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

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Abstract

We develop a computationally tractable model to study the allocational and distributional consequences of replacing a highly dual employment protection legislation (EPL) system with a unified EPL scheme. To illustrate our approach, we specialise the discussion to Spain – a country considered as an epitome of a labour market with dual EPL. First, we show that introducing a unified EPL scheme reduces unemployment and worker turnover at short job tenures. However, these changes are quantitatively limited as most of the adjustments occur through a change in bargained wages. Second, as a consequence, the policy reform has very heterogeneous effects on the lifetime value and on the volatility of labour income. The results support the view that replacing dual EPL with a unified scheme creates winners and losers among workers who are employed when the reform is implemented.

Keywords: Employment Protection; Dualism; Labour Market Reform

JEL codes: E24, J63, J65

*This version: January 2018. We are grateful to Arpad Abraham, Samuel Bentolila, Olivier Charlot, Jim Costain, Leo Kaas, Marco Leonardi, Christian Merkl, Salvador Ortigueira and Etienne Wasmer for useful comments that helped to improve the paper. We also thank seminar participants at a Bank of Spain-Bank of France joint conference (Madrid, 2015), the Konstanz GSDS-Colloquium, the Search and Matching annual conference (Aix-en-Provence, 2015), the 30th Congress of the European Economic Association, the VfS-Annual Meeting 2015, European University Institute, Queen Mary University of London, University College London, University of Milan, Universita Cattolica of Milan, Universidad Carlos III, the 11th joint ECB/CEPR labour market workshop (Frankfurt, 2015), the 20th T2M conference (Paris, 2016), the 41st Simposio de la Asociación Española de Economía (Bilbao, 2016), and the Annual Conference of the Royal Economic Society (Bristol, 2017) for their suggestions. All remaining errors are our own.

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1 Introduction

Reforms of employment protection legislation (EPL hereafter) remain high on the policy agenda for the so-called dual labour markets in Europe – typically in Mediterranean countries and France (Saint-Paul [1996], Dolado [2016]). A recurrent theme is that of the EPL *gap*, alluding to the abrupt increase in the stringency of EPL that occurs after a few periods of employment. In this setting, workers who have been employed long enough benefit from high employment protection, whereas those just hired enjoy virtually none. As pointed out by Blanchard and Landier [2002], lacking enough wage flexibility, a large EPL gap creates a "revolving door" through which workers rotate between short-term employment and unemployment. There is plentiful evidence of the negative consequences of this excess worker turnover.[1] As a result, proposals have been put forward to remove once and for all the large discontinuity in EPL, and replace it with a unified scheme where employment protection would increase only gradually with job tenure.[2] This call has been reiterated in the wake of the Great Recession and the ensuing poor performance of southern European labour markets (Bentolila et al. [2012a]).

Against this backdrop, our paper takes a step towards addressing two questions facing reforms of the EPL gap. First, what are the improvements in equilibrium allocations that can be achieved through these reforms? Despite general agreement that it would benefit the functioning of labour markets, very little work has been done to assess the allocational impact of replacing dual EPL with a unified scheme. Second, what are the distributional consequences of such structural EPL reforms? There is a presumption that there would be numerous insiders who lose from the policy change and, thus, who would oppose a reform leading to a new EPL scheme. Yet there is little known about the relevance of this argument, i.e. the heterogeneity of the impact among workers who populate the labour market when the EPL reform is implemented. To our knowledge, this paper is the first to propose a quantitative analysis of these two issues.

We investigate the effects of replacing a dual EPL system by a unified scheme through the lens of a general equilibrium search-matching model of the labour market. The model that we advance has a number of distinctive features that are essential for our purposes. Firstly, we explicitly keep track of job tenure in order to model the EPL gap. In the benchmark equilibrium, there is an abrupt shift in severance pay entitlements after a short period on the job, which alters wages as well as decisions to dissolve the employment relationship between workers and firms. Second, we consider key elements that provide a role for an EPL scheme whose generosity increases gradually with job tenure, in line with the policy proposals advocating a unified EPL scheme. There is no savings, agents are risk averse and therefore demand a smooth income stream. They transit stochastically from being young to old, and are prevented from receiving job offers in the latter

[1] For instance, Bentolila and Dolado [1994] emphasise the high wage pressure that results from dual EPL; Saint-Paul [2002] shows that it incentivises the adoption of mature rather than innovative technologies; Bentolila et al. [2012c] present evidence of negative effects on unemployment, human capital and innovation; Cabrales et al. [2017] document that dual EPL leads to low investment in employer-sponsored training schemes.

[2] Inspired by Blanchard and Tirole [2003], these policy proposals include Cahuc and Kramarz [2004] and Cahuc [2012] for France, Boeri and Garibaldi [2008] and Ichino [2009] for Italy, and Andrés et al. [2009] for Spain. The rationales for making employment protection increase with job tenure range from the large losses of specific human capital to the psychological costs suffered by long-tenured workers in case of dismissal, documented for instance in the abundant literature on displaced workers.

state.[3] Facing such deteriorated employment opportunities, workers at longer job tenures (hence more likely to be older workers) value a generous severance package which they can use to buy an annuity and increase consumption until they leave the economy. Third, we demonstrate that the model is computationally tractable outside the steady state. This is an important feature of our analysis as it enables us to evaluate the distributional consequences of introducing unified EPL for the *current* population in the labour market at the time of the reform.

To conduct our quantitative assessment, we anchor the model to Spanish data and policies. Spain is a natural choice because it is often considered as the epitome of a labour market with a very large EPL gap (see Dolado et al. [2002] and OECD [2014]). We design a simple unified EPL scheme for the Spanish labour market, namely one with an entry phase and a linear relationship between statutory severance payments and job tenure.[4] The parameters of this scheme are set to maximise the steady-state lifetime utility of new labour-market entrants. Not surprisingly (since the ingredients motivating the introduction of EPL in the model are quite minimal), this yields an EPL scheme that is much less generous than that in the benchmark equilibrium, which replicates the large Spanish EPL gap before the Great Recession.[5] Therefore the reform that we consider entails a substantial shift in government-mandated severance pay. Importantly, we account for a key feature of EPL reforms, namely that agents cannot be exempted retroactively from their accrued-to-date rights. That is, workers already employed retain any previous entitlements to severance payments accumulated under the dual EPL system, and they accumulate additional entitlements at a rate prescribed by the unified EPL scheme from the date of the reform onwards. Our model remains computationally tractable in this context.

Our first set of results concerns the allocational consequences of replacing dual EPL with a unified scheme. Despite the large differences between the two schemes, we find rather modest differences across equilibrium allocations. For instance, when comparing steady-state allocations, the job-finding rate increases by 'only' 4.5 percent and the unemployment rate decreases by 7.8 percent. The main effect of the policy reform is to reduce the separation rate at short tenures while slightly raising it at longer job tenures. Along the transition path, for all these variables the adjustments are completed quickly. The fact that the EPL reform has modest real effects has a flipside: most adjustments occurs through a change in the wages bargained between workers and firms. Under the unified EPL scheme, wages increase less steeply with job tenure since most workers have a lower outside option. On average, among those in the labour market when the reform is implemented, the net present value of lifetime income decreases (by 0.5 percent), and

[3]We use the terminology "young" and "old" for simplicity, and in keeping with life-cycle OLG models where young agents are those who work. Alternatively, one can think of our model as featuring a risk of job displacement, where workers can be hit by a shock to their employability (for instance, jobs in the industry of employment of the worker have been offshored). The stochastic life-cycle (or job displacement) structure captures adequately the uncertainty associated with individuals' employment histories: while some workers lose the ability to find another job long before retirement, others transit only briefly through this phase.

[4]In line with existing regulations, we determine severance payments in terms of days of wages per years of service. The profile of a unified EPL scheme refers to the way these payments increase with job tenure.

[5]We use calibration targets from data and policies before the Great Recession, when the unemployment rate in Spain was similar to the European average, i.e. around 8.5 percent. The Spanish labour market underwent a significant reform of its EPL system in 2012. The parameters of the unified EPL scheme that we compute are closer to (but still less generous than) the post-2012 Spanish regulation of redundancy pay for dismissals due to economic reasons. We analyse the post-2012 scheme using our model in Appendix B.

the standard deviation of income that they face over their lifetime decreases (by 2.2 percent) as well. On average across workers, these changes are welfare-improving.

