological costs suffered in case of dismissal – a negative externality that firms should also internalise (see [Blanchard and Tirole, 2003](#)). However, despite being high on the European political agenda, so far most SOEC proposals have been rather vague on their specific recommendations.<sup>4</sup> As a result, several design and implementation details need to be worked out before new employment protection regulations can become operational.

In this paper, we take a first step towards addressing the following pending issues. First, in contrast to current two-tier EPL regulations, it is broadly agreed that a SOEC should exhibit a smooth tenure profile; yet, little is known on the precise definition of such a profile. Second, despite general agreement that a SOEC would benefit the functioning of labour markets, little is known about the improvements in equilibrium allocations and welfare that would result from its implementation. Third, in the specific context of dual labour markets, a recurrent theme is that many insiders would lose from the policy change and, thus, would oppose a reform leading to a SOEC; yet, little is known about the relevance of this argument, i.e., the political strength of insiders, the size of their welfare losses, and whether an appropriately designed transition towards the new steady state could limit these losses.

To investigate these issues, we develop a calibrated variant of the [Mortensen and Pissarides \(1994\)](#)'s equilibrium search and matching model, geared to assess the effects of replacing a two-tier EPL system by a SOEC. We consider a labour market with just one contract which is characterised by a discontinuous shift in severance pay entitlement after just a few years of job tenure. In this regard, the first periods of this labour contract play a similar role to TC, except that it does not have a pre-specified termination date, while the latter periods become akin to those under a PC.<sup>5</sup> In exchange for this analytical simplification, our model has a number of distinctive features that are essential for our purposes. First, workers are risk averse and therefore demand insurance. This enables us to design a SOEC which is optimal according to a welfare criterion reflecting its insurance role. Second, despite having a distribution of workers across tenure levels and a period-by-period budget constraint for a tax-financed unemployment insurance scheme, our model is computationally tractable outside the steady state. Thus, we can study the transition from the extant regulation to the optimal SOEC. Third, during the transition, we are able to recover the pre-reform tenure of workers who are already employed when the SOEC reform is introduced. In this fashion, we account for the fact that those workers cannot be exempted retroactively from their accrued-to-date rights.

In the environment considered, EPL plays an insurance role through a key distinction between *young* and *older* workers who coexist in the labour market.<sup>6</sup> Both receive severance pay when dismissed, but

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<sup>4</sup>See, e.g., Chapter 4 of the [2014 OECD Employment Outlook](#) devoted to this topic.

<sup>5</sup>Our implicit assumption is that all contracts start with low EPL, like with TC, and therefore that no worker is ever directly hired under a contract entailing high EPL. This seems to line up well with Spain (our case study) where only 8% of new hires are under PC (see [Bentolila et al., 2012](#)). Moreover, as noted earlier, the main distortion in dual labour markets comes from high EPL gaps and not the existence of TC and PC. Although there is only one contract in our model, we stick to the SOEC label in the alternative proposal to use the same term as in the policy debate. Whereas in the benchmark case, the EPL schedule is highly discontinuous, it is continuous in the SOEC.

<sup>6</sup>In our model, young workers should be interpreted as prime-age workers (workers aged 25 to 54). Correspondingly, older workers are those aged 55 to 64 years old. We use this terminology for simplicity, and in keeping with standard OLG

differ with respect to the use they can make of this compensation due to credit market imperfections. Specifically, young workers with lower and riskier incomes have limited access to borrowing and therefore consume the severance package immediately after a job loss (see [Crossley and Low, 2014](#)), yet they search actively for jobs when laid off. In contrast, older unemployed workers stop searching but are allowed to buy annuities on their severance packages in order to smooth out their consumption until they die. These features of the model stress that there is a strong motive for policy to step in and provide insurance in the form of mandated severance pay.

We use the model to analyse *constrained* optimal ELP, in that we take extant unemployment insurance (UI) as given. In other words, we abstain from considering policies which simultaneously change the severance pay schedule and unemployment compensation, such as the “experience-rating” type of policies which has been advocated, *inter alia*, by [Blanchard and Tirole \(2008\)](#), see below). In our view, to properly assess the effects of changing UI policies, one must consider the moral hazard problems that arise with the search behaviour of benefit recipients. This is beyond the scope of our analysis. Instead, we report how the optimal SOEC changes with exogenous changes in the generosity of UI benefits. The two policies are related in our model in that the government levies a tax on wages to finance UI benefits, and both UI and EPL affect employment and wages.

For illustrative purposes, the model is calibrated to the Spanish labour market before the Great Recession, at a time when the unemployment rate in this country was similar to the EU average rate, namely about 8.5%. We choose Spain because it has been often considered as the epitome of a dual labour market with a very high EPL gap (see e.g., [Dolado et al., 2002](#)). Nonetheless, the methodology proposed here could be extended to other segmented labour markets, like e.g., France or Italy.<sup>7</sup> Using the calibrated model, we compute the optimal profile of a SOEC, defined as the profile maximising the steady-state lifetime utility of new labour-market entrants. We then study the transitional path, in order to evaluate the welfare implications for the *current* population in the labour market and assess the political support of the reform.

Our main findings are as follows. First, a SOEC with one year of eligibility period and a slope of 14 d.w.y.s. is optimal according to the criterion just described. The insight for having an initial eligibility period and an increasing tenure profile in our optimal SOEC is that it trades off lower protection at short tenures (to promote job creation and reduce inefficient job turnover) with higher protection at longer tenures (to enhance job security for older workers with diminishing opportunities in the labour market). The unemployment insurance payroll tax can be lowered by 0.8 percentage points as a result of the decline in unemployment. The unemployment rate of young workers and the non-employment rate of older workers decrease by one percentage point. Our findings further suggest significant welfare gains associated with the introduction of the SOEC: a new labour-market entrant experiences a 1.7% increase in steady-state lifetime consumption. This can be attributed to a smoother wage profile at short tenures and higher entry wages, as well as a tighter labour market and the reduction in the payroll tax.

Second, for the current generation of workers, we find that the welfare gain in terms of lifetime

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models where young agents are those who work and old agents are those who consume savings and get a pension.

<sup>7</sup>Likewise, our model could also be used to study other severance payments schemes compared to the simple SOEC we propose. For instance, since we model individual job tenure explicitly, it is possible to introduce severance payments that vary non-linearly with tenure. We illustrate this point in Subsection 5.4. This is not the route we pursue in the rest of the paper: our main motivation for modeling tenure is that we seek to capture the abrupt shift and the cap in severance pay observed in a dual labour market.

consumption is 0.9% on average. We identify winners and losers from the reform along the transition from a dual EPL system to the SOEC. Our analysis suggests that roughly 87% of workers would benefit from the policy change. This figure masks important discrepancies across age groups. Implementing a SOEC improves welfare on average by 1.3% among young workers (the larger share of the overall population) during the transition to the new steady state, whereas older workers experience a loss of similar magnitude. These welfare losses are caused by the actual implementation of the reform: while previous entitlements to severance payments accumulated during the period prior to the reform are retained, the optimal SOEC reduces entitlements brought about by an additional year of tenure from the date of the reform onwards. Several sensitivity exercises with respect to key parameters of the model (UI generosity, the costs of dismissal procedures, etc.) show the robustness of the optimal profile of the SOEC and its welfare implications.

At this stage it is worth discussing some implications of the assumptions we make to maintain tractability. Indeed, with hand-to-mouth young workers and older workers who abandon job search, we circumvent the calculation of a cross-sectional distribution of assets, and we avoid carrying the distribution of job tenures as a variable affecting agents' decisions. On the one hand, the EPL discontinuity is operative for rather short tenures (two years in our setup) and, due to the "revolving door" effect, most layoffs affect young workers shortly after entering the labour market. As a result, the assumption that laid-off young workers consume their severance pay within one period (one quarter in our setup) is not so unrealistic. In effect, the average severance package in our benchmark equilibrium is 150 d.w.y.s (i.e. 1.6 quarters) and in 64% of dismissals it entails 20 d.w.y.s. (i.e. 0.22 quarters) or less. On the other hand, the assumption that older workers cannot search for a new job after being dismissed captures the fact re-entering the labour market at an age close to retirement is often difficult. In this respect, the model provides a role for EPL to foster job security and help older workers bridge the gap to retirement. Thus, while primarily intended at making the computational task manageable, our assumptions turn out to have reasonable implications.

Our analysis contributes to the very rich policy debate presented in the opening paragraphs of the paper. As mentioned earlier, one of the main forerunners of our analysis is [Blanchard and Tirole \(2008\)](#)'s study of the joint design of unemployment insurance and employment protection. Their focus is theoretical and aims to establish the optimal relationship between these programs. By contrast, our approach is quantitative and intended to provide figures that would inform actual policy schemes in the context of a dysfunctional labour market, as is the Spanish one. Further, while their analysis is static, ours involves rich dynamics and considers the transition from dual EPL to a SOEC.

Another closely related paper is [Alvarez and Veracierto \(2001\)](#), who consider a model with precautionary savings and costly search efforts for the unemployed. Their goal is to study the consequences of introducing mandatory (lump-sum) severance payments in an environment where wage rigidity results in an inefficiently high number of layoffs. Recently, [Lalé \(2015\)](#) has analysed a model that also features savings, but wherein wages are allowed to be flexible, which entails non-trivial welfare implications. We differ from these two papers essentially by: (i) precluding young workers moving consumption across dates, (ii) explicitly modelling tenure as a state variable and (iii) allowing severance payments to depend on tenure. These assumption enable us to study the transition dynamics while these two papers are restricted to steady state comparisons. Interestingly, [Lalé \(2015\)](#) obtains similar steady-state welfare gains in staeady state when studying a combination of severance compensations and unem-

ployment insurance benefits. Thus, with hand-to-mouth young workers and older workers who have access to annuities, our model seems to approximate reasonably well the welfare figures that arise in a complete life-cycle model with savings. As discussed earlier, this is due partly to the fact that most job destructions in our setup occur for jobs of short duration, which involve young workers whose savings are bound to be very limited.

The relationship between tenure and severance payments is also carefully analysed in two recent papers. The first one is [García Pérez and Osuna \(2014\)](#), who study the effects of introducing a SOEC in the context of the Spanish labour market. The main differences between our approach and theirs is that: (i) workers are risk neutral in their setup whereas they are risk averse and value consumption smoothing in ours, (ii) they impose a given tenure profile for a SOEC rather than deriving it from a welfare criterion and (iii) they do not seek to finance the provision of unemployment insurance benefits, which makes the transition dynamics trivial in their setup. The other paper is [Boeri et al. \(2013\)](#): they propose a rationale for having mandatory severance pay increase with tenure on the job. The insight is that financing initial investment in training through wage deferrals is not sustainable if employers cannot commit to keep workers who have invested in training. They establish this argument within a stylized model with risk neutral agents and where labour market variables are jump variables. Thus, by providing a different rationale for a positive slope in the tenure profile of the SOEC, we view our work as complementary to theirs.

The rest of the paper is structured as follows. Section 2 presents our model. Section 3 calibrates the model to Spanish labour market data and policies and analyses the steady state. Section 4 presents the optimal design of the SOEC and a comparison across steady states. Section 5 discusses the results for the transitional phase towards the SOEC. Section 6 reports a number of robustness checks. Finally, Section 7 concludes. Two appendices are included in the paper: Appendix A presents our numerical methodology in detail and Appendix B contains additional tables and figures.

## 2 The Model

This section presents our model. It is a variant of [Mortensen and Pissarides \(1994\)](#), which we accommodate to: (i) provide a role for insurance, (ii) keep track of workers' tenure at their jobs; and (iii) obtain tractability outside the steady state to analyse transition dynamics.

### 2.1 Economic Environment

Time is discrete and runs forever. The economy may not be in steady state and thus we need to keep track of calendar time. This is indexed by the subscript  $t$ .

#### Workers

The economy is populated by a continuum of risk-averse workers who derive utility from consumption  $c_t > 0$  according to the per-period utility function

$$u(c_t) = \frac{c_t^{1-\eta} - 1}{1-\eta}, \tag{1}$$

where  $\eta > 0$  is the coefficient of relative risk aversion. Workers discount the future at an exogenous interest rate denoted by  $r$ .

An important assumption is that workers face incomplete asset markets and that there is no storage technology. We preclude access to savings in order to reduce the dimension of state variables in the model and, foremost, to provide and enhance an insurance role for employment protection. While this has the potential of exacerbating welfare effects, we include public insurance from unemployment benefits and also some form of private insurance into the model (details follow).

## Production

Production is carried out by a continuum of firms. A firm is a small production unit with only one job, either filled or vacant. There is a per-period cost  $k > 0$  of having a vacant job. Firms enter the market freely and they maximise the expected discounted sum of profit streams.

Workers and firms meet each other via search. They are brought together by a Cobb-Douglas matching function with constant returns to scale:

$$m(u_t, v_t) = Au_t^\psi v_t^{1-\psi} \quad (2)$$

where  $u_t$  and  $v_t$  are the number of job seekers and vacancies, respectively,  $\psi \in (0, 1)$  is the elasticity of the number of contacts to the number of job-seekers, and  $A$  is a matching-efficiency parameter. Accordingly, the vacancy-filling probability for firms,  $q(\theta_t) = A\theta_t^{-\psi}$ , is decreasing in labour market tightness  $\theta_t \equiv v_t/u_t$ ; the job-finding probability for workers,  $\theta_t q(\theta_t)$ , is increasing in  $\theta_t$ .

Labour is the only input and production is linear in labour. Productivity, denoted as  $z$ , is idiosyncratic to the worker-firm pair. Every worker-firm pair starts at the same productivity level, which is denoted as  $z_0$ , and there is no on-the-job search. In subsequent periods, productivity evolves according to a finite Markov process with transition matrix  $\Pi = (\pi_{z,z'})$ . Fluctuations in productivity may induce the worker-firm pair to destroy the job. Later on in the analysis, we also introduce an exogenous separation shock in order to improve the fit of the model; we defer this element to the calibration section of the paper.

Finally, anticipating on the design of employment protection schemes, we denote by  $\tau$  the tenure of a worker-firm match. Thus, every worker-firm pair is characterised by at least two state variables: productivity  $z$  and tenure  $\tau$ .

## Young vs. Older Workers

The working life span is uncertain, and we assume that ageing occurs stochastically; see e.g. [Castañeda et al. \(2003\)](#). We distinguish young ( $y$ ) workers from older ( $o$ ) workers and use index  $i \in \{y, o\}$  to denote the age of the workers. In each period, young workers become older with probability  $\gamma$  while older workers retire and thus exit our economy with probability  $\chi$ . A measure of newborns enters the economy at the beginning of each period to maintain the size of the workforce at a constant unit level.

There are two essential differences between young workers and older workers. First, following job loss, young workers keep searching for new jobs whereas older workers abandon job search until they retire. Secondly, older workers have access to an insurance vehicle: they can buy an annuity upon

separation from the job. In this way, they can smooth their consumption until they leave the economy.

It is appropriate here to add some further comments on these two assumptions. Under the considered annuity system, we must keep track of older workers' tenure levels at the time of job loss, since this capitalizes into the annuity scheme. However, due to our simplifying assumption that non-employed older workers abstain searching for jobs once laid off, the distribution of these workers across tenure levels in their previous job is irrelevant for firms' vacancy posting decisions. Conversely, young unemployed workers are homogeneous as they are prevented from capitalizing their employment history into annuities.

### Government-mandated Programs

The government runs two labour market programs: unemployment insurance and employment protection schemes.

The unemployment insurance program provides a constant-level benefit, denoted as  $b^i$ , to non-employed workers; that is, we allow the benefit level to depend on the age group of the worker. There is no monitoring technology; therefore, older workers can collect  $b^o$  after a job loss even though they stop searching for jobs. The provision of unemployment insurance is financed by the proceeds of a payroll tax  $\kappa_t$ . Importantly, we assume that the budget for this program is balanced in every period.

The other labour market program, employment protection, consists of mandating a transfer from the firm to the worker which is paid at the time of job separation (i.e., government-mandated severance pay). Consistent with actual policies, the severance pay component, denoted as  $\phi(\tau)$ , is a function of tenure  $\tau$  of the worker. In our benchmark model we ignore red-tape costs involved in the dismissal procedure. Later on, in our robustness checks we will also introduce a firing tax component, in line with a long-established literature (e.g. [Bertola and Rogerson, 1997](#)). Thus, unless otherwise indicated, the severance package is a pure transfer from the firm to the worker.<sup>8</sup> Finally, in the event of a separation between a firm and an older worker triggered by the exogenous retirement shock, we assume that severance payments are waived.