Turning to the distributional consequences, we find substantial heterogeneity in the impact of the policy change. At the time of implementation of the EPL reform, workers differ with respect to tenure at their current job. The model-generated distribution of job tenure closely resembles its empirical counterpart, meaning that the model is well suited to study how this conditions the impact of the reform. The gains from replacing dual EPL by a unified scheme are concentrated on labour-market outsiders: workers who are unemployed or employed with a short tenure get the best of both worlds, namely an increase in the net present value of lifetime income and a reduction of the volatility of income. Workers employed at longer tenure experience the converse outcomes. To appreciate the magnitude of the differences, we calculate welfare changes in permanent consumption units (bearing in mind that agents cannot save in the model). Among older workers the average loss suffered by the bottom quintile is 2.1 percent, while in the top quintile of young workers the average gain is 1.7 percent. We emphasise these findings because they may well underscore the actual difficulty of reforming a highly dual labour market.

Our paper contributes to the rich policy debate presented in the opening paragraphs. It is mainly related to three strands of literature on employment protection.

First, there is a rich literature dealing with the relationship between EPL and the provision of insurance against income fluctuations. The theoretical underpinnings of this relationship are discussed in Pissarides [2001] and Blanchard and Tirole [2008]. Alvarez and Veracierto [2001] propose a first quantitative assessment using a model with precautionary savings, costly search efforts, and wage rigidities that result in privately inefficient layoffs. Cozzi and Fella [2016] analyse a similar model that features, in addition, human capital losses after job displacement. The papers closer to ours are Rogerson and Schindler [2002] and Lalé [2016]. Rogerson and Schindler [2002] use a partial equilibrium model with a job displacement shock, which is similar to the shock in our model that prevents (older) workers from regaining employment before leaving the economy. Lalé [2016] develops a model with precautionary savings, search-matching frictions, and wherein workers and firms bargain over wages and separation decisions. Among many differences, these papers consider simple EPL schemes (a uniform lump-sum severance package) in a *laissez-faire* economy, and they focus exclusively on steady-state analyses. By contrast, while we rule out precautionary savings, we carry job tenure as a state variable so as to allow EPL to depend on tenure, and we are able to study the transition dynamics. The latter is especially important because we consider the effects of moving away from a dual EPL system.

The second strand of relevant literature focuses on the interactions between the stringency of EPL and workers' job tenure. A closely related paper in this respect is that of García Pérez and Osuna [2014], who study the effects of introducing a so-called single open-ended contract in Spain. They consider risk-neutral agents, and so there is no rationale for having a smooth EPL scheme in their setup. Their model also does not feature the type of shock that motivates a positive relationship between EPL and job tenure in our analysis. Finally, they abstract from the government budget constraint financing the provision of unemployment insurance (UI) benefits, which is key to making the transition dynamics non-trivial. Another paper in this vein of literature is Boeri et al. [2017]. The authors study a stylised model with risk-neutral agents, where financing initial investment in training trough wage deferrals is not sustainable if employers cannot commit to keep workers who have invested in training. We view our work as complementary to theirs, in that they provide a different rationale for an increasing tenure profile of EPL based on a moral hazard argument. The two papers are also much different in scope and approach, since ours aims at assessing quantitatively the effects of a reform of the EPL gap.

Last, our paper is related to a strand of literature that studies the co-existence of fixed-term and open-ended employment contracts, and the duality of labour markets that results from it. Some prominent examples include Blanchard and Landier [2002], Cahuc and Postel-Vinay [2002], Bentolila et al. [2012b], and Cahuc et al. [2016] among others. To a large extent, the EPL gap in the benchmark equilibrium of our model has the flavour of the divide between fixed-term and open-ended contracts. The first periods of employment play a role similar to temporary contracts, except that there is no pre-specified termination date, while the latter periods become akin to those under open-ended employment contracts. In fact, it seems accurate to describe contractual employment relationships in the Spanish labour market as bound to start with low EPL, since almost no worker in Spain is directly hired with an employment contract entailing high EPL.[6] Our paper therefore complements this line of research. By not modelling different employment contracts explicitly, we simplify the analysis in ways that enable us to tackle more computationally involved issues, such as, e.g., the transition dynamics from dual to unified EPL in a labour market with risk-averse workers.

There is much that our paper does not do. As already mentioned, the model precludes access to savings. With savings, any worker-firm match would need to anticipate the path of consumption-savings by the worker because this path would influence bargained wages.[7] Besides the computational burden and the possibility of obtaining multiple wage schedules consistent with workers' savings decisions, firms would in turn need to keep track of the asset distribution to determine job creation efforts (e.g., Krusell et al. [2010]). All these features would substantially jeopardise the tractability of the model. We think that, on the other hand, savings are not essential for the allocational impact and the effect of the EPL reform on workers' earnings. As regards the welfare implications, we report a few numbers with the caveat that they may be mismeasured by the model.[8] Related, our analysis does not consider optimal policies – at least not beyond the calculation of a unified EPL scheme maximising some criterion. In this line of inquiry, the relevant questions include how to efficiently provide insurance to workers and how to design optimally EPL and UI. In particular, to properly assess the effects of changing UI policies, one should consider the moral hazard problems that arise with the search behaviour of benefit recipients. These are all interesting, important topics that we leave for future research.

[6]In Spain, only 8 percent of new hires are under open-ended contracts (Bentolila et al. [2012c]). Temporary contracts are sometimes subject to a termination cost that is typically much lower than redundancy pay for workers under open-ended contracts with similar job tenure (Cahuc et al. [2016]).

[7]This follows from the fact that workers' bargaining positions would depend on their own assets holdings.

[8]It is not clear whether the welfare figures would be much different with savings. Our model includes an annuity scheme that enables workers to use their severance package so as to increase consumption during unemployment. More importantly, the model is calibrated to match the generous unemployment insurance (UI) benefits of the Spanish economy, which should substantially mitigate the precautionary savings motive. In Lalé [2016], whose model includes savings and is calibrated on U.S. data and policies (which implies UI benefits that are much less generous than in Spain), the steady-state welfare figures are not too different with and without access to savings. Lalé does not study the impact of the transition path due to the complexity of the model with savings.

The paper is organised as follows. Section 2 presents the environment of our model, the Bellman equations and bargaining relationships between agents. We define the equilibrium conditions and establish results which enable us to study the transition dynamics in Section 3. In Section 4, we select parameter values based on Spanish data and policies to proceed with the numerical analysis, and we define a unified EPL scheme. Section 5 presents the results of the numerical experiments which we use to discuss the effects of replacing dual EPL with a unified scheme. Section 6 concludes.

2 The Model

This section presents our search-matching model of the labour market. There are a number of assumptions that are standard and commonly made when using this class of models. In addition, there are a few assumptions that are specific to our model, and which are tailored to tackle our main research questions. We highlight these assumptions in the first subsection below.

2.1 Economic Environment

Time is discrete and runs forever. The economy may be out of its steady-state equilibrium, and thus we keep track of calendar time indexed by the subscript t.

Workers. The economy is populated by a continuum of workers, who live through a stochastic life cycle: each period, young workers (y) become older with probability γ, while older workers (o) retire and exit our economy with probability χ. A measure of newborns enters the economy at the beginning of each period, so that the size of the workforce is kept at a constant unit level. We use index i to denote the age of the workers, i.e. $i \in \{y, o\}$.

Workers are risk averse: they value consumption $c_t > 0$ according to a CRRA utility function:

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

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

In addition to risk-averse preferences, an important assumption is that workers face incomplete asset markets and do not have access to a full storage technology. As will be explained in detail below, they have access to an annuity scheme that enables them to use their severance package so as to increase consumption during unemployment. Thus, workers value a smooth consumption stream, their means to achieve this are limited, and the motivation for introducing EPL is that it can partially remedy this issue.

Production. Production is carried out by a continuum of firms. Each firm is a small production unit with only one job, either filled or vacant. Labour is the only input and production is linear in labour. Productivity, denoted by z_t, is idiosyncratic to the worker-firm pair. All worker-firm pairs start at the same initial productivity level z_0. In subsequent periods, productivity evolves according to a finite Markov-chain process, where $\pi_{z,\bullet}$ denotes the transition function for z, i.e. $\pi_{z,z'} = \Pr\{z_{t+1} = z' | z_t = z\}$. Fluctuations in productivity may induce the worker-firm pair to destroy the job. Later on in the analysis, we also allow for exogenous separation shocks (i.e., quits) in order to improve the fit of the model. To economise on notation, we defer this element to the numerical analysis of the model (Sections 4 and 5).

Anticipating on the design of government-mandated employment protection schemes, we denote by τ the tenure of a worker-firm match. Thus, every worker-firm pair in each period t is characterised by at least two state variables: productivity z and job tenure τ.

Search-matching Frictions. Workers and firms meet each other via random search. Firms incur a per-period cost $k > 0$ of posting a vacancy to attract workers. The number of meetings between workers and firms is determined by a standard Cobb-Douglas matching function with constant returns to scale:

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

where u_t and v_t are the number of *job seekers* and vacancies, respectively. The parameter $\psi \in (0, 1)$ measures the elasticity of the number of meetings to the number of job seekers and A characterises matching efficiency. Accordingly, the vacancy-filling probability faced by firms, $q(\theta_t) = A\theta_t^{-\psi}$, is decreasing in labour market tightness $\theta_t \equiv v_t/u_t$, while the job-finding probability for job seekers, $\theta_t q(\theta_t)$, is increasing in θ_t.

To circumscribe the population of job seekers, we make the following two assumptions. First, we rule out on-the-job search: workers can only search while being unemployed. The second and more important assumption concerns older workers: unlike young workers, older workers stop receiving job offers. As a consequence, following job losses, they remain out of work until they leave the economy. This assumption enables us to capture a relevant phenomenon in most countries, namely, that re-gaining employment at an age close to retirement is difficult. Via the correlation between age and job tenure, this creates a simple rationale for EPL to increase with tenure. At higher τ, more stringent EPL can help prevent workers from being laid-off (job security motive), and/or provide them with a generous severance package to sustain consumption after job loss (insurance motive).

Government-mandated Programs. The government runs two labour market programs. The first one is an unemployment insurance (UI) program providing a constant-level benefit, denoted as b^i with $i \in \{y, o\}$, to non-employed workers, where benefits are allowed 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 UI benefits is financed by the proceeds of a payroll tax denoted as κ_t.

The second program, which is the focus of our analysis, is employment protection. This program consists of government-mandated severance pay, which is paid at the time of job separation. Consistent with actual policies, the severance pay component, denoted as $\phi(\tau)$, is a function of job tenure. In our benchmark model, we ignore pure red-tape costs involved in the dismissal procedure. Later on in robustness checks, we will consider the effects of 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.

Annuities. As mentioned earlier, while workers cannot save, they nevertheless have access to a partial insurance vehicle. Specifically, they are allowed to buy an annuity upon separation from the job with the proceeds of the severance pay that they receive. We assume that, in contrast with the UI program, the annuity system monitors perfectly the job-search behaviour of workers.[9] Thus, the insurance is partial in that workers can use the annuity scheme only to increase consumption until their next job arrives (young workers) or until they leave the economy (older workers). In our view, this provides a reasonable middle course between precluding any form of private insurance and allowing full access to savings.

The annuity system works as follows: upon job loss, a worker uses her severance package, $\phi(\tau)$, to purchase an actuarially-fair annuity which she holds for the duration of her spell of joblessness. Since an unemployed older worker does not search for a new job any more, her per-period payment is given by:

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

where $1/\chi$ is the expected number of periods until the worker leaves the economy. For a young worker, on the other hand, the payment depends on the expected duration of joblessness at the time when she loses her job and buys the annuity. We denote this expected duration by Δ. It is important to note that a young unemployed workers carries Δ as a *fixed* state variable for the duration of her spell of joblessness. As a result, the annuity payment received by a young worker is:

$$a^y(\Delta, \tau) = \frac{1}{1-(1+r)^{-\Delta}} \frac{r}{1+r} \phi(\tau), \quad \tau = 1, \ldots. \tag{4}$$

For future reference, we also define $a^y(\Delta, 0)$ as follows: $a^y(\Delta, 0) = 0$ for all Δ. Notice that when a worker unemployed at time t holds an annuity $a^y(\Delta, \tau)$, the variable Δ can in general be different from the expected duration of a jobless spell that prevails at time t, denoted by Δ_t.

2.2 Bellman Equations

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

[9]The implications of this assumption are twofold. First, for unemployed workers, the value of reemployment upon meeting a new employer dominates the value of continued search (since the latter would entail losing the annuity). Thus, it is always optimal to begin the employment relationship conditional on meeting. Second, for firms with a vacancy, the assumption implies that the job seekers whom they meet are homogeneous with respect to their outside option (continued search with no annuity). As a result, firms need not keep track of the distribution of annuities among unemployed workers to compute the returns to filling a vacancy.

While unemployed, a young worker receives a flow income b^y and, potentially, an annuity payment $a^y(\Delta,\tau)$. A young worker becomes older with probability γ and the asset value becomes $\widetilde{U}^o_{t+1}(\Delta,\tau)$, which we define momentarily. Otherwise, she remains in the current age category and either finds a firm with a vacancy with probability $\theta_t q(\theta_t)$, or remains unemployed. If the worker finds a vacancy, her asset value is $W^y_t(z_0,0)$, the value of being employed at the entry productivity level and with no job tenure. This is her preferred option since, under perfect monitoring, rejecting the job yields the asset value $U^y_t(\Delta,0)$. Hence:

$$\begin{aligned}U^y_t(\Delta,\tau) =& u(a^y(\Delta,\tau)+b^y) + \frac{1}{1+r}\Big[(1-\gamma)\big(\theta_t q(\theta_t) W^y_{t+1}(z_0,0) \\ &+ (1-\theta_t q(\theta_t)) U^y_{t+1}(\Delta,\tau)\big) + \gamma \widetilde{U}^o_{t+1}(\Delta,\tau)\Big]. \quad (5)\end{aligned}$$

In turn, an older non-employed worker with τ periods of tenure in her previous job receives a flow income b^o and an annuity payment $a^o(\tau)$, and she remains in the labour market with probability $1-\chi$. Thus, the corresponding asset value $U^o_t(\tau)$ is:

$$U^o_t(\tau) = u(a^o(\tau)+b^o) + \frac{1-\chi}{1+r} U^o_{t+1}(\tau). \quad (6)$$

Likewise, the asset value $\widetilde{U}^o_t(\Delta,\tau)$ satisfies:

$$\widetilde{U}^o_t(\Delta,\tau) = u(a^y(\Delta,\tau)+b^o) + \frac{1-\chi}{1+r}\widetilde{U}^o_{t+1}(\Delta,\tau). \quad (7)$$

Next, consider employed workers. These workers consume their wage, denoted by $w^i_t(z,\tau)$, while employed at a job with productivity z and tenure τ. Productivity evolves stochastically over time, and tenure increases deterministically according to: $\tau' = \tau + 1$. Every period, the value of continuing the employment relationship is compared to the value of job destruction. In the latter event, older workers receive the asset value $U^o_t(\tau)$ whereas the value of younger workers becomes $U^y_t(\Delta_t,\tau)$. Therefore, $W^y_t(z,\tau)$ satisfies:

$$\begin{aligned}W^y_t(z,\tau) =& u(w^y_t(z,\tau)) + \frac{1}{1+r}\Bigg((1-\gamma)\sum_{z'}\pi_{z,z'}\max\Big\{W^y_{t+1}(z',\tau'), U^y_{t+1}(\Delta_{t+1},\tau')\Big\} \\ &+\gamma\sum_{z'}\pi_{z,z'}\max\Big\{W^o_{t+1}(z',\tau'), U^o_{t+1}(\tau')\Big\}\Bigg). \quad (8)\end{aligned}$$

The value of employment for older workers, $W^o_t(z,\tau)$, is given by:

$$W^o_t(z,\tau) = u(w^o_t(z,\tau)) + \frac{1-\chi}{1+r}\sum_{z'}\pi_{z,z'}\max\Big\{W^o_{t+1}(z',\tau'), U^o_{t+1}(\tau')\Big\}. \quad (9)$$

With regard to firms, let J^i_t 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 $\phi(\tau)$. To close the model, in Section 3 we impose a free-entry condition, so that in the sequel the asset value of having a vacant position is zero in every period t. Hence:

$$J_t^y(z,\tau) = z - (1+\kappa_t) w_t^y(z,\tau) + \frac{1}{1+r}\left((1-\gamma)\sum_{z'} \pi_{z,z'} \max\left\{ J_{t+1}^y(z',\tau'), -\phi(\tau') \right\} + \gamma \sum_{z'} \pi_{z,z'} \max\left\{ J_{t+1}^o(z',\tau'), -\phi(\tau') \right\}\right), \quad (10)$$

$$J_t^o(z,\tau) = z - (1+\kappa_t) w_t^o(z,\tau) + \frac{1-\chi}{1+r}\sum_{z'} \pi_{z,z'} \max\left\{ J_{t+1}^o(z',\tau'), -\phi(\tau') \right\}. \quad (11)$$