### Disposable Income

We now describe the income workers receive (and consume) in the different states of the labour market. While employed, workers obtain a wage  $w_t^i(z, \tau)$  after bargaining over the surplus of the match (we specify the wage setting process in Subsection 2.3). The wage can depend on productivity  $z$ , tenure  $\tau$ , the age of the worker  $i$ , and it can also depend on calendar time  $t$ .

In non-employment, young workers collect unemployment benefits  $b^y$ . As mentioned earlier, lacking access to annuity schemes, they consume the severance package  $\phi(\tau)$  in the period after the job loss. Older workers, on the other hand, can buy an annuity upon receiving the severance package and collect the proceeds until they retire. As a result, the total disposable income of older non-employed

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<sup>8</sup>As a result, this labour market program is self-financed. In our robustness checks with a firing tax, we assume that the proceeds are wasted instead of being used to lower the payroll tax  $\kappa_t$ . Thus, we do not study whether the EPL scheme could help financing the provision of unemployment insurance benefits.

workers becomes:

$$\tilde{b}(\tau) = b^o + \frac{1}{1 - (1+r)^{-1/\chi}} \frac{r}{1+r} \phi(\tau), \quad (3)$$

where the last term represents the payoff of an actuarially fair annuity associated with the severance payment  $\phi(\tau)$ , and  $1/\chi$  is the expected number of periods until an old worker retires.

## 2.2 Bellman Equations

We formulate workers' and firms' decision problems in recursive form. We denote by  $U_t^i$  (resp.  $W_t^i$ ) the value of being non-employed (resp. being employed), with  $i \in \{y, o\}$ , and we set the value of retirement equal to zero.

While unemployed, a young worker receives a flow income  $b^y$ , remains in the current age category with probability  $(1 - \gamma)$  and either finds a job with probability  $\theta_t q(\theta_t)$ , or stays unemployed. Otherwise, such a worker becomes old with probability  $\gamma$  and the asset value is  $U_{t+1}^o(0)$ . Hence:

$$U_t^y = u(b^y) + \frac{1}{1+r} \left[ (1-\gamma) (\theta_t q(\theta_t) W_{t+1}^y(z_0, 0) + (1 - \theta_t q(\theta_t)) U_{t+1}^y) + \gamma U_{t+1}^o(0) \right] \quad (4)$$

where  $W_t^y(z_0, 0)$  denotes a young worker's asset value of being employed at the entry productivity level and with no tenure. An older non-employed worker with  $\tau$  periods of tenure in her previous job has flow income  $\tilde{b}(\tau)$  and remains in the labour market with probability  $(1 - \chi)$ , such that the corresponding asset value  $U_t^o(\tau)$  is:

$$U_t^o(\tau) = u(\tilde{b}(\tau)) + \frac{1-\chi}{1+r} U_{t+1}^o(\tau). \quad (5)$$

Next, consider employed workers. These workers consume their wage  $w_t^i(z, \tau)$  while employed at a job with productivity  $z$  and tenure  $\tau$ . In the event of job destruction, older workers receive the asset value  $U_t^o(\tau)$  whereas the value of younger workers becomes:  $U_t^y(\tau) \equiv U_t^y + u(b^y + \phi(\tau)) - u(b^y)$ . That is, they consume the severance payment (as a function of previous tenure) in the period after dismissal. Therefore,  $W_t^y(z, \tau)$  satisfies:

$$W_t^y(z, \tau) = u(w_t^y(z, \tau)) + \frac{1}{1+r} \left( (1-\gamma) \sum_{z'} \pi_{z,z'} \max \left\{ W_{t+1}^y(z', \tau'), U_{t+1}^y(\tau') \right\} + \gamma \sum_{z'} \pi_{z,z'} \max \left\{ W_{t+1}^o(z', \tau'), U_{t+1}^o(\tau') \right\} \right). \quad (6)$$

The value of employment for older workers, on the other hand, is given by:

$$W_t^o(z, \tau) = u(w_t^o(z, \tau)) + \frac{1-\chi}{1+r} \sum_{z'} \pi_{z,z'} \max \left\{ W_{t+1}^o(z', \tau'), U_{t+1}^o(\tau') \right\}. \quad (7)$$

As for firms, let  $J_t^i$  denote the value of having a filled job, where  $i \in \{y, o\}$  is the age of the worker who is currently employed. Just like the worker, the firm forms expectations over future values of

productivity and age. In the event of job destruction, the value of a firm is that of having a vacant position minus the severance package  $\phi(\tau)$ . Finally, the value of holding a vacant job is zero in every period  $t$  (free-entry condition). Hence:

$$J_t^y(z, \tau) = z - (1 + \kappa_t)w_t^y(z, \tau) + \frac{1}{1+r} \left( (1 - \gamma) \sum_{z'} \pi_{z,z'} \max \left\{ J_{t+1}^y(z', \tau'), -\phi(\tau') \right\} + \gamma \sum_{z'} \pi_{z,z'} \max \left\{ J_{t+1}^o(z', \tau'), -\phi(\tau') \right\} \right) \quad (8)$$

$$J_t^o(z, \tau) = z - (1 + \kappa_t)w_t^o(z, \tau) + \frac{1 - \chi}{1+r} \sum_{z'} \pi_{z,z'} \max \left\{ J_{t+1}^o(z', \tau'), -\phi(\tau') \right\}. \quad (9)$$

### 2.3 Wage Setting

In line with most of the literature, we assume that wages are set by Nash bargaining each period. Let  $\beta \in (0, 1)$  denote the bargaining power of the worker. Wages are therefore given by:

$$w_t^i(z, \tau) = \arg \max_w \left\{ \left( W_t^i(z, \tau; w) - U_t^i(\tau) \right)^\beta \left( J_t^i(z, \tau; w) + \phi(\tau) \right)^{1-\beta} \right\} \quad (10)$$

for all  $(z, \tau)$  and  $i \in \{y, o\}$ . For future reference, it is useful to write the first-order condition associated with the above maximisation problems. That is,

$$(1 - \beta) \frac{1 + \kappa_t}{J_t^i(z, \tau) + \phi(\tau)} = \beta \frac{u'(w_t^i(z, \tau))}{W_t^i(z, \tau) - U_t^i(\tau)}. \quad (11)$$

The numerator on the left-hand side of equation (11) is the effect for the firm of a marginal reduction in the wage, which increases profit streams by  $1 + \kappa_t$ . On the right-hand side of the equation, the effect of a marginal increase in the wage on the utility of the worker depends on the value of the wage, due to diminishing marginal utility of consumption. Thus, unlike the canonical search and matching model, our model features non-transferable utilities between agents. This implies that we cannot solve for the joint surplus of the match in order to obtain the wage functions.<sup>9</sup>

### 2.4 Separation Decisions

Associated with the max operator in the value functions of employment, there are productivity thresholds that determine separation decisions. Let  $\bar{z}_t^i(\tau)$  denote the productivity cutoff for a match with a worker of age  $i \in \{y, o\}$  and tenure  $\tau$ : this is the value of  $z$  that makes both parties indifferent between keeping the job alive and dissolving the match. Since private bargains are efficient,  $\bar{z}_t^i(\tau)$  can be recovered by

<sup>9</sup>Another implication is that [Lazear \(1990\)](#)'s "bonding critique" is not entirely applicable to our setup. Workers and firms differ as to their valuation of payments and there is a non-negativity constraint on workers' consumption, which prevents neutralizing severance payments fully; see [Lalé \(2015\)](#) for a discussion in a similar context. Moreover, in the calibrated version of the model, there is an exogenous separation shock, which hence cannot be contracted on.

using either the value functions of the worker or that of the firm. That is,

$$W_t^i(\bar{z}_t^i(\tau), \tau) = U_t^i(\tau), \quad J_t^i(\bar{z}_t^i(\tau), \tau) = -\phi(\tau). \quad (12)$$

Due to the non-standard problem in the determination of wages, it is also convenient to define separation decisions in relation to the reservation wages of the worker and the firm. Let  $\underline{w}_t^i(z, \tau)$  denote the lowest possible wage that a worker of age  $i$  and current tenure  $\tau$  would accept in a job with productivity  $\tau$ . These reservation wages solve:

$$u(\underline{w}_t^y(z, \tau)) = U_t^y(\tau) - \frac{1}{1+r} \left( (1-\gamma) \sum_{z'} \pi_{z,z'} \max \left\{ W_{t+1}^y(z', \tau'), U_{t+1}^y(\tau') \right\} + \gamma \sum_{z'} \pi_{z,z'} \max \left\{ W_{t+1}^o(z', \tau'), U_{t+1}^o(\tau') \right\} \right) \quad (13)$$

$$u(\underline{w}_t^o(z, \tau)) = U_t^o(\tau) - \frac{1-\chi}{1+r} \sum_{z'} \pi_{z,z'} \max \left\{ W_{t+1}^o(z', \tau'), U_{t+1}^o(\tau') \right\}. \quad (14)$$

Similarly, the highest possible wage that the firm would pay to this worker,  $\bar{w}_t^i(z, \tau)$ , is given by:

$$\bar{w}_t^y(z, \tau) = \frac{1}{1+\kappa_t} \left[ z + \phi(\tau) + \frac{1}{1+r} \left( (1-\gamma) \sum_{z'} \pi_{z,z'} \max \left\{ J_{t+1}^y(z', \tau'), -\phi(\tau') \right\} + \gamma \sum_{z'} \pi_{z,z'} \max \left\{ J_{t+1}^o(z', \tau'), -\phi(\tau') \right\} \right) \right] \quad (15)$$

$$\bar{w}_t^o(z, \tau) = \frac{1}{1+\kappa_t} \left( z + \phi(\tau) + \frac{1-\chi}{1+r} \sum_{z'} \pi_{z,z'} \max \left\{ J_{t+1}^o(z', \tau'), -\phi(\tau') \right\} \right). \quad (16)$$

A separation occurs when:  $\bar{w}_t^i(z, \tau) < \underline{w}_t^i(z, \tau)$ . This condition pins down the productivity thresholds  $\bar{z}_t^i(\tau)$ . Notice that, in equations (13)–(16), reservation wages depend on calendar time  $t$  through the outside option of workers and through the payroll tax  $\kappa_t$ .

## 2.5 Stock-flow Equations

Using labour market tightness  $\theta_t$  and separation decisions  $\bar{z}_t^i(\tau)$ , we can write the stock-flow equations that govern the evolution of population distributions from one period to the next. Let  $\lambda_t^y(z, \tau)$  (resp.  $\lambda_t^o(z, \tau)$ ) denote the population of young (resp. older) workers employed at a job with current productivity  $z$  and with tenure  $\tau$  at time  $t$ . Likewise, let  $\mu_t^y$  (resp.  $\mu_t^o(\tau)$ ) denote the population of young (resp. older) unemployed workers. Notice that for older non-employed workers we need to keep track of the tenure variable.

New hires are given by:

$$\lambda_{t+1}^y(z_0, 0) = \theta_t q(\theta_t) (1 - \gamma) \mu_t^y \quad (17)$$

while employment in on-going jobs ( $\tau' > 0$ ) evolves according to:

$$\lambda_{t+1}^y(z', \tau') = \sum_z \mathbb{1}\{z' \geq \bar{z}_{t+1}^y(\tau')\} \pi_{z,z'} (1 - \gamma) \lambda_t^y(z, \tau) \quad (18)$$

$$\lambda_{t+1}^o(z', \tau') = \sum_z \mathbb{1}\{z' \geq \bar{z}_{t+1}^o(\tau')\} \pi_{z,z'} (\gamma \lambda_{t+1}^y(z, \tau) + (1 - \chi) \lambda_{t+1}^o(z, \tau)). \quad (19)$$

As for the evolution of the non-employment pool, we have:

$$\mu_{t+1}^y = \bar{\mu}^y + (1 - \theta_t q(\theta_t)) (1 - \gamma) \mu_t^y + (1 - \gamma) \sum_{\tau} \sum_z \mathbb{1}\{z' < \bar{z}_{t+1}^y(\tau')\} \pi_{z,z'} \lambda_t^y(z, \tau) \quad (20)$$

where  $\bar{\mu}^y = \chi \frac{\gamma}{\chi + \gamma}$  is the mass of new entrants in every period. That is, with our stochastic life-cycle there are  $\frac{\gamma}{\chi + \gamma}$  older workers in the workforce; a fraction  $\chi$  of them retires every period, and the same number of individuals enters to keep the size of the workforce at a constant level.

Among the old non-employed with tenure level  $\tau$  at the time of dismissal from the previous job, the law of motion is:

$$\begin{aligned} \lambda_{t+1}^o(\tau) &= \gamma \mu_t^y \mathbb{1}\{\tau = 0\} + (1 - \chi) \mu_t^o(\tau) \\ &\quad + \sum_z \mathbb{1}\{z' < \bar{z}_{t+1}^o(\tau')\} \pi_{z,z'} (\gamma \lambda_t^y(z, \tau) + (1 - \chi) \lambda_t^o(z, \tau)). \end{aligned} \quad (21)$$

The term  $\gamma \mu_t^y \mathbb{1}\{\tau = 0\}$  accounts for the fact that a young unemployed worker who becomes old enters the pool of older workers with no tenure accumulated in the previous job.

Finally, given that the size of the workforce is equal to one in every period  $t$ , it follows that:

$$\sum_{\tau} \sum_z (\lambda_t^y(z, \tau) + \lambda_t^o(z, \tau)) + \sum_{\tau} \mu_t^o(\tau) + \mu_t^y = 1 \quad (22)$$

## 2.6 Equilibrium Conditions

There are two aggregate quantities which are pinned down by equilibrium conditions, both in steady state and during a transition phase: labour-market tightness  $\theta_t$  and the tax rate  $\kappa_t$ .

### Free Entry

As is conventional, in every period of the model a free-entry condition dictates that firms exhaust the present discounted value of job creation net of the vacancy-posting cost. This implies that labour market tightness in period  $t$  is given by

$$\frac{k}{q(\theta_t)} = \frac{1}{1+r} J_{t+1}^y(z_0, 0). \quad (23)$$

Notice that the right-hand side of the equation, i.e. the present discounted value of filling a vacant position, depends on calendar time  $t + 1$  only. Using this insight, it follows that the outside options of both agent types in period  $t$  are fully determined once value functions in period  $t + 1$  are known.

## Balanced Budget

Since the government balances the budget of the unemployment insurance system period by period, the payroll tax satisfies

$$\kappa_t \sum_{\tau} \sum_z (w_t^y(z, \tau) \lambda_t^y(z, \tau) + w_t^o(z, \tau) \lambda_t^o(z, \tau)) = \sum_{\tau} b^o \mu_t^o(\tau) + b^y \mu_t^y \quad (24)$$

for all  $t$ . Notice that workers and firms need to know the tax rate  $\kappa_t$  to set wages, while the latter in turn affect the revenues raised by the tax.

## 2.7 Transition and Steady State

Having described the economic environment and equilibrium conditions, we are in a position to define transition paths and steady-state equilibria. In the sequel, we are typically interested in the transition between two allocations indexed by calendar time, say  $t_0$  and  $t_1 > t_0$ . Hence:

**Definition.** A transition path between  $t_0$  and  $t_1$  is a sequence of value functions  $(U_t^y, U_t^o(\tau), W_t^y(z, \tau), W_t^o(z, \tau), J_t^y(z, \tau), J_t^o(z, \tau))_{t=t_0, \dots, t_1}$ , a sequence of wage functions  $(w_t^y(z, \tau), w_t^o(z, \tau))_{t=t_0, \dots, t_1}$ , a sequence of separation decision rules  $(\bar{z}_t^y(\tau), \bar{z}_t^o(\tau))_{t=t_0, \dots, t_1}$ , a time-path for labour market tightness  $(\theta_t)_{t=t_0, \dots, t_1}$  and for the payroll tax  $(\kappa_t)_{t=t_0, \dots, t_1}$ , and a sequence of distribution of workers across employment status, productivity levels, tenure and age groups  $(\mu_t^y, \mu_t^o(\tau), \lambda_t^y(z, \tau), \lambda_t^o(z, \tau))_{t=t_0, \dots, t_1}$  such that:

1. Agents optimize: Given  $(\theta_t)_{t=t_0, \dots, t_1}$ ,  $(\kappa_t)_{t=t_0, \dots, t_1}$  and the sequence of wage functions  $(w_t^y(z, \tau), w_t^o(z, \tau))_{t=t_0, \dots, t_1}$ , the value functions  $U_t^y, U_t^o(\tau), W_t^y(z, \tau), W_t^o(z, \tau), J_t^y(z, \tau), J_t^o(z, \tau)$  satisfy equations (4) – (9), respectively, and the separation decisions  $\bar{z}_t^y(\tau), \bar{z}_t^o(\tau)$  satisfy equation (12) in every period  $t$ .
2. Nash bargaining: Given  $(\theta_t)_{t=t_0, \dots, t_1}$ ,  $(\kappa_t)_{t=t_0, \dots, t_1}$  and the sequence of value functions  $(U_t^y, U_t^o(\tau), W_t^y(z, \tau), W_t^o(z, \tau), J_t^y(z, \tau), J_t^o(z, \tau))_{t=t_0, \dots, t_1}$ , the wage functions  $w_t^y(z, \tau), w_t^o(z, \tau)$  solve equation (11) in matches where  $z \geq \bar{z}_t^i(\tau)$  and  $i \in \{y, o\}$  in every period  $t$ .
3. Free entry: Given  $(J_{t+1}^y(z_0, 0))_{t=t_0, \dots, t_1}$ , labour market tightness  $(\theta_t)_{t=t_0, \dots, t_1}$  is the solution to equation (23) in every period  $t$ .
4. Balanced budget: Given the sequence of wage functions  $(w_t^y(z, \tau), w_t^o(z, \tau))_{t=t_0, \dots, t_1}$  and the sequence of distribution of workers across states of nature  $(\mu_t^y, \mu_t^o(\tau), \lambda_t^y(z, \tau), \lambda_t^o(z, \tau))_{t=t_0, \dots, t_1}$ ,  $(\kappa_t)_{t=t_0, \dots, t_1}$  is the solution to equation (24) in every period  $t$ .
5. Law of motion: Given  $(\theta_t)_{t=t_0, \dots, t_1}$  and the sequence decision rules  $(\bar{z}_t^y(\tau), \bar{z}_t^o(\tau))_{t=t_0, \dots, t_1}$  for separation, the distribution  $\mu_t^y, \mu_t^o(\tau), \lambda_t^y(z, \tau), \lambda_t^o(z, \tau)$  evolves according to the law of motion described in equations (17) – (22) from period  $t$  to  $t + 1$ .

When all exogenous features of the economic environment (policy parameters, preferences, etc.) remain constant, and because there is no aggregate shock, the economy reaches a steady-state equilibrium after a possibly long transition path.<sup>10</sup> We use the following definition:

**Definition.** A steady-state equilibrium is: (i)-(ii) a list of value functions, wage functions, separation decision rules that satisfy optimization (equations (4) – (9) and equation (12)) and Nash bargaining (equation (11)), (iii) a value for labour-market tightness pinned down by free entry of firms (equation (23)), (iv) a pay-roll tax that balances the budget of the unemployment insurance (equation (24)) and (v) a time-invariant distribution for the law of motion described in equations (17) – (22).

Before turning to numerical applications, we stress a difference between the two aggregate quantities of this economy, namely labour-market tightness  $\theta_t$  and the tax rate  $\kappa_t$ . On the one hand,  $\theta_t$  is a forward-looking variable as per equation (23). Thus, we can proceed backwards from steady state  $t_1$  in order to construct the time-path  $(\theta_t)_{t=t_0, \dots, t_1}$ . On the other hand, the tax rate  $\kappa_t$  is partly a backward-looking variable that depends on the distribution of workers across employment status, productivity levels, tenure and age groups, partly a forward-looking variable through wages negotiated in period  $t$ . Hence, computing a transition path requires knowledge of the entire sequence  $(\kappa_t)_{t=t_0, \dots, t_1}$ . Yet, a key feature of our environment is that decisions along the transition path depend on the aggregate state of the economy only through  $\theta_t$  and  $\kappa_t$ . Appendix A provides the details of our numerical methodology to compute steady-state equilibria and transition paths.

### 3 The Benchmark Equilibrium

This section describes our calibration and characterises the steady state of the benchmark economy. We select parameters to reproduce a set of informative data moments for Spain over the period 2005-2007, i.e. just before the outbreak of the Great Recession, when the Spanish unemployment rate was similar to the average unemployment rate (about 8.5%) in the Euro area. We choose that period because, in our view, an 8.5% unemployment rate is a plausible steady-state value, instead of the subsequent 25% reached during the slump (see [Bentolila et al., 2012](#)).

#### 3.1 Parameterisation and Calibration

We need a number of preliminary specifications in order to list the parameters of the model. Firstly, we parameterise the Markov process for match-specific idiosyncratic productivity as follows. We assume that  $z$  can take on values in the interval  $[0, 1]$ . Each period,  $z$  switches to a new value  $z'$  which is drawn from a Normal distribution with mean  $z$  and standard deviation  $\sigma_{\bar{z}}$ , truncated and normalized to integrate to one over the support of productivity. The resulting productivity process resembles a random walk, although the truncation makes the innovation term different from a normal white noise process. We experimented with many stochastic processes for  $z$ , including less persistent ones. Since other specifications did not substantially alter the model's workings, we have chosen to revert to a process

<sup>10</sup>Notice that the fixed-point nature of an equilibrium with respect to labour-market tightness and the payroll tax implies that, in principle, there may exist multiple equilibria. We are not interested *per se* in the high-tax-high-unemployment equilibria that can be triggered by the payroll tax. Therefore, in our computations, we always start by picking a low tax rate and we iterate until convergence of the balanced-budget equation.

**Table 1.** Parameter values (one model period is one quarter)

Description	Parameter	Value	Moment	Target
<i>Calibrated externally</i>				
Interest rate	$r$	0.01		
Risk aversion	$\eta$	2		
Ageing probability	$\gamma$	1/120		
Retirement probability	$\chi$	1/40		
Cap on tenure	$T$	120		
Matching function	$\psi$	0.5		
Bargaining power	$\beta$	0.5		
<i>Calibrated internally</i>				
Matching function	$A$	0.4000	Job-finding prob. (%)	40.0
Vacancy cost	$k$	0.2805	Tightness (norm.)	1.00
Unemployment income	$b^y$	0.2637	Replacement rate (%)	58.0
Unemployment income	$b^o$	0.1953	Replacement rate (%)	45.4
Exogenous separation	$\delta$	0.0060	Fraction of quits (%)	20.0
Initial productivity	$z_0$	0.3233	Job destr. ( $\leq 2$ years, %)	7.44
S.d. of productivity draws	$\sigma_{\bar{z}}$	0.0590	Job destr. ( $> 2$ years, %)	2.09

parameterised only by  $\sigma_{\bar{z}}$ . Next, as indicated in Subsection 2.1, we assume that matches are also subject to an exogenous separation shock. We denote by  $\delta$  the per-period probability that this shock is realised. Finally, we impose a cap on tenure denoted by  $T$ .

Under these specifications, the model has 14 parameters, namely  $\{r, \eta, \gamma, \chi, T, \psi, \beta, A, k, b^y, b^o, \delta, z_0, \sigma_{\bar{z}}\}$ . The first seven parameters are set outside the model while the remaining ones are calibrated internally to match a set of data moments. Throughout the numerical experiments, we interpret a model period as one quarter.

### Parameters Set Externally

The first seven rows of Table 1 report parameter values set outside the model. The chosen interest rate is set at  $r = 0.01$  to yield an annual interest rate of about 4 percent. The coefficient of relative risk aversion in (1) is  $\eta = 2$ , which is a common value in the literature. The demographic probabilities are set at  $\gamma = 1/120$  and  $\chi = 1/40$  to match the expected durations of the first (“young”) and second (“old”) phase of a worker’s life-cycle. This choice is motivated by our interpretation of young workers as those aged 25–54, and older workers as those aged 55–64. Moreover, it is consistent with the observation that workers aged 55–64 account for about 25 percent of the working-age population in Spain. We set the cap on tenure,  $T$ , equal to 120 model periods, i.e., 30 years.<sup>11</sup> Finally, as is conventional in the literature (see [Petrongolo and Pissarides, 2001](#)), the unemployment-elasticity of the number of matches and workers’ bargaining power are set to  $\psi = \beta = 0.5$ .

### Calibrated Parameters

The last seven rows in Table 1 show the parameters set within the model. We follow standard practices and use the free-entry condition to pin down the vacancy-posting cost  $k$  after normalizing labour market

<sup>11</sup>That is, with a deterministic life-cycle, workers (including the young) would never reach the maximum tenure level.

tightness  $\theta$  to unity. For the remaining six parameters, we aim at matching the following moment conditions, most of which are obtained from the Spanish Labour Force Survey for 2005-2007: (1) the average duration of unemployment for young workers is 2.5 quarters, i.e., 7.5 months; (2) the quarterly job destruction rate for temporary jobs is 7.44 percent (García Pérez and Osuna, 2014); (3) the quarterly job destruction rate for permanent jobs is 2.09 percent (García Pérez and Osuna, 2014); (4) the replacement rate of unemployment benefits for young workers, defined as the ratio between the benefit payment  $b^y$  and the average wage  $\tilde{w}^y$ , is 58 percent;<sup>12</sup> (5) the replacement rate of unemployment benefits for older workers,  $b^o/\tilde{w}^o$ , is 45 percent;<sup>13</sup> (6) quits account for about 20 percent of all separations (Rebollo-Sanz, 2012).<sup>14</sup> Our motivation for using information on quits is as follows. In the data, we cannot observe the number of job separations that could be deterred by enforcing tougher employment protection. We interpret quits as an upper bound to this number. In the model, the parameter that embodies this role is  $\delta$ , the probability of an exogenous separation. Thus, we use condition (6) to pin down a value for  $\delta$ .<sup>15</sup>

### The Severance Pay Function

The crux of our analysis relates to the severance pay function. We follow Bentolila et al. (2012) and García Pérez and Osuna (2012) in computing a function of job tenure that stands similar to EPL in Spain prior to the onset of the Great Recession.<sup>16</sup> As the latter authors do, we specify it as a function of the average annual wage in the labour market, rather than as a function of wage-tenure and/or productivity-tenure profiles. This simplifying assumption allows us to keep the solution of the model on a tractable level, because no knowledge on the wage profile is required when specifying  $\phi(\tau)$ .<sup>17</sup>

In particular, we use the following pieces of information to compute  $\phi(\tau)$ . We identify the first two years of employment with fixed-term contracts prevailing in the Spanish labour market. During the chosen calibration period, these contracts feature termination costs of 8 d.w.y.s., representing 2.2 percent (= 8/365) of the average yearly wage. If the worker is not dismissed before the end of this period, we identify the subsequent periods of employment as those regulated by permanent contracts. Workers on permanent contracts are entitled to 45 d.w.y.s. since joining the firm, with a maximum of 3.5 annual wages, under an unfair dismissal which represent most of the dismissals until 2012.<sup>18</sup> For

<sup>12</sup>Estimates for the average net replacement rate across different family types and earnings levels range from an initial value of 67% after layoff to 49% over 60 months of unemployment (OECD, 2004). We pick an intermediate value of 58% and perform a sensitivity analysis in Section 6.

<sup>13</sup>We make the assumption that older workers can draw on regular unemployment benefits for 2 years (at a 67%-replacement rate), and then fall back on less generous social assistance (at a 40%-replacement rate). At an expected duration of 10 years, this yields a weighted average of  $2 \cdot 0.67 + 8 \cdot 0.40 = 0.454$ .

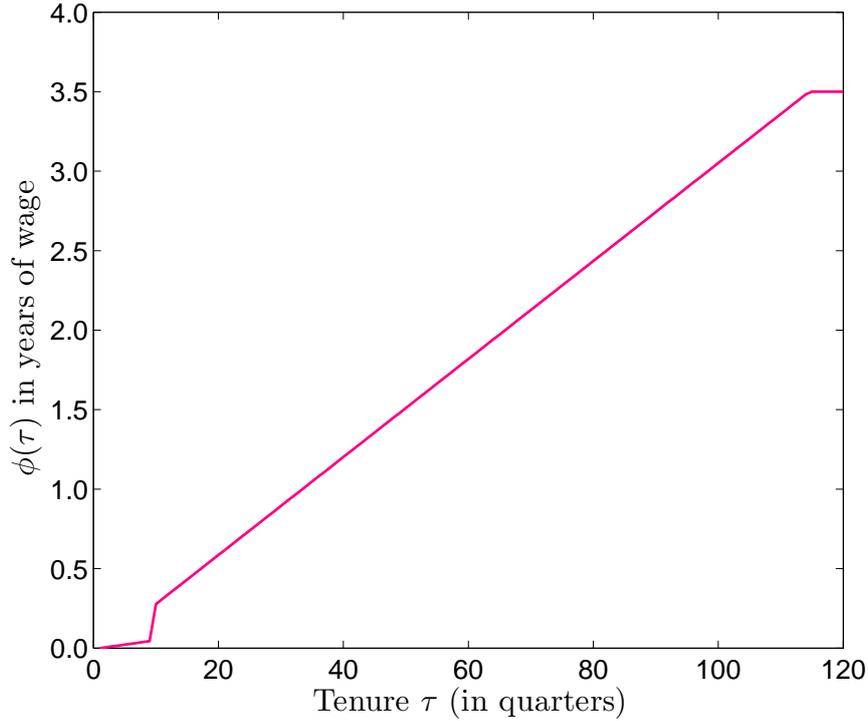
<sup>14</sup>To be precise, Rebollo-Sanz (2012) reports that quits account for 22 percent of all separations over the years 2000–2007. This was a period of economic expansion in Spain, and job-to-job transitions are notoriously pro-cyclical. For these reasons, we use a more conservative figure of 20 percent.

<sup>15</sup>Following an exogenous separation, we assume that the firms pays the severance package to which the worker is entitled. That is, we do not interpret the  $\delta$  shock as a quit decision – it is not a decision. We use  $\delta$  to discipline the elasticity of the separation rate to changes in the employment protection scheme. In sensitivity checks (Section 6), we re-run the experiments under the assumption that severance payments are waived in the event of an exogenous separation.

<sup>16</sup>There was a reform in February 2012 when severance pay for unfair dismissals of permanent workers went down from 45 to 33 d.w.y.s. while termination costs to temporary workers went up from 8 to 12 d.w.y.s. (see Subsection 5.4). We use the pre-reform EPL scheme since our calibration targets are based on pre-2012 data.

<sup>17</sup>Notice that the average wage is an equilibrium outcome of the model, not a pre-specified parameter. To compute an equilibrium, we add an outside loop to iterate over the average wage used to specify the severance pay function.

<sup>18</sup>We assume that all firms pay unfair dismissal costs of 45 d.w.y.s., even when severance for fair (economic) reasons



**Figure 1.** Severance payments in the benchmark economy

instance, a worker who is employed at the same firm for more than two years and loses her/his job in the third year is entitled to 37 percent ( $= 3 \times 45/365$ ) of the average yearly wage.

Using these pieces of information, severance payments for a worker whose tenure at the current firm is  $\tau$  are computed as follows:

$$\phi(\tau) = \begin{cases} (8/365) \times \tilde{w} \times \tau, & 1 \leq \tau \leq 8 \\ (45/365) \times \tilde{w} \times \tau, & 9 \leq \tau \leq 113. \\ (45/365) \times \tilde{w} \times 113, & \tau > 113. \end{cases} \quad (25)$$

Figure 1 depicts this function with tenure (in quarters) on the horizontal axis and a multiple of the average annual wage on the vertical axis.

## 3.2 Benchmark Economy

Table 2 reports a selection of aggregate statistics in our benchmark economy. These value are, whenever possible, compared to their empirical counterparts. As can be observed, the model fits the moments targeted in our calibration strategy very precisely. Moreover, most non-targeted moments are reasonably close to the corresponding data values. The unemployment rate among young workers in the benchmark economy is 9.0 percent, while the corresponding value in the data is slightly lower at 8.6 percent. Across the population of older workers, the model generates a non-employment rate of 36.2 percent. The empirical share of non-employed male workers between 55 and 64 years of age is slightly larger

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was lower, i.e., 20 d.w.y.s (with a maximum of 24 months). We do so because, even during the Great Recession, two-thirds of dismissals have been unfair since firms avoided appeals to court by workers by paying the maximum rate, under the so-called “express dismissal” rule (see [Bentolila et al., 2012](#)).