2.3 Wage Setting

As is standard in 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. The wage schedules for all (z,τ) are then determined as follows:

$$w_t^y(z,\tau) = \arg\max_w \left\{ \left(W_t^y(z,\tau;w) - U_t^y(\Delta_t,\tau) \right)^{\beta} \left(J_t^y(z,\tau;w) + \phi(\tau) \right)^{1-\beta} \right\}, \quad (12)$$

$$w_t^o(z,\tau) = \arg\max_w \left\{ \left(W_t^o(z,\tau;w) - U_t^o(\tau) \right)^{\beta} \left(J_t^o(z,\tau;w) + \phi(\tau) \right)^{1-\beta} \right\}. \quad (13)$$

It is useful to study the first-order condition associated with these maximisation problems. For instance, for equation (12), we have:

$$(1-\beta)\frac{1+\kappa_t}{J_t^y(z,\tau)+\phi(\tau)} = \beta \frac{u'\left(w_t^y(z,\tau)\right)}{W_t^y(z,\tau) - U_t^y(\Delta_t,\tau)}. \quad (14)$$

The numerator on the left-hand side of equation (14) 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. Notice that this feature prevents us from solving for the joint surplus of the match in order to obtain the wage functions and separation decisions. This is unlike the canonical search-matching model, which assumes that utility can be transferred between the worker and the firm.[10]

2.4 Job Separation Decisions

Associated with the max operator in the value functions of employment, there are productivity thresholds that determine job separation decisions. Let $\overline{z}_t^i(\tau)$ denote the productivity cutoff, i.e.

[10] Another implication is that Lazear [1990]'s "bonding critique" is not entirely applicable here. Lazear's result refers to the fact that severance payments can be undone by efficient worker-firm bargains. In 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. Lalé [2016] discusses this issue in a similar context (i.e., risk-averse workers who bargain with risk-neutral employers).

the value of z that makes both parties indifferent between keeping the job alive and dissolving the job-match. Furthermore, let $\underline{w}_t^i(z,\tau)$ denote the lowest possible wage that a worker of age i and current tenure τ would accept in a job with productivity z, and let $\overline{w}_t^i(z,\tau)$ denote the highest possible wage that the firm would accept to pay to this worker. By definition, we have:

$$\underline{w}_t^i\left(\overline{z}_t^i(\tau),\tau\right)=\overline{w}_t^i\left(\overline{z}_t^i(\tau),\tau\right). \tag{15}$$

For workers, reservation wages $\underline{w}_t^i(z,\tau)$ satisfy:

$$u\left(\underline{w}_t^y(z,\tau)\right)=U_t^y(\Delta_t,\tau)-\frac{1}{1+r}\Bigg((1-\gamma)\sum_{z'}\pi_{z,z'}\max\left\{W_{t+1}^y(z',\tau'),U_{t+1}^y(\Delta_{t+1},\tau')\right\} \\ +\gamma\sum_{z'}\pi_{z,z'}\max\left\{W_{t+1}^o(z',\tau'),U_{t+1}^o(\tau')\right\}\Bigg), \tag{16}$$

$$u\left(\underline{w}_t^o(z,\tau)\right)=U_t^o(\tau)-\frac{1-\chi}{1+r}\sum_{z'}\pi_{z,z'}\max\left\{W_{t+1}^o(z',\tau'),U_{t+1}^o(\tau')\right\}. \tag{17}$$

The highest possible wages paid by firms, $\overline{w}_t^i(z,\tau)$, solve:

$$\overline{w}_t^y(z,\tau)=\frac{1}{1+\kappa_t}\Bigg[z+\phi(\tau)+\frac{1}{1+r}\Bigg((1-\gamma)\sum_{z'}\pi_{z,z'}\max\left\{J_{t+1}^y(z',\tau'),-\phi(\tau')\right\} \\ +\gamma\sum_{z'}\pi_{z,z'}\max\left\{J_{t+1}^o(z',\tau'),-\phi(\tau')\right\}\Bigg)\Bigg], \tag{18}$$

$$\overline{w}_t^o(z,\tau)=\frac{1}{1+\kappa_t}\left(z+\phi(\tau)+\frac{1-\chi}{1+r}\sum_{z'}\pi_{z,z'}\max\left\{J_{t+1}^o(z',\tau'),-\phi(\tau')\right\}\right). \tag{19}$$

Notice that, in equations (16) – (19), reservation wages depend on the current calendar time t through the outside option of workers and the payroll tax κ_t. These are the variables that make the bilateral bargains between workers and firms depend on the aggregate state of the economy (i.e., at a steady state or not). They become independent of the aggregate state if we assume away the budget constraint that determines κ_t.

3 Steady State and Transition

Having described the environment and the employment relationships, we next formulate the equilibrium conditions of the model. These conditions are satisfied in any period t irrespective of whether the economy is at a steady state or not. We provide two key results below which enable us to study the transition path consistent with the equilibrium conditions.

3.1 Equilibrium Conditions

There are two aggregate quantities pinned down by equilibrium conditions: labour market tightness θ_t and the payroll tax rate κ_t. The latter depends on the cross-sectional distribution of workers. We denote by $\lambda_t^y(z,\tau)$ (resp. $\lambda_t^o(z,\tau)$) the population measure of young (resp. older) workers employed at a job with current productivity z and with tenure τ, and by $\mu_t^y(\tau)$ (resp. $\mu_t^o(\tau)$) the measure of young (resp. older) unemployed workers at time t.[11] These measures satisfy a set of stock-flow equations which we defer to Appendix A.1 to save on space.

Free Entry. As already mentioned, we let a free-entry condition determine the equilibrium value of θ_t. In every period t, firms exhaust the present discounted value of job creation net of the vacancy-posting cost. Since workers and firms always form a match conditional on meeting, and workers are homogeneous with respect to their outside option at that point, the free-entry condition yields:

$$\frac{k}{q(\theta_t)} = \frac{1}{1+r} J_{t+1}^y(z_0, 0) \tag{20}$$

for all t. 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.

Balanced Budget. To pin down the payroll tax, it is assumed that the government balances the budget of the unemployment insurance system period by period. Thus, κ_t satisfies:

$$\kappa_t \sum_\tau \sum_z \left(w_t^y(z,\tau)\,\lambda_t^y(z,\tau) + w_t^o(z,\tau)\,\lambda_t^o(z,\tau)\right) = \sum_\tau \left(b^o \mu_t^o(\tau) + b^y \mu_t^y(\tau)\right) \tag{21}$$

for all t. Workers and firms need to know the tax rate κ_t to set wages, and the latter in turn affect the revenues raised by the tax.

3.2 Two Definitions

When all exogenous features of the economic environment (policy parameters, preferences, etc.) are constant, and because there is no aggregate shock, the economy is in a steady-state equilibrium. Otherwise it is evolving along a transition path. We define the latter in detail below, and use a less formal definition for the steady state in what follows:

Definition 1. A steady-state equilibrium is: (i) a list of value functions and separation decision rules that satisfy optimization (equations (5) – (11) and equation (15)) (ii) a list of wage functions consistent with Nash bargaining (equations (12) and (13)), (iii) a value for labour market tightness pinned down by free entry of firms (equation (20)), (iv) a payroll tax that balances the budget

[11] The variable Δ is not included in $\mu_t^y(\tau)$ because we do not need to keep track of the *joint* distribution $\mu_t^y(\Delta,\tau)$ during the transition phase (see equation (33) in Appendix A.3). As for the analysis of distributional effects in Subsection 5.2, the only expected duration Δ that is relevant is the value in the steady state prior to the policy reform, which is a fixed number. So, regarding young unemployed workers, all the calculations related to the transition dynamics require only the marginal distribution across previous job tenure (τ).

of the unemployment insurance system (equation (21)), and (v) a time-invariant distribution for the law of motion described in Appendix A.1.