**Table 2.** Benchmark economy: Comparison with the data

Description	Model	Data	Comment
Unemployment rate, young (%)	9.0	8.6	
Non-employment rate, old (%)	36.2	43.0	
Non-employment rate, all (%)	15.8	16.5	
Replacement rate $b^y/\tilde{w}^y$ (%) <sup>(a)</sup>	58.0	58.0	part of calibration
Replacement rate $b^o/\tilde{w}^o$ (%) <sup>(a)</sup>	45.4	45.4	part of calibration
Average wage, young	0.46	–	
Average wage, old	0.43	–	
Average productivity, young	0.57	–	
Average productivity, old	0.62	–	
Job destruction rate, $\leq 2$ years of tenure (%)	7.46	7.44	part of calibration
Job destruction rate, $> 2$ years of tenure (%)	2.08	2.09	part of calibration
Share of quits among separation (%) <sup>(b)</sup>	20.4	20.0	part of calibration
Job finding rate (%)	40.0	40.0	part of calibration
Payroll tax (%) <sup>(c)</sup>	9.25	7.60	

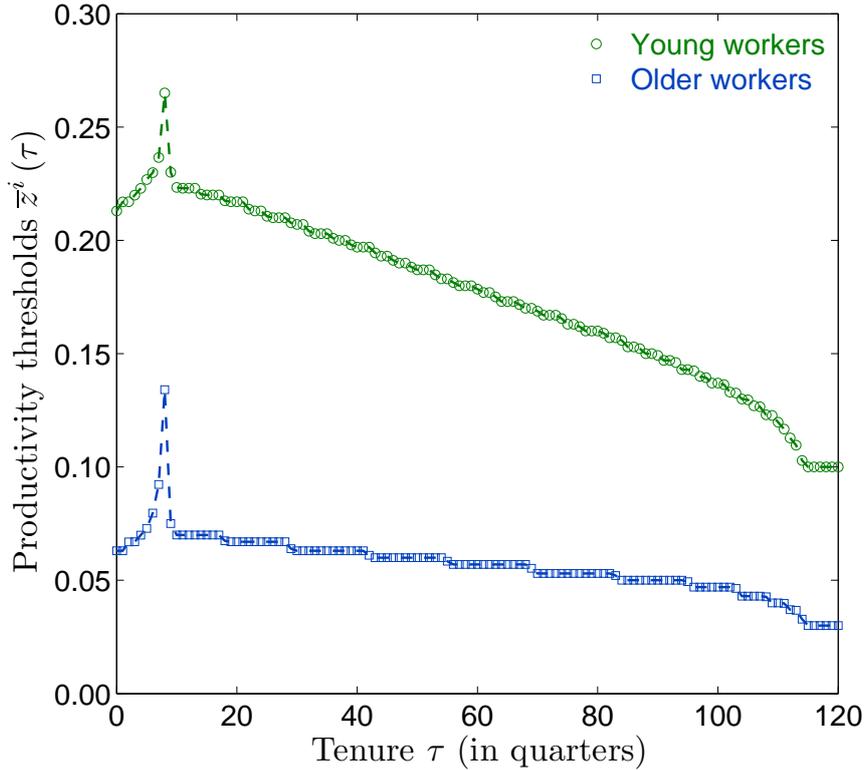
NOTE: Unless otherwise indicated by a footnote, data moments are obtained from the Spanish Labour Force survey for the years 2005-2007. <sup>(a)</sup> Based on estimates from [OECD \(2004\)](#). <sup>(b)</sup> Based on estimates from [Rebollo-Sanz \(2012\)](#). <sup>(c)</sup> Own calculations based on Social Security contributions geared towards unemployment insurance.

at 43 percent. Since our model abstracts from disabilities, health shocks and other reasons for non-employment, we interpret the gap between the empirical share and the model value as a plausible outcome. The aggregate non-employment rate among all workers in our benchmark economy is 15.8 percent against 16.5 percent in the data. Finally, the budget-balancing payroll tax is 9.25 percent in the model. This is slightly larger than the actual value of 7.60 percent, which is the sum of employers' and workers' social security contributions to unemployment insurance in Spain.

### Separation Decisions

Figure 2 depicts the productivity cutoffs to dismiss young and older workers, resp.  $\bar{z}^y(\tau)$  and  $\bar{z}^o(\tau)$  (the vertical axis covers only the interval  $[0.0, 0.3]$  to improve legibility). First, note that newly-formed matches start at a productivity level that is fairly close to the corresponding separation threshold (0.32 vs. 0.22). As a result, a large fraction of matches facing an adverse productivity draw over the first quarters of tenure are dissolved endogenously. This feature of the model makes new jobs relatively fragile and rationalizes high job destruction rate at short tenures. On the other hand, matches that experience a positive productivity draw move towards the upper region of the productivity domain and thus become less susceptible of being destroyed. These “career” jobs are bound to become stable employment relationships and they are characterised by a substantially lower job destruction rate at longer tenures.

Next, as evidenced in Figure 2, there are characteristic spikes in the job destruction region at  $\tau = 8$ . These reflect the discontinuous jump (“wall”) in the firing cost schedule (Figure 1). Since workers are risk averse, future severance payments are only partially internalized through lower wages. This puts a lower bound on workers' reservation wages and implies that relatively unproductive matches are destroyed before the increase in severance pay takes place. Overall, this results in a “camel shaped”



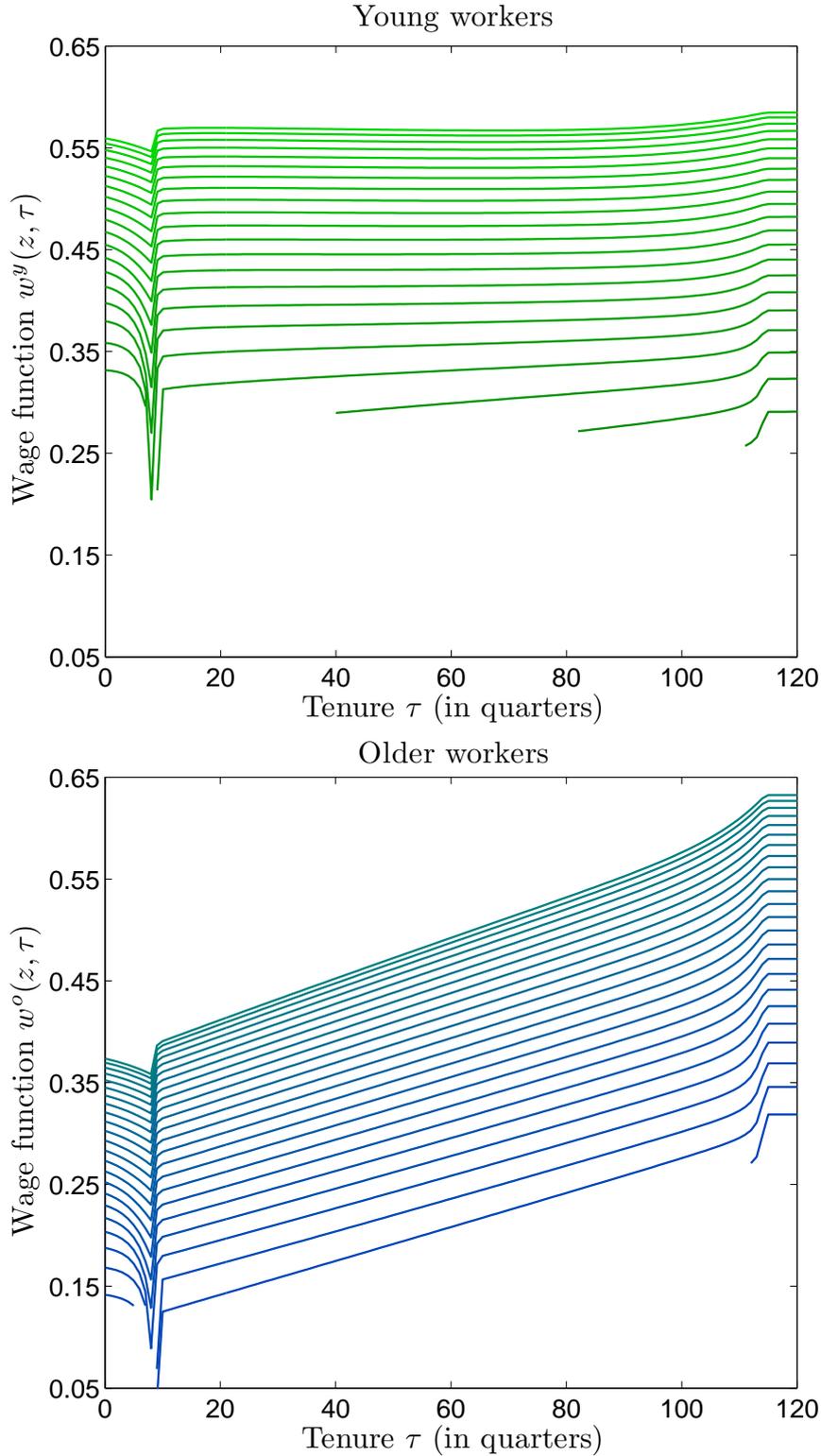
**Figure 2.** Separation thresholds in the benchmark economy

The plot shows the separation thresholds for young (green circles) and older workers (blue squares). Separation thresholds are plotted as a function of tenure  $\tau$ .

distribution of tenure, with a large fraction of jobs with less than 2 years and a large fraction with more than 10 years of tenure.

As can be seen in Figure 2, productivity cutoffs are generally lower for older workers because in our model they do not have the option value of searching for a new job. Only worker-firm matches operating at very low productivity levels find it optimal to discontinue the match and let the worker retire early. Finally, the productivity thresholds are decreasing with tenure as firms find it more costly to fire a worker and pay the severance package.

Before turning to the equilibrium wage functions, we find it useful to evaluate our assumption that laid-off young workers are prevented from capitalising their employment histories into annuities. Looking at job destruction patterns in our benchmark equilibrium, we find that workers who have entered the model economy over the last 10 years are five times more likely to be dismissed than workers who have been in the economy for more than 30 years. The former group corresponds to workers aged 25-34 years who are more likely to be hand-to-mouth consumers with limited access to credit markets and little or no savings. We also find that the distribution of severance payments that are paid out to laid-off young workers is skewed to the right: while the average paid-out severance package in our benchmark economy corresponds to 150 daily wages (or 1.7 quarters), less than half of the severance payments actually entail more than 20 daily wages.



**Figure 3.** Wage function in the benchmark economy for young and older workers

The plot shows the wage functions in the benchmark economy (young workers in the upper chart, older workers in the lower chart). In each chart, the top line indicates high-productivity and the bottom line indicates low-productivity levels. Wage functions are plotted as a function of tenure  $\tau$ . To improve legibility, we report wages at 25 evenly-spaced points of the support for productivity. The lines are not shown or they are interrupted if  $z < \bar{z}^i(\tau)$ .

## Wages and Tenure

The wage functions for young and older workers are depicted in Figure 3. There are several features to highlight. Firstly, there is a dip in the wage schedule at the end of the first two years of tenure. The key for this result is again the shape of the severance pay function and the fact that wages are renegotiated every period: as the worker-firm match approaches the period in which the increase in severance pay hits, workers are willing to accept lower wages temporarily in exchange for higher future entitlements to severance payments if their job is not destroyed. Secondly, the wage curve is rather flat for young workers and steeper for old workers. This reflects the degree to which firm-worker matches are willing to internalize future severance payments through lower initial wages. Young workers consume their severance package in the period after a layoff. Thus, a larger severance payment buys them only a one-period increase in the level of consumption (at diminishing marginal utility). This makes their outside option increase only very gradually with tenure. By contrast, for older workers a more generous entitlement to severance transfers, as their tenure increases, allows them to buy more valuable annuities. Put differently, their wage profile resembles more the shape that one would obtain in a [Lazear \(1990\)](#)-type setting where severance payments are fully neutralized.

## 4 Designing Smooth Employment Protection

This section contains the first part of our main quantitative results. We use our model calibrated to Spanish data and policies as a laboratory to design a SOEC. We lay out an optimality criterion, and describe the implications of the optimal SOEC on steady-state equilibrium allocations and welfare.

### 4.1 Implementation

We consider a relatively simple class of severance payment functions to define a SOEC, namely a subset of piecewise-linear functions of tenure. We specify severance payments as:

$$\phi(\tau) = \max\{\alpha_s + \rho_s \times \tau; 0\}, \quad (26)$$

where  $\alpha_s \in \mathbb{R}$  is a parameter, and  $\rho_s \geq 0$  measures the rate of return to each year of tenure (in days of wages per year of service, d.w.y.s.), conditional on eligibility. We explicitly allow the intercept  $\alpha_s$  to be negative; in that case,  $\tau_s \equiv -\alpha_s/\rho_s$  is the point where severance payments are activated, that is, the minimum service tenure required for eligibility. If  $\alpha_s$  is non-negative, then  $\tau_s = 0$ , and newly-matched workers become entitled to severance payments immediately.

There are three main principles guiding the design of a simple SOEC as in equation (26). First, in spite of its parsimonious parameterisation, it can be readily compared to actual policy schemes.<sup>19</sup> Second, while our model rationalizes implementing a SOEC, it does not provide arguments for having a function with many kinks and different slopes across tenure levels. Third, with more parameters in the severance pay function, it becomes more likely to have local optima only in the objective function

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<sup>19</sup>See, for instance, Section 1 in [Boeri et al. \(2013\)](#). Figure 1 in that paper shows that a piecewise-linear function of tenure is an accurate description of EPL schemes implemented in most countries.

presented in the next section. In addition, with only two parameters, we find that our optimality criterion has a global maximum.

## 4.2 The Optimality Criterion

The optimality criterion draws on steady-state comparisons: we define the optimal SOEC as the contract maximising the steady-state lifetime utility of a new labour-market entrant.<sup>20</sup> In practice, we implement a SOEC for different combinations of  $\alpha_s$  and  $\rho_s$ , compute the steady-state equilibrium and store the value  $U^y$  that results. Thus, the optimal SOEC is the bundle  $(\alpha_s, \rho_s)$  defined as:

$$(\alpha_s, \rho_s) = \arg \max \{U^y\}. \quad (27)$$

In the sequel, instead of reporting the lifetime value  $U^y$  attained according to equation (27), we measure welfare effects in terms of consumption equivalent units. Formally, let  $U_b^y$  denote the lifetime utility of a newborn worker in the benchmark economy, and let  $U_s^y$  be her lifetime utility under the optimal SOEC. The percentage change in lifetime consumption arising from the optimal SOEC is given by  $\vartheta$ , which can be shown to solve:

$$1 + \vartheta = \left( \frac{(r + \chi)U_s^y + \frac{1+r}{1-\eta} \times \frac{r+\gamma+\chi}{r+\gamma}}{(r + \chi)U_b^y + \frac{1+r}{1-\eta} \times \frac{r+\gamma+\chi}{r+\gamma}} \right)^{\frac{1}{1-\eta}}. \quad (28)$$

We show in Figure B4 in the Appendix that the optimality criterion is concave in  $\alpha_s$  and  $\rho_s$  (this property also holds in all our robustness checks, whose corresponding charts are displayed in the online appendix). As a result, within the class of severance payment functions considered, the optimal SOEC is unique. Moreover, we find that a positive intercept  $\alpha_s$  deteriorates welfare (see Figure B3 in the Appendix). For this reason, in the sequel we focus on the effects of the minimum service tenure  $\tau_s$  (negative  $\alpha_s$ ), combined with the effects of  $\rho_s$ .

## 4.3 Steady-State results

Table 3 reports the welfare change associated with different combinations of  $\tau_s$  and  $\rho_s$ . On a given row, we fix the minimum service tenure for eligibility and we increase the slope gradually along the columns.

As illustrated in the table, a SOEC has the potential to generate significant welfare gains when compared to the current EPL scheme. In particular, a SOEC with 1 year of minimum service and a slope of 14 d.w.y.s. maximises steady-state lifetime utility of a newborn worker, and the associated welfare gain is 1.68%. Henceforth, we refer to this combination as the optimal SOEC. A graphical comparison between the current EPL scheme and the optimal SOEC is provided in Figure 4 (upper panel). The latter is associated with lower severance payments than the benchmark scheme, and the slope of 14

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<sup>20</sup>It is possible to define an optimality criterion that would include the transition dynamics, but such a criterion would have several drawbacks. First, by construction, it would depend on the distribution of workers at the time when the reform is implemented. Second, as shown in Section 5, the transition path is difficult to predict and, as a result, it is likely that the optimality criterion is not well-behaved in  $\alpha_s$  and  $\rho_s$ . Third, the computational burden makes it impractical to run a grid search on  $\alpha_s$  and  $\rho_s$  to maximise a criterion that includes the transition path.

**Table 3.** Steady-state comparisons of various SOEC

		Slope $\rho_s$ (in d.w.y.s.)								
		0	4	8	12	14	16	20	45	60
Initial eligibility										
$\tau_s$ (in months)	0	0.956	1.439	1.573	1.589	1.571	1.508	1.365	-0.437	-2.014
	6	0.956	1.431	1.599	1.665	1.666	1.643	1.572	0.265	-0.980
	12	0.956	1.408	1.585	1.668	<b>1.681</b>	1.680	1.630	0.584	-0.443
	18	0.956	1.385	1.565	1.652	1.671	1.680	1.651	0.801	-0.086
	24	0.956	1.365	1.540	1.636	1.655	1.669	1.658	0.950	0.176
	30	0.956	1.343	1.516	1.612	1.638	1.654	1.654	1.062	0.379
	36	0.956	1.324	1.496	1.588	1.617	1.636	1.644	1.148	0.544

NOTE: An entry in the table is the percentage change in lifetime consumption of new labour-market entrants.

d.w.y.s. lies between the respective figures of temporary contracts (8 d.w.y.s.) and permanent contracts (45 d.w.y.s.) that prevail under current EPL. Moreover, our analysis suggests that there is a welfare-improving role for severance pay as the optimal SOEC is strictly preferred to a laissez-faire scheme (first column,  $\tau_s = \rho_s = 0$ ). The fact that the optimal SOEC is positively sloped further suggests that it trades off lower protection at short tenures, to promote job creation, with higher protection at long tenures, to enhance job security and provide more insurance for older workers with diminishing opportunities in the labour market.

### Equilibrium Allocations and Welfare

Table 4 reports a set of aggregate statistics for the steady-state equilibrium under the optimal SOEC in comparison with the benchmark economy. Our analysis suggests that introducing this SOEC has a significant positive effect on labour market tightness. As a result, jobless workers are matched to firms at a higher rate, which decreases the duration of unemployment. The optimal SOEC, moreover, reduces the job destruction rate for short-tenured jobs below 2 years from 7.5% to 6.3% per quarter, while the corresponding rate for worker-firm matches with longer tenure increases slightly from 2.08% to 2.25%. Overall, these effects translate into a reduction in the unemployment rate from 9.0% to 8.1%. As the non-employment rate for older workers also decreases by roughly one percentage point from 36.2% to 35.1%, the net effect on employment across the whole population is positive (14.9% vs. 15.8%). Relative to the benchmark economy, the optimal SOEC results in an increase in welfare of 1.68% and a reduction in the budget-balancing payroll tax rate of 0.8 percentage points.

The bottom panel of Figure 4 sheds more light on these results. It depicts the wage-tenure profile (the wage is averaged across match productivities for each tenure) in the benchmark case and under the optimal SOEC. As can be observed, the wage-tenure profile is smoother under the optimal SOEC, and it is characterized by higher wage levels than the benchmark profile during the first 18 years and lower wage levels afterwards.<sup>21</sup> The key for the less inclined wage schedule is that (i) young workers do not have to initially bargain for low wages in exchange for larger expected future severance pay, which

<sup>21</sup>The upward-sloping wage-tenure profile is due to a combination of factors. At short tenures, the average wage increases due to a selection effect, as many jobs experience favourable productivity draws while unproductive jobs get destroyed. At long tenures, the average wage rises further, due to an increasing share of jobs occupied by older workers. Furthermore, workers can bargain for higher wages as their outside option increases with larger severance packages.

**Table 4.** Current vs. optimal SOEC: Steady-state comparison

Description	Baseline	Optimal SOEC
Unemployment rate, young (%)	9.0	8.1
Non-employment rate, old (%)	36.2	35.1
Non-employment rate, all (%)	15.8	14.9
Average wage, young	0.46	0.48
Average wage, old	0.43	0.36
Average productivity, young	0.57	0.57
Average productivity, old	0.62	0.62
Job destruction rate, less than 2 years of tenure (%)	7.46	6.26
Job destruction rate, more than 2 years of tenure (%)	2.08	2.25
Job finding rate (%)	40.0	43.0
Labour market tightness $\theta$	1.00	1.15
Payroll tax $\kappa$ (%)	9.25	8.46
Welfare of a newborn worker (% , relative to baseline)	–	1.68

implies higher earnings at the entry level; and (ii) older workers have lower reservation values since the level of the severance pay function is lower than in the benchmark case.

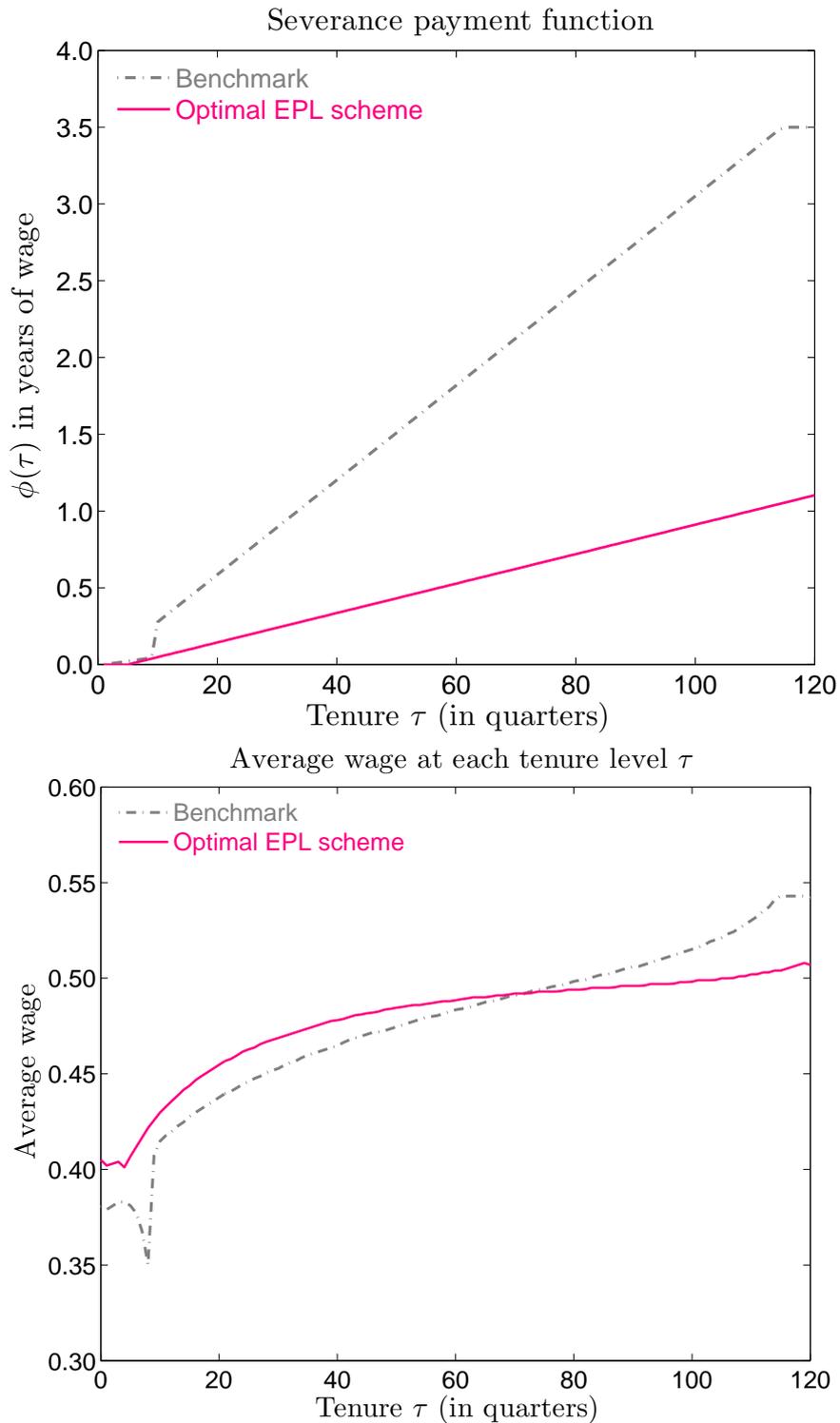
Foremost, the optimal SOEC removes “revolving doors” in labour market trajectories implied by dual EPL. Under the benchmark scheme, the tenure distribution is characterised by a large fraction of jobs with less than 2 years of tenure, as matches without favourable productivity changes get quickly destroyed. The optimal SOEC, in turn, by exhibiting a smoother year-by-year profile, shifts the distribution towards longer tenures; as a result, the tenure distribution under the optimal SOEC has more jobs between 2 and 10 years of tenure.

### A Decomposition Exercise

To provide further insight into the welfare effects of the optimal SOEC, we run a sequence of counterfactual experiments that aim at disentangling the role of four components. First, we adjust the benchmark severance pay function so as to remove the “wall” effect: keeping tightness and tax constant, we shift the schedule downwards in the second segment to eliminate the discontinuity after 2 years. This implies a smoother wage profile over the first two years of tenure, and shifts the wage-tenure profile upwards as the degree of internalization of future severance payments diminishes. Secondly, we adjust the slope by rotating the function on both segments to yield the actual SOEC (again, keeping tightness and tax constant). Rotating the firing cost function flattens out the wage profile and, thus, increases entry wages for newly-matched workers. Thirdly, we raise labour market tightness to the equilibrium level computed under the optimal SOEC, keeping the tax constant. Finally, we adjust the payroll tax as well. We interpret the first two adjustments as governing partial equilibrium effects, while the latter two account for general equilibrium adjustments in prices.

Total effect	Remove wall	Adjust slope	Tightness $\theta$	Payroll tax $\kappa$
1.681	0.429	0.091	0.693	0.470
	(25.5)	(5.4)	(41.2)	(27.9)

The figures above presents our results (the second row gives the relative contribution of each counterfactual). The total welfare gain of 1.68% is again reported in the first column. The remaining columns



**Figure 4.** Current scheme vs. optimal SOEC: Steady-state comparison of selected outcomes  
 The upper chart shows severance payments as a function of tenure  $\tau$ . The lower chart shows the wage on average across match across match productivities for each tenure. In each chart, the dashed line corresponds to the current scheme (benchmark economy) and the solid line corresponds to the optimal SOEC.

provide the welfare change associated with each counterfactual. As can be seen, general equilibrium effects jointly account for roughly 70 percent of the overall welfare gain, while partial equilibrium effects account for the remaining 30 percent. The largest contribution stems from higher job finding rates due to a tighter labour market (41.2 percent), followed by the reduction in the payroll tax (27.9 percent). The elimination of the discontinuity in the severance payment schedule after 2 years yields considerable further welfare gains (25.5 percent), while decreasing the gradient accounts for the remaining 5.4 percent. In the next section, we show that general equilibrium effects also play an important role when the transition path is taken into account.

## 5 From Dual to Unified Employment Protection

In this section, we present our second set of findings, building and expanding on the results of Section 4. Our model provides a framework for discussing further issues, such as the actual introduction of a SOEC and the transition dynamics that result, as well as the implications for workers who are already in the labour market when the reform is implemented.

### 5.1 Implementation

A key feature of our model is that we can mimic real-life EPL reforms upon introducing a SOEC. Indeed, in actual EPL reforms, workers employed before the reform cannot be exempted retroactively from their accrued-to-date rights. In line with the February 2012 reform of the Spanish labour market, we therefore assume that all existing worker-firm matches accumulate entitlements to severance payments at a rate prescribed by the new policy scheme from the date of the reform onwards, and that any previous entitlements accumulated during the tenure prior to the reform are retained.<sup>22</sup> Formally, we assume that the reform introduces the optimal SOEC, denoted as  $\phi_1(\cdot)$ , in the calendar period  $t_0$ , and we let  $\phi_0(\cdot)$  denote the severance pay function that prevails before  $t_0$ . The severance pay function for an existing worker-firm match in some period  $t \geq t_0$  is then:

$$\phi_t(\tau) = \phi_0(\tau - (t - t_0)) + \phi_1(\tau_s + (t - t_0)) \mathbb{1}\{\tau - (t - t_0) \geq \tau_s\}. \quad (29)$$

That is, a worker whose tenure at time  $t$  is  $\tau$  had  $\tau - (t - t_0)$  periods of tenure when the reform was announced, and  $(t - t_0)$  of post-reform tenure.  $\phi_0(\tau - (t - t_0))$  is the severance pay retained from the pre-reform period and  $\phi_1(\tau_s + (t - t_0))$  is the payment in any post-reform period, conditional on eligibility (i.e., if  $\tau - (t - t_0) \geq \tau_s$ ).<sup>23</sup> Notice that, during the transition towards a new steady state, workers under the  $\phi_t(\tau)$  and the  $\phi_1(\tau)$  scheme coexist in the labour market.

<sup>22</sup>To emphasize differences with a *statu-quo* reform where any worker employed at the time of the reform can remain under the previous EPL scheme (a scenario we study in Subsection 5.5), we call this a partially non-retroactive reform. Using our model, we can also study a “pure” retroactive reform where the SOEC replaces the previous scheme in existing jobs irrespective of any accrued-to-date rights. However, such a scenario appears unrealistic, and is actually prevented by the Spanish constitution.

<sup>23</sup>Put differently,  $\tau$  and  $t$  are sufficient statistics for pre-reform tenure, which is key for our application. There is one exception, namely workers who have reached  $T$ , the cap for tenure. But since the slope of the optimal SOEC is lower than in the benchmark (and we maintain the initial cap on severance payments), this case can be ignored: a worker employed in period  $t_0$  and with  $T$  periods of tenure in any period  $t \geq t_0$  is entitled to  $\phi_0(T)$ , and therefore we do not need to recover her pre-reform tenure.

## 5.2 Transition Path

Figure 5 shows the time path of several labour market variables during the transition from dual EPL to the optimal SOEC. Most of the adjustment takes place during the first year of the reform, which dovetails with the fact that the reform affects not only new jobs but also existing worker-firm matches. The upper charts show the time-path of the general equilibrium variables, tightness  $\theta_t$  and the payroll tax  $\kappa_t$ . Labour market tightness acts like a jump variable: it overshoots slightly on impact and then decreases to its future steady-state level. The gradual decrease in taxes, on the other hand, is explained by the decline in non-employment after the reform (details follow). Unemployment among younger workers mirrors the behaviour of tightness: the job-finding rate soars instantaneously as firms create more vacancies associated with the SOEC, which lowers unemployment. The decline in non-employment among older workers is more gradual since it is only driven by the flows from employment. Finally, short-tenured jobs (less than 2 years) are extended in the short run: the job destruction goes down from 7.5% to 5.5% on impact. It then rises slightly to its future steady state value of 6.3%, reflecting that the less stringent SOEC scheme facilitates dismissals. For jobs with more than 2 years of tenure, there is a short-lived decline followed by convergence to the higher long-run level.<sup>24</sup>

## 5.3 Welfare and Political Support

The upper panel of Table 5 reports the welfare effects of moving towards a SOEC for the *current* generation of young and older workers.<sup>25</sup> The lower panel shows the political support for this reform. In both panels, we exclude older workers who have already retired early at time  $t_0$  since they cannot be affected by the policy change. In order to gain some insights about these results, Columns 2-4 display the welfare changes associated with three partial-equilibrium, consecutive experiments: first introducing a SOEC (aggregating changes in intercept and slope), then adjusting labour-market tightness, and finally letting the payroll tax change.