Appendix A.2 provides an algorithm to compute a steady-state equilibrium allocation. In the sequel, we are typically interested in the transition between two allocations indexed by calendar dates, say t_0 and $t_1 > t_0$. We use the following definition:

Definition 2. A transition path between t_0 and t_1 is a sequence of value functions $(U_t^y(\Delta,\tau)$, $U_t^o(\tau)$, $\widetilde{U}_t^o(\Delta,\tau)$, $W_t^y(z,\tau)$, $W_t^o(z,\tau)$, $J_t^y(z,\tau)$, $J_t^o(z,\tau))_{t=t_0,\ldots,t_1}$, a sequence of wage functions $(w_t^y(z,\tau),\ w_t^o(z,\tau))_{t=t_0,\ldots,t_1}$, a sequence of separation decision rules $(\overline{z}_t^y(\tau),\ \overline{z}_t^o(\tau))_{t=t_0,\ldots,t_1}$, a time-path for labour market tightness $(\theta_t)_{t=t_0,\ldots,t_1}$ and for the payroll tax $(\kappa_t)_{t=t_0,\ldots,t_1}$, and a sequence of distribution of workers across employment status, productivity levels, tenure and age groups $(\mu_t^y(\tau),\ \mu_t^o(\tau), \lambda_t^y(z,\tau), \lambda_t^o(z,\tau))_{t=t_0,\ldots,t_1}$ such that:

1. Agents optimise: Given $(\theta_t)_{t=t_0,\ldots,t_1}$, $(\kappa_t)_{t=t_0,\ldots,t_1}$ and the sequence of wage functions $(w_t^y(z,\tau)$, $w_t^o(z,\tau))_{t=t_0,\ldots,t_1}$, the value functions $U_t^y(\Delta,\tau)$, $U_t^o(\tau)$, $\widetilde{U}_t^o(\Delta,\tau)$, $W_t^y(z,\tau)$, $W_t^o(z,\tau)$, $J_t^y(z,\tau)$, $J_t^o(z,\tau)$ satisfy equations (5) – (11), respectively, and the separation decisions $\overline{z}_t^y(\tau)$, $\overline{z}_t^o(\tau)$ satisfy equation (15) in every period t.

2. Nash bargaining: Given $(\theta_t)_{t=t_0,\ldots,t_1}$, $(\kappa_t)_{t=t_0,\ldots,t_1}$ and the sequence of value functions $(U_t^y$, $U_t^o(\tau)$, $W_t^y(z,\tau)$, $W_t^o(z,\tau)$, $J_t^y(z,\tau)$, $J_t^o(z,\tau))_{t=t_0,\ldots,t_1}$, the wage functions $w_t^y(z,\tau)$, $w_t^o(z,\tau)$ solve equations (12) and (13) in matches where $z \geq \overline{z}_t^i(\tau)$ and $i \in \{y, o\}$ in every period t.

3. Free entry: Given $\left(J_{t+1}^y(z_0, 0)\right)_{t=t_0,\ldots,t_1}$, labour market tightness $(\theta_t)_{t=t_0,\ldots,t_1}$ is the solution to equation (20) in every period t.

4. Balanced budget: Given the sequence of wage functions $(w_t^y(z,\tau),\ w_t^o(z,\tau))_{t=t_0,\ldots,t_1}$ and the sequence of distribution of workers across states of nature $(\mu_t^y(\tau),\ \mu_t^o(\tau), \lambda_t^y(z,\tau)$, $\lambda_t^o(z,\tau))_{t=t_0,\ldots,t_1}$, $(\kappa_t)_{t=t_0,\ldots,t_1}$ is the solution to equation (21) in every period t.

5. Law of motion: Given $(\theta_t)_{t=t_0,\ldots,t_1}$ and the sequence of decision rules $(\overline{z}_t^y(\tau),\ \overline{z}_t^o(\tau))_{t=t_0,\ldots,t_1}$ for job separation, the distribution $\mu_t^y(\tau)$, $\mu_t^o(\tau)$, $\lambda_t^y(z,\tau)$, $\lambda_t^o(z,\tau)$ evolves according to the law of motion described in Appendix A.1 from period t to $t+1$.

It is not clear from the above definition whether a transition path can actually be computed. We discuss this issue in the next subsection before turning to numerical applications.[12] In addition to giving insights into the workings of the model, this discussion allows us to explain how the details of the implementation of EPL reforms matter for the transition dynamics.

[12] Another issue is whether the steady-state equilibrium and the transition path are unique. Firstly we note that, in principle, there may exist multiple equilibria due to the fixed-point nature of a steady-state equilibrium with respect to tightness and the payroll tax. We are not interested *per se* in the high-tax/high-unemployment equilibria that can be triggered by the payroll tax. Therefore, in the computations, we always start by picking a low tax rate and we iterate until convergence of the balanced-budget equation. As for the transition path, we never encountered multiple solutions for any guess of the time path $(\kappa_t)_{t=t_0,\ldots,t_1}$ used in the computations. Of course, this does not rule out the existence of multiple transition paths.

3.3 The Transition Dynamics

The transition dynamics depend crucially on the time path of the aggregate quantities of the economy, namely $(\theta_t)_{t=t_0,\dots,t_1}$ and $(\kappa_t)_{t=t_0,\dots,t_1}$. On the one hand, θ_t is a forward-looking variable as per equation (20). Thus, we can proceed backwards from period t_1 in order to construct the sequence $(\theta_t)_{t=t_0,\dots,t_1}$. On the other hand, the tax rate κ_t is partly a backward-looking variable through the cross-sectional distribution of the economy, and partly a forward-looking variable through wages negotiated in period t. Computing a transition path therefore requires knowledge of the entire sequence $(\kappa_t)_{t=t_0,\dots,t_1}$.

In practice, we construct the sequence $(\kappa_t)_{t=t_0,\dots,t_1}$ iteratively. The two propositions below proceed under the assumption that we have such a sequence $(\kappa_t)_{t=t_0,\dots,t_1}$ at hand:

Proposition 1. *(Feasibility of a transition path) Suppose that at a finite date t_1 the economy is arbitrarily close to a steady-state equilibrium allocation. Then computing a transition path starting from the allocation in period t_0 is feasible.*

Proof. See Appendix A.3. The insight is that for any expected duration of a spell of joblessness, Δ, we have a closed-form solution to calculate $U^y_{t_1}(\Delta,\tau)$. This enables us to construct $U^y_t(\Delta,\tau)$ for all $t \leq t_1$ and all Δ. Finally, computing the value of young employed workers, $W^y_t(z,\tau)$, requires knowledge of Δ_t, the expected duration of a jobless spell if they were to become unemployed in period t, and Δ_{t+1}. We use $(\theta_t)_{t=t_0,\dots,t_1}$ to construct the sequence $(\Delta_t)_{t=t_0,\dots,t_1}$. □

We now discuss the type of transition path that is of interest for our research questions. We focus on the path of an EPL reform that resembles real-life EPL reforms, such as the latest EPL reform in the Spanish labour market that took place in 2012 (see Appendix B). A key feature of such reforms is that they are *partially non-retroactive*: workers employed before the reform cannot be exempted retroactively from their accrued-to-date rights. In practice, existing worker-firm pairs accumulate entitlements to severance payments at a rate prescribed by the new policy scheme from the date of the reform onwards, and any previous entitlements accumulated during the tenure prior to the reform are retained.

Formally, we are interested in a reform that introduces a new severance package function, $\phi_1(\tau)$, in period t_0. Until date t_0, the economy is at a steady state and the severance payment under the EPL program that prevails is denoted as $\phi_0(\tau)$. The specificity of the transition path of an EPL reform is twofold: it involves the co-existence of worker-firm matches that started either during the $\phi_0(\tau)$ or the $\phi_1(\tau)$ regime, and $\phi_0(\tau)$ differs from the *actual* severance payment in existing worker-firm matches under a partially non-retroactive reform.

Proposition 2. *(Feasibility of an EPL reform) A transition path towards the equilibrium obtained under $\phi_1(\tau)$ is computationally feasible. If the reform is partially non-retroactive, then in any period $t \geq t_0$ worker-firm matches that have existed at t_0 are subjected to:*

$$\phi_t(\tau) = \phi_0(\tau - (t - t_0)) + \phi_1(\tau) - \phi_1(\tau - (t - t_0)). \tag{22}$$

Proof. The co-existence of two types of employment relationships implies that we keep track of a binary state variable to distinguish between existing and newly-formed matches (Appendix A.4).