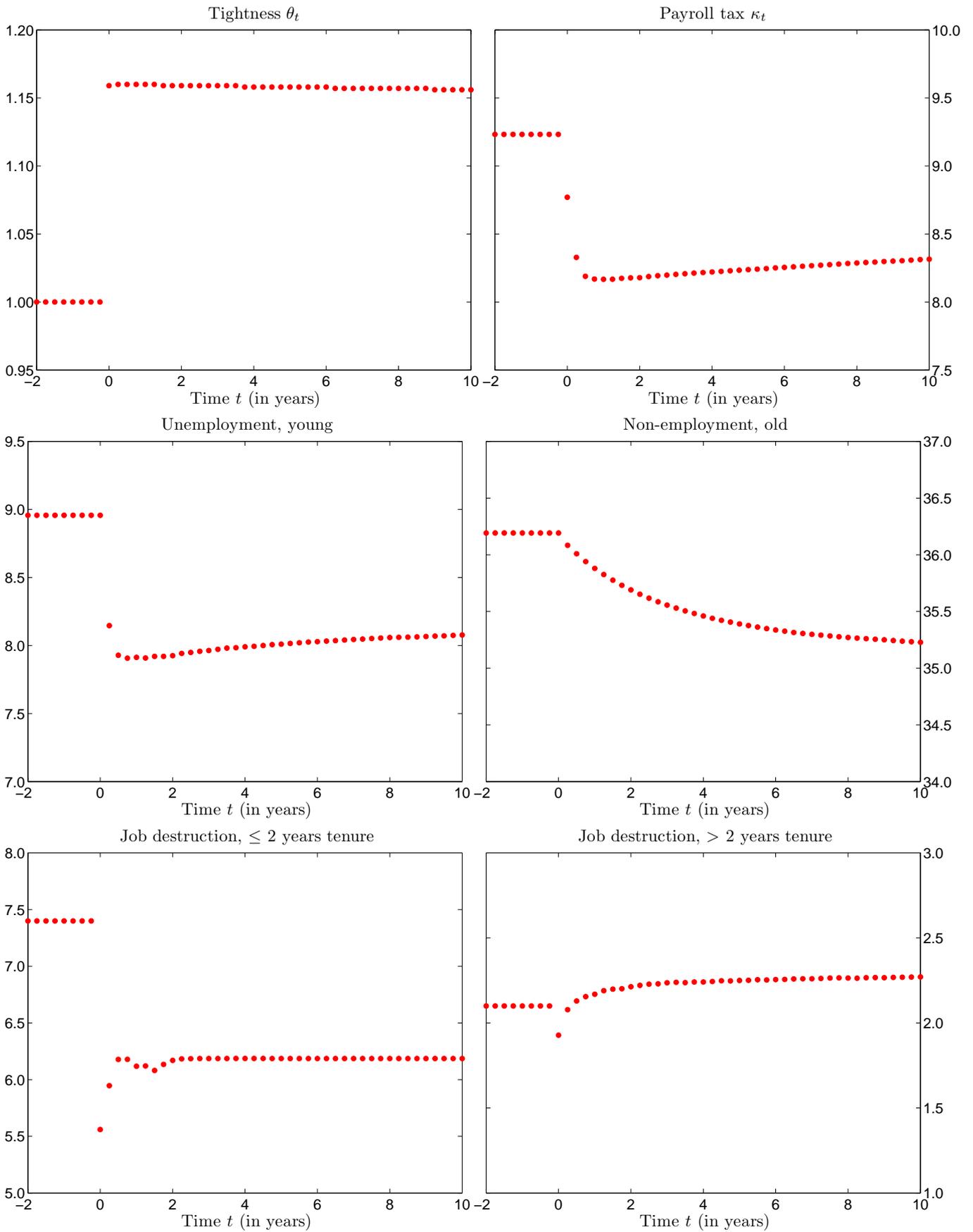
As can be inspected, a large majority of young workers benefits from the reform through the three adjustment margins. The reason is that the surge of the job finding rate following the introduction of the SOEC compensates them for the lower redundancy pay in case of dismissal. In contrast, most older workers are harmed by the SOEC, because severance pay is lower after the reform, although they benefit from the reduction in the payroll tax due to lower unemployment. Yet, the overall effect is negative for these workers. Among the three adjustments in Columns 2-4, the most relevant (and beneficial) one for younger workers is the fall in the tax rate while the most relevant for older workers

<sup>24</sup>In fact, the job destruction rate at more than 2 years of tenure remains more elevated than the value reached in the future steady state for roughly 30 years. This is explained by severance pay that combine accrued-to-date rights with the new EPL scheme (i.e. equation (29)). Workers who would have stayed in employment otherwise become more likely to separate from their jobs since the returns to tenure (in terms of severance pay) are lower. Charts for the long-run dynamics of the transition are available from the authors upon request.

<sup>25</sup>For young workers, the formula for computing welfare effects in consumption equivalent units is similar to equation (28). The formula for older workers is:

$$1 + \vartheta = \left( \frac{(r + \chi)V_s + \frac{1+r}{1-\eta}}{(r + \chi)V_b + \frac{1+r}{1-\eta}} \right)^{\frac{1}{1-\eta}} \quad (30)$$

where  $V_b$  is the lifetime utility of an old worker in a given labour market state of the benchmark economy, and  $V_s$  is her lifetime utility at the time when the reform is implemented.



**Figure 5.** Transition dynamics towards the optimal SOEC

The charts display the time path of several labour market variables during the transition towards the optimal SOEC under a partially non-retroactive reform. Except for labour market tightness  $\theta$ , the figures on the vertical axis are expressed in percent. On the horizontal axis, time is measured in years relative to the introduction of the SOEC, which occurs in period 0.

**Table 5.** Welfare effects of a SOEC and political support

	Overall effect (1)	Effect of SOEC (2)	Effect of $\theta_t$ (3)	Effect of $\kappa_t$ (4)
<b>A. Welfare effect</b>				
All workers	0.887	-0.093	0.438	0.543
Young workers	1.323	0.241	0.514	0.594
	[-0.748, 2.924]	(18.2)	(38.9)	(44.9)
Older workers	-1.341	-1.666	0.000	0.325
	[-6.837, 8.023]	(124.2)	(0.0)	(-24.2)
<b>B. Political support</b>				
All workers	87.06	64.14	21.01	1.91
Young workers	99.98	73.41	25.48	1.09
Older workers	26.25	20.54	0.00	5.71

NOTE: Column 1 present the overall effect of the policy reform. Columns 2, 3, 4 decompose the reform into three consecutive adjustments: effects of introducing a SOEC (Column 2), the resulting change in  $\theta$  (Column 3) and the resulting change in  $\kappa$  (Column 4). An entry in Panel A of the table is the percentage change in lifetime consumption. The numbers in squared brackets in Panel A are the minimum and maximum welfare change experienced by workers. The numbers in parenthesis in Panel A, Columns 2, 3, 4 are the relative contribution of each consecutive adjustments. An entry in Panel B of the table is the fraction of workers who benefit from the policy reform. In Panel B, Columns 2, 3, 4, an entry is the increment in the fraction of winners brought by each consecutive adjustments.

is the reduction in severance pay (detrimental). In sum, despite the fact that young workers gain 1.32% and old workers lose 1.34%, the main welfare change from implementing a reform is positive and amounts to an increase of 0.88% in overall welfare because the former group represent a larger fraction of the population compared to the second group.

The previous results predict very well political support of this reform. As can be observed in lower panel of Table 5, there is a large majority in favour of such a reform: almost 87 percent of the population would gain from the policy change. However, there is a substantial discrepancy across the two age groups: while there is almost universal support across young workers, three quarters of older workers would actually be against the reform and suffer non-negligible losses.<sup>26</sup> This result is noteworthy because in Southern EU countries unions are often dominated by older workers, which could explain the resistance to EPL reforms in those countries.

## 5.4 Comparison: The 2012 Reform

As already mentioned, Spain underwent an EPL reform in February 2012 (Decree Law 3/2012), whereby compensation costs for temporary contracts went up from 8 to 12 d.w.y.s. while severance pay for permanent contracts decreased from 45 to 33 d.w.y.s. (with a cap of 24 months, lower than the previous cap of 42 months). Figure B1 in Appendix B depicts the pre-2012 and post-2012 profiles of severance

<sup>26</sup>While the welfare losses for older workers seem very large, one should bear in mind that the figures measure a change in permanent consumption over an horizon of ten years (in expectation) for this age group.

payments, while Tables B2 and B3 perform the steady-state comparison and welfare analysis that were provided for the optimal SOEC in Tables 4 and 5, respectively. We observe in Table B2 that the steady-state welfare effect of the 2012 reform (0.86%) is about one-half of the corresponding gain under the optimal SOEC (1.68%). The gain from the 2012 reform is even lower than under the SOEC when considering welfare for the current generation of workers: 0.38% vs. 0.89%. The insight for these results is that the 2012 reform decreased but did not eliminate the discontinuity in severance pay which leads to “revolving doors”. Despite increasing the separation rate for short tenures and increasing it at longer tenure, the 2012 scheme leaves labour market tightness almost unchanged, in contrast with the implementation of the optimal SOEC which raises tightness from the baseline value of 1.00 to 1.15.

## 5.5 Comparison: A *statu-quo* Reform

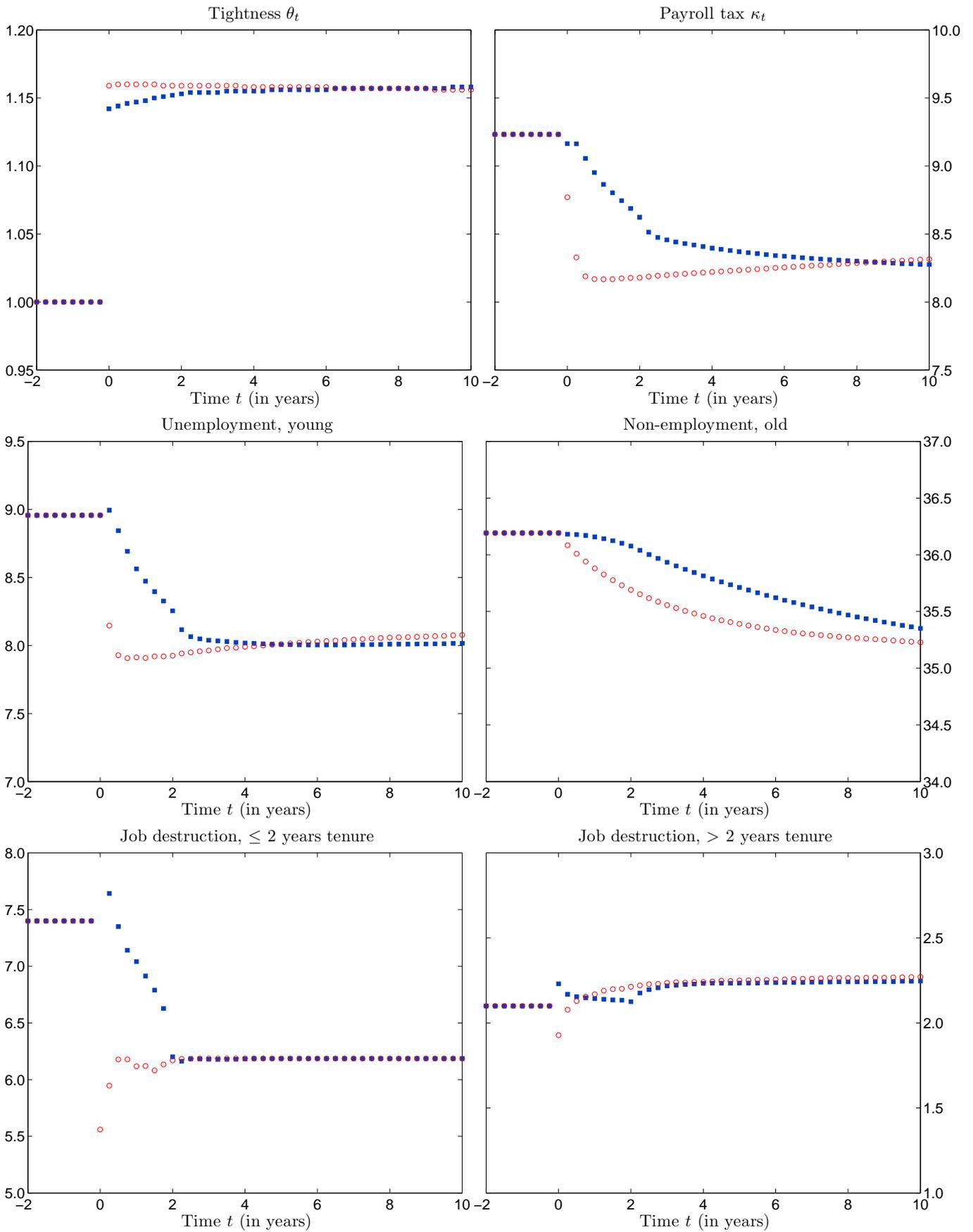
For completeness, we compare the transition dynamics of our benchmark reform with those of an alternative reform, which we denote by the *statu-quo*. In this alternative scenario, we assume that the optimal SOEC is introduced in the following way: unemployed and newborn workers who are matched to a firm at any date  $t \geq t_0$  are subject to the new severance payment schedule while workers who are still employed under the previous EPL scheme have the option to remain under the terms of this scheme. If they want to change to the SOEC introduced at  $t_0$ , they have to dissolve their current employment relationship first and then search for a new job (thus, only young workers already employed at  $t_0$  have the option of being eventually employed under the terms of the SOEC).

As can be observed in Figure 6, where we compare the two reforms (red circles correspond to the benchmark case whilst the blue dots correspond to the *statu-quo* reform), the transition is slower under the *statu-quo* reform and there are some detrimental effects in the short run. Labour market tightness surges immediately but by less than under the benchmark reform, whereas the tax rate falls more slowly because of the initial increase in the unemployment rate of young workers. Short-tenured jobs (less than 2 years) are destroyed immediately to take advantage of the much less stringent SOEC scheme; this is also the case, albeit to a much lesser extent, for low-productivity jobs held by workers with longer tenure. The effects explain the more sluggish decline in non-employment rates among both young and older workers.

It is important to note that, in spite of the sluggish reaction of the tax rate and non-employment rates, a *statu-quo* reform maximises political support and leads to higher welfare gains compared to our benchmark, the partially non-retroactive reform.<sup>27</sup> Among the current generation of workers, the welfare effects are as follows:

All workers	Young workers	Older workers
1.261	1.457	0.236
(25.5)	[1.351, 1.643]	[0.037, 0.751]

<sup>27</sup>In the short-run, it is likely that an actual *statu-quo* reform deteriorates welfare compared to our benchmark reform, due to the greater number of transitions through unemployment and the sluggish adjustment of the tax rate (cf. Figure 6). Our model cannot capture these effects well because of the stochastic structure of the life-cycle. Indeed, any worker aged 25 to 54 in the model expects to stay in this age category for 30 years. This mitigates the detrimental short run effects just discussed. In this regard, our benchmark reform which changes the generosity of EPL schemes in existing worker-firm matches performs better in capturing negative effects in the short run.



**Figure 6.** Transition dynamics: non-retroactive vs *statu-quo* reforms

The charts display the time path of several labour market variables during the transition towards a SOEC. The blue squares correspond to the *statu-quo* reform. The red circles correspond to the partially non-retroactive reform. Except for labour market tightness  $\theta$ , on the vertical axis the figures are expressed in percent. On the horizontal axis, time is measured in years relative to the introduction of the SOEC, which occurs in period 0.

(as in Table 5, the numbers in squared brackets are the minimum and maximum of welfare change). A *statu-quo* reform provides agents with the option value of choosing the EPL scheme they prefer, which accounts for the findings. Overall, the difference in welfare effects between the benchmark and the *statu-quo* reform seems plausible. In particular, we observe that the welfare losses suffered by some older workers in Table 5 (up to -6.8% in terms of consumption units) are caused by the partially retroactive component of the reform.

## 6 Sensitivity Analysis

In this section we conduct a few sensitivity exercises to analyse how the numerical results change with some key parameters of the model. In particular, we consider the following alternative scenarios: (i) the UI replacement rates for young workers is set at 50 percent and 65 percent respectively; (ii) there are red-tape costs such that 50% of the total severance package is lost; and (iii) exogenous separations (quits) do not entitle the worker to a severance payment. In each scenario, the model is recalibrated to match the targets presented in Section 3 (see Appendix B.1 for details). In this regard, this is not simple comparative statics exercise.