Next, we draw on the observation that τ and t are sufficient statistics for pre-reform and post-reform job tenure. That is, a worker whose tenure at time t is τ had $\tau - (t - t_0)$ periods of job tenure when the reform was implemented, and $(t - t_0)$ of post-reform job tenure. $\phi_0(\tau - (t - t_0))$ is the severance pay retained from the pre-reform period. The post-reform scheme entitles the worker to receive $\phi_1(\tau)$ minus payments that have not been accumulated under that scheme, which amount to $\phi_1(\tau - (t - t_0))$. □

In the sequel, the partially non-retroactive reform is our baseline scenario. In addition, in Subsection 5.3 we also study the path of an alternative EPL reform, denoted as a *statu-quo* reform, where only new workers are subject to the unified EPL rules.[13] In all our applications, we will impose a cap T on job tenure τ (see "Preliminaries" in Subsection 4.1). This implies that the pre-reform tenure for workers who have reached T cannot be recovered. However, this does not jeopardise the result of Proposition 2 since the severance pay $\phi_0(\tau)$ is also capped in our applications, and the cap is maintained after the reform.[14]

4 Computation of Benchmark Equilibrium

In this section, we select parameter values to compute the benchmark equilibrium of our economy, aiming to reproduce a set of data moments for Spain in the years before the Great Recession. We also define a unified EPL scheme for this economy and describe several equilibrium outcomes.

4.1 Parametrisation/Calibration

Preliminaries. We need a number of preliminary specifications in order to list the parameters of the model. Firstly, we parametrise 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 $\sigma_{\overline{z}}$, truncated and normalised to integrate to one over the support of productivity.[15] Next, as indicated in Subsection 2.1, we assume that matches are also subject to an exogenous separation shock. We denote by δ the per-period probability that this shock is realised. Finally, we impose a cap on job tenure denoted by T.

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

[13] Another type of EPL reform that can be readily described by our model is a "pure" retroactive reform, where the new severance package function, $\phi_1(\tau)$ replaces the previous scheme in existing jobs $\phi_0(\tau)$ irrespective of any accrued-to-date rights. However, such a scenario appears unrealistic.

[14] In the numerical experiments, the severance pay function $\phi_1(\tau)$ is always much less generous at long job tenures than the $\phi_0(\tau)$ function. Therefore we assume that a worker who is already entitled to $\phi_0(T)$ when the reform is implemented does not accumulate additional entitlements prescribed by the $\phi_1(\tau)$ scheme. This is innocuous because we set T to a large number in the experiments.

[15] Though this suggests that the resulting productivity process is a random walk, it must be noted that 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 parametrised only by $\sigma_{\overline{z}}$.

Parameters Set Externally. Panel A of Table 1 reports parameter values set outside the model. The interest rate is $r = 0.01$ to yield an annual interest rate of 4 percent. The coefficient of relative risk aversion 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 job tenure T equal to 120 model periods, i.e., 30 years. Finally, as is conventional in the literature (see Petrongolo and Pissarides [2001]), we set the elasticity of the vacancy-filling probability with respect to tightness ψ and the bargaining power of workers β equal to 0.5.

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

Description	Parameter	Value	Moment	Target	Model
A. Parameters set externally					
Interest rate	r	0.01			
Risk aversion	η	2			
Ageing probability	γ	1/120			
Retirement probability	χ	1/40			
Cap on tenure	T	120			
Matching function	ψ	0.5			
Bargaining power	β	0.5			
B. Parameters set internally					
Matching function	A	0.4000	Job-finding probability	40.0	40.0
Vacancy cost	k	0.2201	Tightness (norm.)	1.00	1.00
Unemployment income	b^y	0.2203	Replacement rate	58.0	58.0
Unemployment income	b^o	0.1617	Replacement rate	45.0	45.4
Exogenous separation	δ	0.0050	Fraction of quits	17.0	17.1
Initial productivity	z_0	0.2800	Job destruction, $\leq$2 years	7.5	7.6
S.d. of productivity draws	$\sigma_{\overline{z}}$	0.0440	Job destruction, $>$2 years	2.1	2.3

Notes: Panels A and B report the parameter values used for the benchmark equilibrium of the model. In Panel B, targeted moments and model-generated moments (with the exception of tightness) are expressed in percentage points. Labour market tightness is normalised to 1 in the benchmark equilibrium.

Calibrated Parameters. We follow standard practices and use the free-entry condition to pin down the vacancy-posting cost k after normalizing labour market tightness θ to unity. Next, we use the Spanish Labour Force Survey and the European Labour Force Survey to calibrate the remaining parameters (and, later on, to evaluate the fit for untargeted moments). We aim at matching the following six data moments: (1) the quarterly job-finding rate is 40 percent (García Pérez and Osuna [2014]); (2) the quarterly job destruction rate for short-term tenured (temporary) jobs is 7.5 percent (García Pérez and Osuna [2014]); (3) the quarterly job destruction rate for open-ended (permanent) jobs is 2.1 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 $\widetilde{w}^y$, is 58 percent;[16] (5) the replacement rate of unemployment benefits for older workers $b^o/\widetilde{w}^o$ is 45 percent;[17] (6) the quit rate among all job separations is 17 percent (Rebollo-Sanz [2012]). 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 putting an upper bound to this number. In the model, the parameter that embodies this role is δ, the probability of an exogenous separation. Thus, we use condition (6) to pin down a value for δ.[18] Panel B of Table 1 shows the parameters obtained through the calibration.

4.2 Dual and Unified EPL Schemes

Dual EPL scheme. The crux of our analysis relates to severance pay functions. In the benchmark equilibrium, our goal is to reproduce the discontinuous EPL scheme ruling in Spain prior to the onset of the Great Recession (Bentolila et al. [2012c]), in line with the data used to inform our model in the previous subsection. As in García Pérez and Osuna [2012], we parametrise severance pay as a function of job tenure and of the average (annual) wage. Notice that the average wage is an equilibrium outcome of the model, not a pre-specified parameter. To compute a steady-state equilibrium, we add an outside loop to iterate over the average wage used to specify the severance pay function (cf. Appendix A.2).[19]

We use the following pieces of information to specify $\phi(\tau)$ in the benchmark equilibrium. We identify the first two years of employment with fixed-term contracts prevailing in the Spanish labour market. During the pre-recession period, these contracts featured termination costs of 8 days of wages per year of services (d.w.y.s. hereafter), representing 2.2 percent (= 8/365) of the average yearly wage. If the worker is not dismissed before the end of this two-year period, we identify the subsequent periods of employment as those regulated by open-ended contracts. Workers on these more permanent contracts were entitled to 45 d.w.y.s. under an unfair dismissal, with a cap of 3.5 annual wages.[20] For instance, a worker who has been employed at the same firm for more than two years and loses her/his job at the end of the third year would be entitled to 37 percent ($= 3 \times 45/365$) of the yearly wage.

[16]Estimates for the average net replacement rate across different family types and earnings levels range from an initial value of 67 percent after layoff to 49 percent over 60 months of unemployment (OECD [2004]). We pick an intermediate value of 58 percent and perform a sensitivity analysis in Appendix C.

[17]Suppose that older workers can draw on regular unemployment benefits for 2 years (at a 67-percent replacement rate), and then fall back on less generous social assistance (at a 40-percent replacement rate). At an expected duration of 10 years, this yields a weighted average of $0.67 \times 2/10 + 0.40 \times 8/10 = 0.454$.

[18]Following an exogenous separation, we assume that the firm pays the severance package to which the worker is entitled. That is, we do not interpret the δ shock as a quit decision – it is not the outcome of a choice. We use δ to discipline the elasticity of the job destruction rate to changes in the employment protection scheme. In sensitivity checks (Appendix C), we re-run our experiments under the assumption that severance payments are waived in the event of an exogenous job separation.

[19]Regardless of the definition of $\phi(\tau)$, the calibration procedure includes targets defined with respect to the average wage, making it necessary to iterate over this equilibrium variable.

[20]Severance pay for fair (economic) reasons was lower during the calibration period, namely it amounted to 20 d.w.y.s. (with a maximum of 24 months). We assume that firms pay unfair dismissal costs because, even during the Great Recession, two thirds of all dismissals in Spain have been labelled 'unfair'. Indeed, firms avoided appeals to court by workers by paying the maximum rate, under the so-called "express dismissal rule" (see Bentolila et al. [2012c]).