**Table 6.** Optimal SOEC and welfare effects under alternative calibrations

	Severance pay function		Welfare effect	
	$\tau_s$ (in months)	$\rho_s$ (in d.w.y.s.)	Steady-state	Transition path
	(1)	(2)	(3)	(4)
Benchmark	12	14	1.681	0.887
Lower UI benefits	6	10	2.068	1.134
Higher UI benefits	18	20	1.329	0.725
Red-tape costs	18	17	1.266	0.527
Quits vs. layoffs	18	15	1.500	0.851

NOTE: Each row displays the parameters of the optimal SOEC (Columns 1 and 2), the welfare effect as measured by the steady-state lifetime utility of new labour-market entrants (Column 3) and the welfare effects on average across workers in the period when the reform is introduced (Column 4).

Table 6 provides an overview of our results (the details are available in the online appendix). The SOEC design is fairly robust to changes in the calibration. For example, lower UI benefits implies a lower eligibility period (6 months instead of 12 months) and a flatter slope (10 d.w.y.s rather than 14 d. w.y.s) while higher UI benefits implies longer eligibility period (18 months rather than 12 months) and steeper slope (20 d.w.y.s rather than 14 d.w.y.s.). The insight for these results is that when UI generosity is low, unemployed workers wish to find a job soon and therefore choose lower severance pay because this increases job creation by more than it increases job destruction. The opposite argument hold when UI is generous and therefore workers find it less costly to remain unemployed in exchange for higher redundancy pay in the future. Furthermore, the SOEC eligibility period increases to 18 months with small changes in the slope, in the presence of red-tape costs and if we assume that exogenous

separations (quits) do not entitle the worker to severance compensations. The intuition in both instances is that the effectiveness of severance pay as an insurance device for workers is more limited. In all four specifications, the overall shape of the optimal SOEC is similar to that obtained under the benchmark calibration.

As can be inspected in the last two columns of Table 6, introducing optimal SOECs involves substantial welfare gains in a steady-state sense as well as for the current generation of workers. Compared to the benchmark, the welfare effects are more (resp. less) pronounced with lower (resp. higher) UI benefits. This dovetails with the idea that severance payments and UI benefits are substitutes in providing workers with a means to smooth consumption. The welfare effects are lower in the presence of red-tape costs because those represent a deadweight loss for the worker-firm pair. They are also lower in the fourth scenario because fewer workers receive a severance package following a job separation. In all instances, the welfare figures (both in steady state and accounting for the transition) are in the same ballpark as the figures based on the benchmark calibration.

Finally, we conjecture that had we allowed for savings among the young workers, the slope would be lower (for given UI), since there is less scope for the insurance mechanism provided by EPL. Likewise, had we allowed for job search among older unemployed workers, it is likely that the slope would be lower as well since now workers have another source of income, besides the redundancy package. Analysing both issues in depth remain high in our future research agenda.

## 7 Conclusion

This paper provides a computationally tractable approach for the design and implementation of an optimal single open-ended labour contract (SOEC) involving universal EPL for all workers. Such a contract could replace large discontinuities in EPL in segmented labour markets. As discussed in the opening paragraphs, there have been several proposals in Southern Europe and France regarding the implementation of a SOEC, but none of them provides figures as to the actual profile of an optimal SOEC, its welfare implications and political support. We attempt to address this deficiency. We advance a model with risk-averse individuals, who therefore prefer consumption smoothing, who face liquidity constraints during the first phase of their life cycle and cannot regain employment after a job loss when they approach the retirement age. Under these conditions, a SOEC provides a much better insurance mechanism against job losses than two-tier EPL.

We calibrate the model and find that a SOEC with 1 year of entry phase and a slope of 14 d.w.y.s maximises the lifetime utility of workers who enter the labour market in steady-state equilibrium. This SOEC delivers substantial improvements in allocations and welfare by removing the “revolving door” implied by segmented EPL, hence eliminating inefficient job turnover at short tenures. We also analyse the transition from an equilibrium with dual EPL to the equilibrium of the SOEC, and find that such a reform entails significant welfare gains for the current population, especially for young workers. For example, a realistic reform that imposes a SOEC for new jobs and maintains accrued-to-date rights for existing jobs while adjusting entitlements accumulated after the reform improves welfare for about 87% of workers, with three quarters of the older workers losing from the reform.

These results are based on a calibration for Spain before the Great Recession. Yet, our approach could also be used to design and analyse a SOEC for other countries with dual employment protection.

In our future research agenda, we would also like to deal with the design of optimal SOEC in combination with the design of optimal UI which, due to the computational complexity of modelling the transition to a new steady state and the difficulty in dealing with moral hazard issues by the unemployed, has been taken as given (though financed by payroll taxes). Another potentially interesting question is how to limit the uncertainty associated to workers' appeal to labour courts to obtain higher redundancy pay for unfair dismissals. The possibility of having a fast-track compensation together with a SOEC as in the recent Jobs Act in Italy could be a fruitful avenue of future research (see [Sestito and Viviano, 2015](#)).

## References

- Alvarez, F. and Veracierto, M. (2001). Severance payments in an economy with frictions. *Journal of Monetary Economics*, 47(3):477–498.
- Andrés, J., Bentolila, S., Dolado, J. J., and Felgueroso, F. (2009). Propuesta para la reactivación laboral en España. *El País*, 26:20.
- Bentolila, S. and Dolado, J. J. (1994). Labour flexibility and wages: Lessons from Spain. *Economic Policy*, 9(18):53–99.
- Bentolila, S., Dolado, J. J., and Jimeno, J. F. (2012). Reforming an insider-outsider labor market: The Spanish experience. *IZA Journal of European Labor Studies*, 1(1):1–29.
- Bertola, G. and Rogerson, R. (1997). Institutions and labor reallocation. *European Economic Review*, 41(6):1147–1171.
- Blanchard, O. and Tirole, J. (2003). Protection de l'emploi et procédures de licenciement. *Rapport du Conseil d'analyse économique, Octobre 2003*.
- Blanchard, O. J. and Landier, A. (2002). The perverse effects of partial labour market reform: Fixed-term contracts in France. *The Economic Journal*, 112(480):F214–F244.
- Blanchard, O. J. and Tirole, J. (2008). The joint design of unemployment insurance and employment protection: A first pass. *Journal of the European Economic Association*, 6(1):45–77.
- Boeri, T. and Garibaldi, P. (2008). *Un nuovo contratto per tutti*. Chiarelettere Milano.
- Boeri, T., Garibaldi, P., and Moen, E. R. (2013). The economics of severance pay. *IZA Discussion Paper No. 7455*.
- Booth, A. and Chatterji, M. (1989). Redundancy payments and firm-specific training. *Economica*, 56(224):505–521.
- Booth, A. L. and Chatterji, M. (1998). Unions and efficient training. *The Economic Journal*, 108(447):328–343.

- Cabrales, A., Dolado, J. J., and Mora, R. (2014). Dual labour markets and (lack of) on-the-job training: PIAAC evidence from Spain and other EU countries. *IZA Discussion Paper No. 8649*.
- Cahuc, P. (2012). For a unified contract. *European Labour Law Journal*, 3(3):190–205.
- Cahuc, P., Charlot, O., and Malherbet, F. (2012). Explaining the spread of temporary jobs and its impact on labor turnover. *IZA Discussion Paper No. 6365*.
- Cahuc, P. and Kramarz, F. (2004). De la précarité à la mobilité: vers une sécurité sociale professionnelle. *Rapport au Ministre de l'Économie, des Finances et de l'Industrie et au Ministre de l'Emploi, du Travail et de la Cohésion Sociale, Décembre 2004*.
- Castañeda, A., Díaz-Giménez, J., and Ríos-Rull, J.-V. (2003). Accounting for the U.S. earnings and wealth inequality. *Journal of Political Economy*, 111(4):818–857.
- Crossley, T. F. and Low, H. W. (2014). Job loss, credit constraints, and consumption growth. *Review of Economics and Statistics*, 96(5):876–884.
- Dolado, J. J., García-Serrano, C., and Jimeno, J. F. (2002). Drawing lessons from the boom of temporary jobs in Spain. *The Economic Journal*, 112(480):F270–F295.
- García Pérez, I. J. and Osuna, V. (2012). The effects of introducing a single open-ended contract in the spanish labour market. *Unpublished manuscript, U Pablo de Olavide*.
- García Pérez, I. J. and Osuna, V. (2014). Dual labour markets and the tenure distribution: Reducing severance pay or introducing a single contract. *Labour Economics*, 29:1–13.
- Ichino, P. et al. (2009). Disegno di legge per la transizione a un regime di flexicurity, n. 1481. *Senato Italiano, Rome*.
- Lalé, E. (2015). Penalty vs. insurance: A reassessment of the role of severance payments in an economy with frictions. *University of Bristol, Discussion paper No. 15/648*.
- Lazear, E. P. (1990). Job security provisions and employment. *Quarterly Journal of Economics*, 105(3):699–726.
- Mortensen, D. T. and Pissarides, C. A. (1994). Job creation and job destruction in the theory of unemployment. *Review of Economic Studies*, 61(3):397–415.
- OECD (2004). Employment protection regulation and labour market performance. *Employment Outlook*.
- OECD (2014). Employment outlook 2014. *Organization for Economic Cooperation and Development*.
- Petrongolo, B. and Pissarides, C. A. (2001). Looking into the black box: A survey of the matching function. *Journal of Economic Literature*, 39(2):390–431.
- Pissarides, C. A. (2001). Employment protection. *Labour Economics*, 8(2):131–159.

- Rebollo-Sanz, Y. (2012). Unemployment insurance and job turnover in Spain. *Labour Economics*, 19(3):403–426.
- Saint-Paul, G. (1996). *Dual labor markets: A macroeconomic perspective*. MIT press.
- Saint-Paul, G. (2002). Employment protection, international specialization, and innovation. *European Economic Review*, 46(2):375–395.
- Sestito, P. and Viviano, E. (2015). Hiring incentives and/or firing cost reduction? Evaluating the impact of the 2015 policies on the Italian labour market. *Mimeo, Banca d'Italia*.

# A Numerical Appendix

This appendix details our numerical methodology to compute steady-state equilibria and transition paths of the model economy presented in Section 2.

## A.1 Computing Steady States

To indicate that the economy is in steady state, we omit the time subscript throughout this subsection. A steady state is non-trivial to compute because the continuation values in certain labour market states are unknown. Specifically,  $U^y$ ,  $W^y(z, T)$ ,  $W^o(z, T)$ ,  $J^y(z, T)$ ,  $J^o(z, T)$ , as well as  $w^y(z, T)$ ,  $w^o(z, T)$  are the solution to fixed-point problems. The computational algorithm is as follows:

1. Solve for  $W^o(z, T)$ ,  $J^o(z, T)$ ,  $w^o(z, T)$  using the following steps:

- (a) Set initial guesses  $\widehat{W}^o(z, T)$ ,  $\widehat{J}^o(z, T)$ ,  $\widehat{w}^o(z, T)$ , where we use  $\widehat{\cdot}$  to indicate a guess.
- (b) Compute the reservation wage of the worker  $\underline{w}^o(z, T)$  and that of the firm  $\overline{w}^o(z, T)$  associated with  $\widehat{W}^o(z, T)$  and  $\widehat{J}^o(z, T)$  using equations (14) and (15).
- (c) If  $\underline{w}^o(z, T) \leq \overline{w}^o(z, T)$ , then solve for the wage  $w$  using the first-order condition of the generalized Nash product:

$$\begin{aligned} & \frac{\beta}{1 + \kappa_f} \left( z - (1 + \kappa)w + \frac{1 - \chi}{1 + r} \sum_{z'} \pi_{z, z'} \max \left\{ \widehat{J}^o(z', T), -\Phi(T) \right\} + \Phi(T) \right) \\ & = \frac{1 - \beta}{u'(w)} \left( u(w) + \frac{1 - \chi}{1 + r} \sum_{z'} \pi_{z, z'} \max \left\{ \widehat{W}^o(z, T), U^o(T) \right\} - U^o(T) \right) \end{aligned}$$

and update  $\widehat{w}^o(z, T)$  using this value (observe that  $U^o(T)$  is completely determined, as per equation (5)). This is a non-linear equation that can be solved using the bisection method. If, on the other hand,  $\overline{w}^o(z, T) < \underline{w}^o(z, T)$ , set  $\widehat{w}^o(z, T) = \frac{1}{2}(\overline{w}^o(z, T) + \underline{w}^o(z, T))$ .

- (d) Update  $\widehat{W}^o(z, T)$ ,  $\widehat{J}^o(z, T)$  using equations (7) and (9).
  - (e) If initial and updated guesses for value functions and wages are close enough, then we are done. Otherwise, go back to step (1a).
2. Compute  $W^o(z, \tau)$ ,  $J^o(z, \tau)$ ,  $w^o(z, \tau)$  recursively from  $\tau = T$ . That is:
- (a) Compute the reservation wage of the worker  $\underline{w}^o(z, \tau)$  and that of the firm  $\overline{w}^o(z, \tau)$  using equations (14) and (15). Notice that the continuation values only involve  $\tau + 1$ , which allows to compute  $\underline{w}^o(z, \tau)$  and  $\overline{w}^o(z, \tau)$ .
  - (b) If  $\underline{w}^o(z, \tau) \leq \overline{w}^o(z, \tau)$ , then solve for the Nash-bargained wage using the first-order condition (11). The continuation values in this equation depend on  $\tau + 1$  only, and the outside option of the worker  $U^o(\tau)$  is pre-determined.
  - (c) Compute the value functions  $W^o(z, \tau)$  and  $J^o(z, \tau)$  from equations (7) and (9).
3. Solve for  $U^y$ ,  $W^y(z, \tau)$ ,  $J^y(z, \tau)$ ,  $w^y(z, \tau)$  using the following steps:

- (a) Set an initial guess for  $\widehat{U}^y$ .
- (b) Solve for  $W^y(z, T)$ ,  $J^y(z, T)$ ,  $w^y(z, T)$  using a methodology similar to step (1), i.e.:
  - i. Set initial guesses  $\widehat{W}^y(z, T)$ ,  $\widehat{J}^y(z, T)$ ,  $\widehat{w}^y(z, T)$ .
  - ii. Use the analogon of step (1b) to obtain the reservation wage of the worker and the reservation wage of the firm.
  - iii. Use the analogon of step (1c) to update the wage. Observe that  $\widehat{U}^y$  is used as the outside option of the worker in the Nash bargain.
  - iv. Update  $\widehat{W}^y(z, T)$  and  $\widehat{J}^y(z, T)$  using equations (6) and (8).
  - v. Iterate until convergence.
- (c) Compute  $W^y(z, \tau)$ ,  $J^y(z, \tau)$ ,  $w^y(z, \tau)$  recursively from  $\tau = T$  using a methodology similar to step (2). Again, observe that knowledge of  $\widehat{U}^y$  is required to compute the Nash-bargained wage.
- (d) Use the Bellman equation of a young unemployed worker to update  $\widehat{U}^y$ . If initial and the updated guesses are close enough, then we are done. Otherwise, go back to step (3a) using the updated  $\widehat{U}^y$ .

The algorithm above builds on the observation that, in a steady state, the value functions  $U^y$ ,  $W^y(z, T)$ ,  $W^o(z, T)$ ,  $J^y(z, T)$  and  $J^o(z, T)$  are the solution to an infinite-horizon problem, whereas the other value functions associated with employment solve a standard finite-period ( $T$ ) problem and  $U^o(\tau)$  is completely determined.

A steady state also involves finding the equilibrium tuple  $(\theta, \kappa)$ . Thus, the algorithm is nested into outer loops to iterate on  $(\theta, \kappa)$ : we fix the payroll tax  $\kappa$ , solve for labour market tightness  $\theta$ , and then update  $\kappa$  until convergence. In the benchmark economy, our calibration procedure allows to skip the loop for  $\theta$  (recall that  $\theta$  is fixed to pin down the vacancy creation cost). Finally, since  $\phi(\tau)$  is specified as a function of the average wage  $\tilde{w}$ , there is an outer loop to iterate on  $\tilde{w}$ .

## A.2 Computing Transition Paths

A transition path between  $t_0$  and  $t_1$  involves a sequence of value functions, wage functions, rules for separation decisions, labour market tightness, payroll tax, and distribution of workers across employment status, productivity levels, tenure and age groups. These sequences satisfy a set of conditions presented in Subsection 2.7.

The transition path avoids some computational issues that arise for the steady state and brings subtleties of its own to the computational task. On the one hand, the transition path eliminates the infinite horizon problem since all continuation values depend on time  $t + 1$ . Moreover, the sequence  $(\theta_t)_{t=t_0, \dots, t_1}$  can be constructed backwards as we compute value functions along the transition path. On the other hand, the transition path requires knowledge of the sequence  $(\kappa_t)_{t=t_0, \dots, t_1}$  and there is an additional state variable for employed workers and for the old unemployed,  $\varepsilon \in \{0, 1\}$ , indicating whether the worker-firm match already exists when the reform is announced ( $\varepsilon = 0$ ) or not ( $\varepsilon = 1$ , which results in the  $\phi_1$  function in equation (29)).

The structure of the model implies that, instead of storing the sequence for all the objects of the transition path, we “only” need the distribution of agents at  $t_0$  and the sequences  $(\theta_t)_{t=t_0, \dots, t_1}$ ,  $(w_t^y(z, \tau, \varepsilon), w_t^o(z, \tau, \varepsilon))_{t=t_0, \dots, t_1}$  and  $(\bar{z}_t^y(\tau, \varepsilon), \bar{z}_t^o(\tau, \varepsilon))_{t=t_0, \dots, t_1}$  to check that a time-path  $(\kappa_t)_{t=t_0, \dots, t_1}$  is consistent with the equilibrium budget condition.

Our methodology to compute these sequences is as follows:

1. Compute the steady state of the economy in period  $t_1$ .
2. Guess a path for the payroll tax  $(\hat{\kappa}_t)_{t=t_0, \dots, t_1}$ .
3. Solve for value functions, wages, separation decisions and labour market tightness recursively from  $t_1$  until  $t_0$  as follows:
  - (a) Compute the severance pay function for workers in  $\varepsilon = 0$  using equation (29).
  - (b) Compute labour market tightness consistent with free entry at time  $t$  and store it.
  - (c) Compute the value of searching for a new job at time  $t$ ,  $U_t^y$ . Note that, in every period of the transition path, a young unemployed worker can only find a job with the  $t_1$  severance pay function applying to this job.
  - (d) Solve for the wage functions of older and younger workers at time  $t$  and store them. Then compute the associated value functions. Finally, compute the separation decisions at time  $t$  and store them.
4. Set the initial distribution of agents to the time-invariant distribution that obtains in the steady-state before  $t_0$ .
5. Using  $(\theta_t)_{t=t_0, \dots, t_1}$ ,  $(w_t^y(z, \tau, \varepsilon), w_t^o(z, \tau, \varepsilon))_{t=t_0, \dots, t_1}$  and  $(\bar{z}_t^y(\tau, \varepsilon), \bar{z}_t^o(\tau, \varepsilon))_{t=t_0, \dots, t_1}$  and the stock-flow equations described in Subsection 2.5 (augmented to include the state variable  $\varepsilon$ ), compute the evolution of the distribution during the time path. Each period, compute the realised payroll tax  $\kappa_t$  implied by the balanced budget condition in order to obtain  $(\kappa_t)_{t=t_0, \dots, t_1}$ .
6. If  $(\hat{\kappa}_t)_{t=t_0, \dots, t_1}$  and  $(\kappa_t)_{t=t_0, \dots, t_1}$  are close enough, then we are done. Otherwise, go back to step (2) with a new guess.

To ensure that the payroll tax obtained at the end of the transition path coincide with the steady-state  $t_1$  payroll tax, we allow for a very large number of periods between  $t_0$  and  $t_1$ . In our application, we set the number of period to 1,000 (250 years). After 500 periods, the number of workers who are still employed under the  $\varepsilon = 0$  rule is 0.0001.

## B Additional Tables and Figures

### B.1 Alternative Calibrations

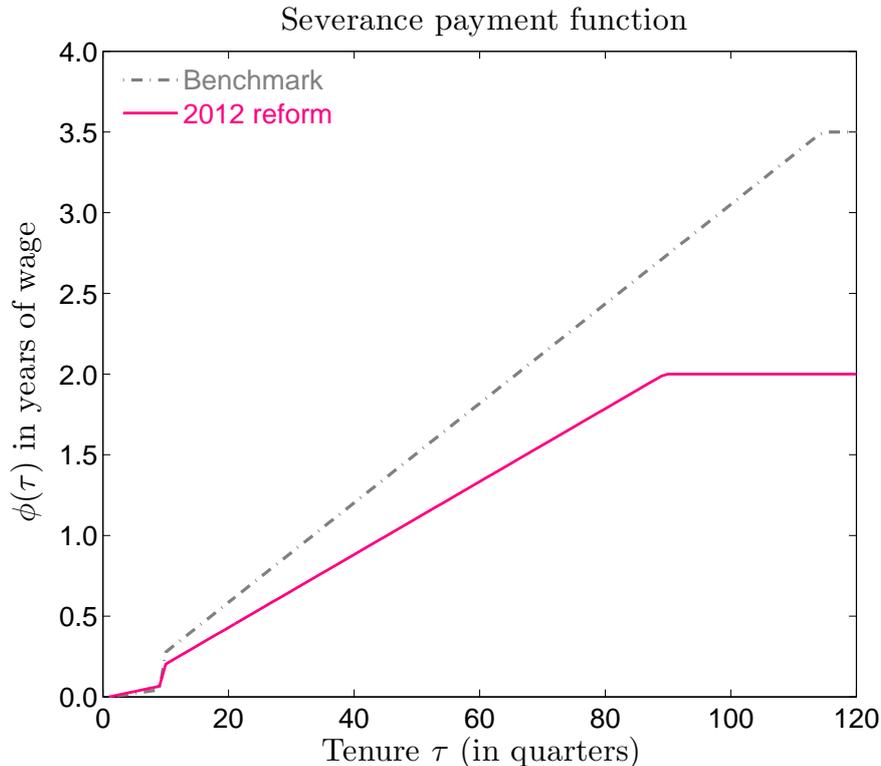
The alternative calibrations presented in Table B1 are numbered as follows: (1) the UI replacement rate for young workers is 50 percent, (2) the UI replacement rate for young workers is 65 percent; (3) red-tape costs waste 50% of the total severance package and (4) exogenous separations do not entitle the worker to a severance payment.

**Table B1.** Parameter values (one model period is one quarter)

Description	Parameter	Benchmark	Sensitivity check			
			(1)	(2)	(3)	(4)
Vacancy cost	$k$	0.2805	0.2828	0.2828	0.3202	0.2869
Unemployment income	$b^y$	0.2637	0.2049	0.3219	0.2539	0.2881
Unemployment income	$b^o$	0.1953	0.1845	0.2043	0.1569	0.2258
Exogenous separation	$\delta$	0.0060	0.0060	0.0060	0.0060	0.0060
Initial productivity	$z_0$	0.3233	0.2600	0.3850	0.2970	0.3650
S.d. of productivity draws	$\sigma_z$	0.0590	0.0590	0.0610	0.0700	0.0630

### B.2 The 2012 Reform

Figure B1 shows the EPL scheme implemented in Spain in 2012; Table B2 reports the effects on equilibrium allocations and steady-state welfare; Figure B2 shows the transition path for this reform; Table B3 reports the welfare effects accounting for the transition dynamics.



**Figure B1.** Current scheme vs. 2012 scheme: Comparison of the severance pay functions

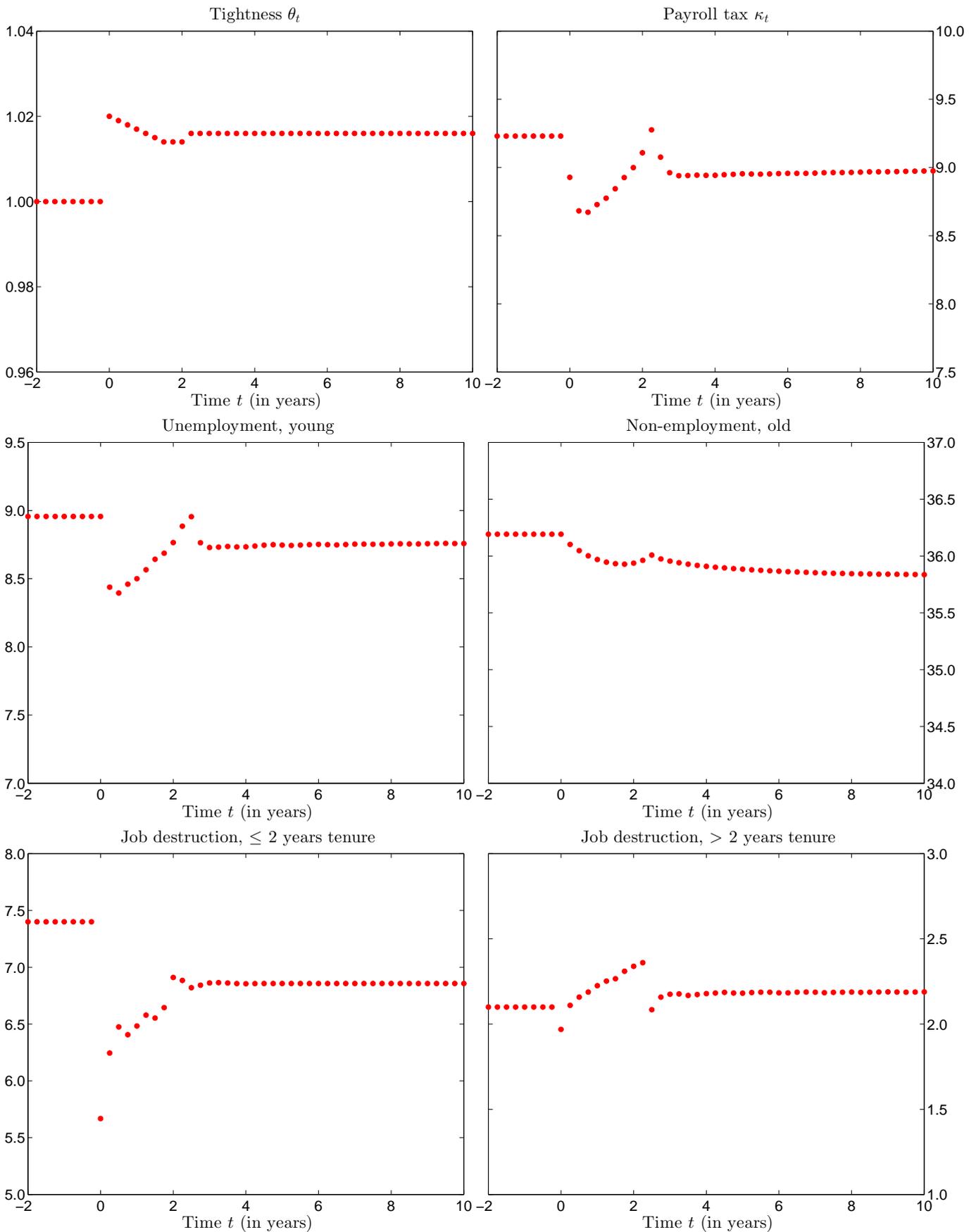
**Table B2.** Current scheme vs. 2012 scheme: Steady-state comparison

Description	Baseline	2012 scheme
Unemployment rate, young (%)	9.0	8.8
Non-employment rate, old (%)	36.2	35.8
Non-employment rate, all (%)	15.8	15.5
Average wage, young	0.46	0.47
Average wage, old	0.43	0.40
Average productivity, young	0.57	0.57
Average productivity, old	0.62	0.62
Job destruction rate, less than 2 years of tenure (%)	7.46	6.86
Job destruction rate, more than 2 years of tenure (%)	2.08	2.19
Job finding rate (%)	40.0	40.3
Labour market tightness $\theta$	1.00	1.01
Payroll tax $\kappa$ (%)	9.25	9.03
Welfare of a newborn worker (% , relative to baseline)	–	0.86

**Table B3.** Welfare effects of the 2012 reform

	Overall effect (1)	Effect of 2012 scheme (2)	Effect of $\theta_t$ (3)	Effect of $\kappa_t$ (4)
All workers	0.384	0.177	0.049	0.158
Young workers	0.657 [-0.270, 2.026]	0.451 (68.6)	0.059 (9.0)	0.171 (26.0)
Older workers	-1.010 [-4.980, 7.420]	-1.113 (110.2)	0.000 (0.0)	0.003 (-10.2)

NOTE: Column 1 present the overall effect of the policy reform. Columns 2, 3, 4 decompose the reform into three consecutive adjustments: effects of introducing the 2012 scheme (Column 2), the resulting change in  $\theta$  (Column 3) and the resulting change in  $\kappa$  (Column 4). An entry in Panel A of the table is the percentage change in lifetime consumption. The numbers in squared brackets are the minimum and maximum welfare change experienced by workers. The numbers in parenthesis in Columns 2, 3, 4 are the relative contribution of each consecutive adjustments.

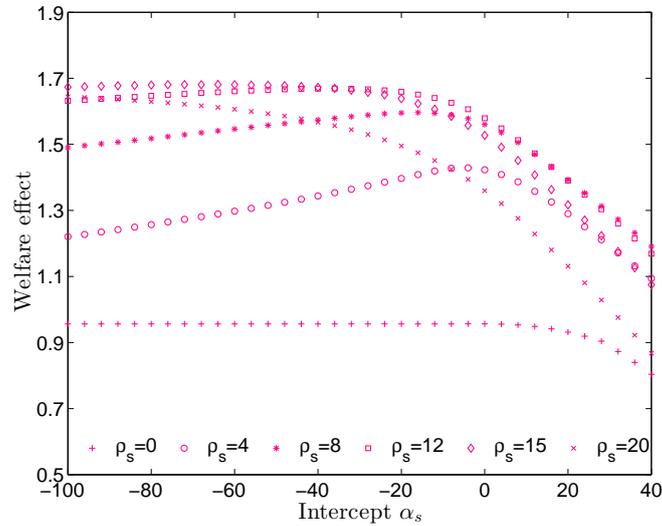


**Figure B2.** Transition dynamics towards the 2012 scheme

The charts display the time path of several labour market variables during the transition towards the 2012 scheme under a partially non-retroactive reform. Except for labour market tightness  $\theta$ , the figures on the vertical axis are expressed in percent. On the horizontal axis, time is measured in years relative to the introduction of the SOEC, which occurs in period 0.

### B.3 Negative Effects of a Positive Intercept $\alpha_s$

We find that a positive intercept  $\alpha_s$  has negative effects of the steady-state lifetime utility of new labour-market entrants. This property is illustrated in Figure B3.

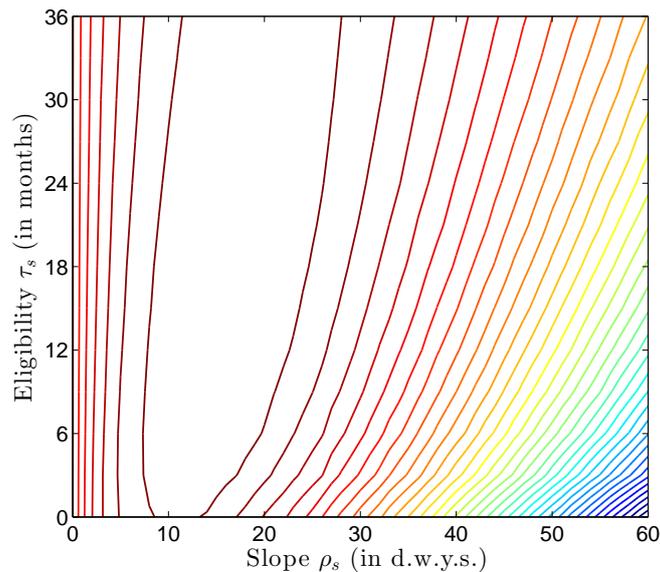


**Figure B3.** Negative effects of a positive intercept

This figure shows the welfare effects (as a percentage change in lifetime consumption of new labour-market entrants) of the intercept  $\alpha_s$  for different values of the slope  $\rho_s$ .

### B.4 Concavity of the Optimality Criterion with $\tau_s$ and $\rho_s$

Although an analytical formula for the optimality criterion is beyond reach, in our numerical experiments we find that the steady-state lifetime utility of new labour-market entrants is concave in  $\tau_s$  and  $\rho_s$ . Figure B4 illustrates this property using our benchmark calibration.



**Figure B4.** Optimality criterion in the benchmark economy

This figure is a contour plot of the steady-state lifetime utility of new labour-market entrants as a function of the rate of return to each year of tenure  $\rho_s$  and minimum service tenure for eligibility  $\tau_s$ .