Thus, severance payments for a worker with job tenure τ are specified as follows:

$$\phi(\tau) = \begin{cases} (8/365) \times \widetilde{w} \times \tau, & 1 \leq \tau \leq 8 \\ (45/365) \times \widetilde{w} \times \tau, & 9 \leq \tau \leq 113 \\ (45/365) \times \widetilde{w} \times 113, & \tau > 113. \end{cases} \tag{23}$$

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

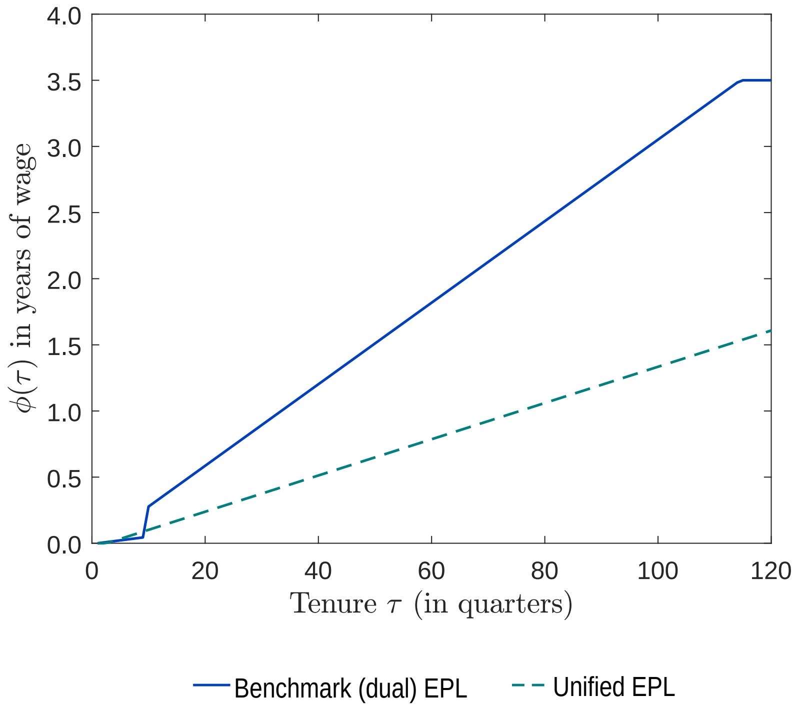

Figure 1. Severance payments, benchmark and unified EPL

Notes: The solid line shows the severance pay function of the benchmark equilibrium. The dashed line shows the severance pay function of the unified EPL scheme.

Unified EPL. We consider simple instruments to define a unified EPL scheme, namely an entry phase (i.e. the minimum service tenure required for eligibility) and a linear relationship between severance pay and job tenure. Formally, we specify severance payments under unified EPL as follows:

$$\phi\left(\tau\right) = \max\left\{\rho_u \times \left(\tau - \tau_u\right)\ ;\ 0\right\}. \tag{24}$$

$\tau_u \geq 0$ measures the number of periods on the job before severance payments are activated. $\rho_u \geq 0$ is the rate of return to job tenure in terms of severance pay (expressed in d.w.y.s.), conditional on eligibility.

To select values for the parameters τ_u and ρ_u, we search for the combinations maximising the steady-state lifetime utility of new labour-market entrants, U^y. This is a natural criterion in our view because it matches the objective function of a planner looking at our life-cycle model economy. In addition, notice that the ingredients motivating the introduction of EPL are rather minimal in this model. First, severance payments perform an insurance role only through the annuity scheme, and they are introduced on top of UI benefits which are likely more adequate to provide insurance to agents. Second, the rationale for the stringency of EPL to increase with tenure builds on the correlation between age (deteriorated employment opportunities) and job tenure. This role is substantially discounted from the perspective of new labour-market entrants, which we use as our criterion. So, the EPL scheme of the benchmark equilibrium will appear overly generous through the lens of this criterion, and we are bound to obtain a unified scheme that is more stingy and entails a considerable shift in EPL policies.

In the benchmark equilibrium, we find that the unified EPL is characterised by an eligibility period of 5 months and a slope of 20 d.w.y.s. from that job tenure onwards. Our task of choosing a unified EPL scheme turns out to be aided by the fact that the steady-state value of U^y appears to be concave with respect to $\{\tau_u, \rho_u\}$. This property also holds in all the robustness checks presented in Appendix C. The dashed line in Figure 1 displays the unified EPL scheme in comparison to the benchmark dual EPL scheme.

4.3 Benchmark Equilibrium Outcomes

As a preamble to the main numerical experiments, we gain an understanding of the effects of dual EPL by studying some outcomes of the benchmark equilibrium.

A key decision is that of job separation. Figure 2 displays the productivity cutoffs to dismiss young and older workers, resp. $\overline{z}^y(\tau)$ and $\overline{z}^o(\tau)$, as a function of job tenure. Several features are worth highlighting. First, as per the calibration newly-formed matches for young workers start at the productivity level $z_0 = 0.28$, which is not far from the separation threshold $\overline{z}^y(1) = 0.22$. As a result, job matches that experience an adverse productivity draw over the first periods are likely to be quickly dissolved. This feature makes new jobs relatively fragile, and rationalises the "revolving door" effect of the EPL gap at short tenures. On the other hand, job matches that experience a positive productivity draw tend to move towards the upper region of the productivity domain. These are likely to become stable employment relationships, or "career jobs", as jobs become less susceptible of being destroyed at longer tenures. Second, there are noticeable spikes in the job destruction region at $\tau = 8$ which reflect the discontinuous jump in the severance pay function after two years of tenure (Figure 1). Since workers and firms differ with respect to preferences, future severance payments are only partially internalised through lower wages (see Footnote 10). As a result, relatively unproductive matches get dissolved before the worker becomes entitled to more generous severance pay. Third, productivity cutoffs are lower for older workers because they face a shorter time horizon and they lack the option value of searching for a new job. Finally, the productivity thresholds are also slowly decreasing with job tenure as firms face an increase in the cost of firing a worker.

Next, we study how the job-finding rate and the aggregation of job separation decisions shape the cross-sectional distribution of the benchmark model. Table 2 presents moments that characterise this distribution and compares them with their empirical counterparts. Recall that our calibration only directly targets the job-finding rate and the job destruction rates under and above two years of job tenure. As shown in Table 2, the model does well in fitting the data.

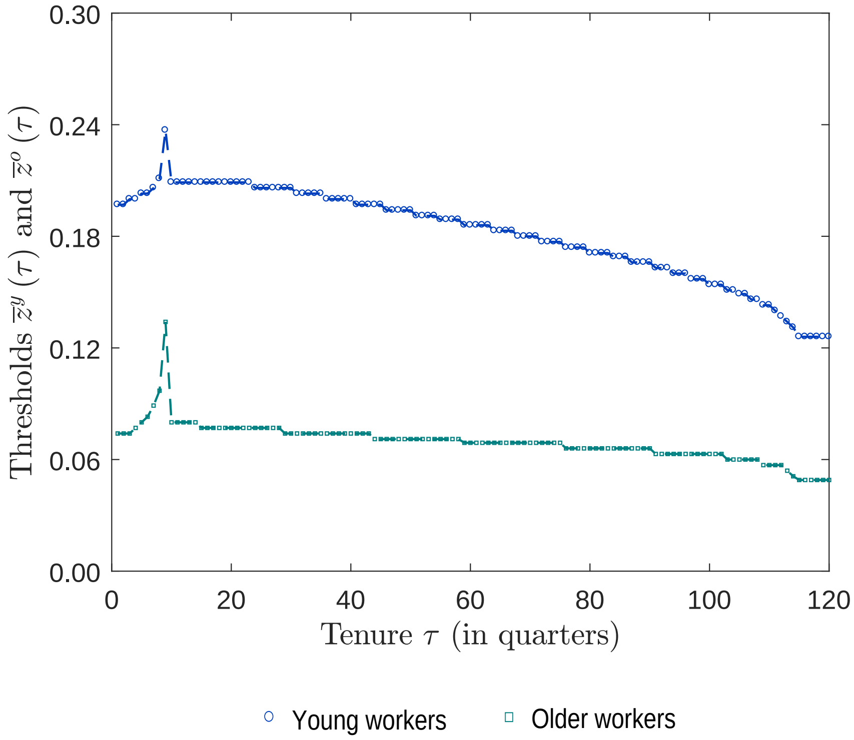

Figure 2. Job destruction thresholds conditional on job tenure τ

Notes: The circles (upper part of the plot) show the job destruction thresholds for young workers. The squares (lower part of the plot) show the job destruction threholds for older workers.

Table 2. Comparison between the model and data

Description	Data	Model
A. Non-employment rates		
Unemployment rate, young	9.0	9.7
Non-employment rate, old	43.1	36.3
Non-employment rate, all	16.5	16.5
B. Distribution of job tenure		
Less than 2 quarters	8.7	6.8
2 to 4 quarters	8.8	5.7
1 to 3 years	15.9	15.9
3 to 5 years	13.2	10.9
5 to 10 years	16.5	18.8
More than 10 years	36.9	41.9

Notes: Panels A and B compare model-generated moments with their empirical counterparts. 'Data' refers to data moments from the Spanish Labour Force survey for the years 2005–2007. In Panel B, each interval includes the upper bound but excludes the lower bound, i.e. 'less than 2 quarters' means '$0 < \tau \leq 2$', '2 to 4 quarters' means '$2 < \tau \leq 4$', etc. All entries are expressed in percentage points.

The unemployment rate among young workers is 9.7 percent vs. 9.0 percent in the data (Panel A). The model generates a non-employment rate of 36.3 percent for older workers. This value is lower than the share of non-employed male workers between 55 and 64 years observed in the data (43.1 percent), but the gap seems reasonable since our model abstracts from disabilities, health shocks and other reasons for non-employment at older ages. The aggregate non-employment rate among all workers in the benchmark equilibrium is 16.3 percent vs. 16.5 percent in the data. Turning to the distribution of job tenure (Panel B), the fit is satisfactory as well. The model slightly overpredicts the share of workers with more than 10 years of tenure, and the share of workers with less than 1 year of tenure is marginally lower than in the data. On the other hand, 45.6 percent of employed workers in the model have between 1 and 10 years of job tenure, which happens to match the data value exactly.

5 Quantitative Analysis

This section reports the quantitative results characterising the effects of replacing dual EPL with a unified scheme. We provide an extensive analysis of the allocational effects and distributional implications of the reform in the benchmark model and in variants of this model.

5.1 Allocational Effects

Long-run Effects. To understand the allocational consequences of the unified EPL scheme, we start out by gauging its long-run effects. Table 3 presents a comparison between steady-state allocations under the two EPL schemes under study. We find that the unified EPL scheme increases total employment. Workers face a lower expected duration of unemployment as per the increase in labour market tightness. Moreover, the unified EPL scheme reduces the job destruction rate at short tenures (under 2 years), while raising it at longer job tenures. This can be seen by looking at Figure 3, which reports the steady-state quarterly job destruction rates in the benchmark equilibrium and under the unified EPL scheme. The visible spike at 8 quarters of job tenure (the so-called "revolving door") disappears under unified EPL, leading to a much smoother profile for job separation. Noticeably, despite the increase in job destruction at longer job tenures, non-employment among older workers becomes lower (Table 3). This is because changing the EPL scheme has an impact over the whole distribution of job tenure.

Quantitatively, we find that the real effects of the unified EPL scheme are rather modest. The unemployment rate decreases from 9.7 to 9.0 percent; the non-employment rate for older workers decreases from 36.3 to 35.2 percent; the net effect on employment across the whole population is less than one percentage point (16.3 vs. 15.5 percent). The flipside of these outcomes is that most of the adjustments occur through a change in the bargaining relationships between agents. Indeed, although there seems to be little change in worker-firm selection over the productivity of job matches (average productivity remains almost constant according to Table 3), the wage-tenure profile shifts markedly. First, this profile becomes smoother because the unified EPL scheme makes the outside option of agents smoother across tenure. Second, the wage profile becomes flatter with respect to job tenure. At the entry level, workers do not need to accept

Table 3. Allocational effects of a unified EPL scheme

Description	Benchmark	Unified EPL
Unemployment rate, young *	9.70	8.96
Non-employment rate, old *	36.3	35.2
Non-employment rate, all *	16.3	15.5
Average wage, young	0.38	0.39
Average wage, old	0.36	0.31
Average productivity, young	0.47	0.47
Average productivity, old	0.53	0.52
Job destruction rate, ≤ 2 years of job tenure *	7.64	6.49
Job destruction rate, > 2 years of job tenure *	2.30	2.44
Job finding rate *	40.0	41.8
Labour market tightness	1.00	1.09
Payroll tax *	9.76	9.09

Notes: The table reports statistics comparing the steady-state allocations of the benchmark equilibrium and of the equilibrium under unified EPL. Entries marked with an asterisk (*) are expressed in percentage points.

large wage cuts in order to make up for the expected future severance pay. Then, workers have lower reservation values, which lowers the wage bargained at long job tenures. To illustrate this, we report the average wage calculated at each job tenure level in Figure 4. We will highlight below that workers employed when the EPL reform is introduced face a lower expected cumulated sum of income as well as less income volatility over their lifetime.

More on the Mechanisms. To provide further insights into the results, we carry out another steady-state comparison, studying the two EPL schemes from the perspective of new labour-market entrants. Specifically, we decompose the gap between their lifetime utility (U^y) in the benchmark steady-state equilibrium and in the equilibrium under unified EPL. We do so by running a sequence of experiments measuring the role of four components. First, we adjust the benchmark severance pay function so as to remove the "EPL gap": keeping labour market tightness and tax constant, we shift the schedule downwards in the second segment to eliminate the discontinuity after two years (cf. Figure 1). Second, we adjust the slope by rotating the function on both segments to yield the unified EPL scheme (again, keeping tightness and tax constant). Third, we raise labour market tightness to its equilibrium level under the unified EPL scheme, keeping the tax constant. Fourth and last, we let the payroll tax adjust as well.

Total effect	Remove EPL gap	Adjust slope	Tightness θ	Payroll tax κ
1.522	0.366	0.316	0.404	0.436
	(24.1)	(20.7)	(26.6)	(28.6)

The results are presented in the table above.[21] The first column reports that the steady-state lifetime value U^y is higher under unified EPL, making the total welfare change amount to an

[21] The effects obtained in this numerical exercise are not independent of the order in which the four different adjustments are implemented. Yet, in practice, we find that the results are similar when we change the order of the adjustments.

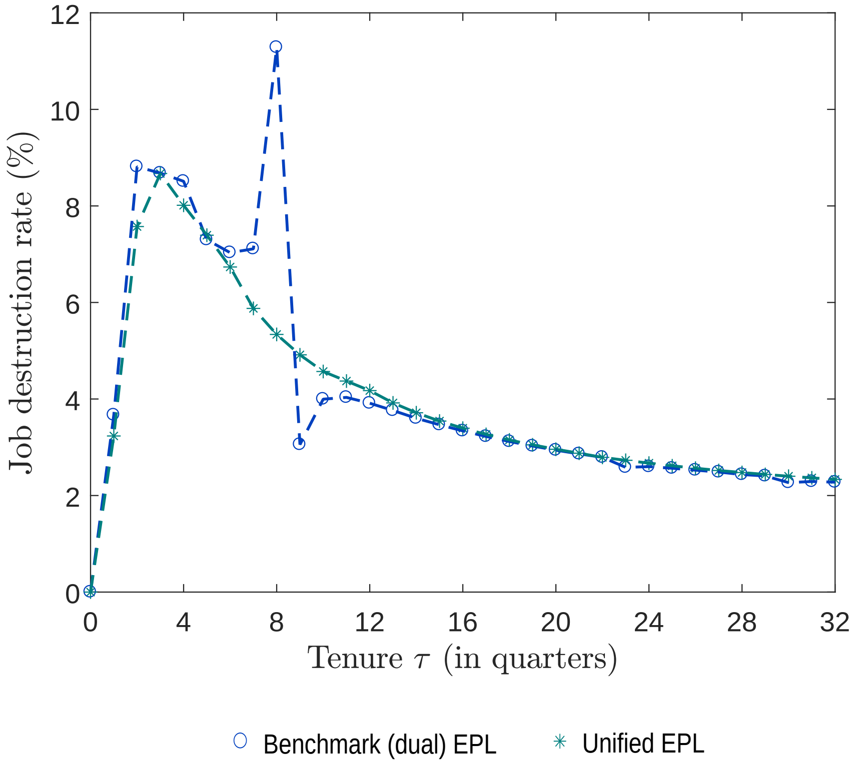

Figure 3. Job destruction rate conditional on job tenure τ

Notes: The circle show the quarterly job destruction rate conditional on job tenure in the benchmark equilibrium. The stars show the job destruction rate in the equilibrium under unified EPL.

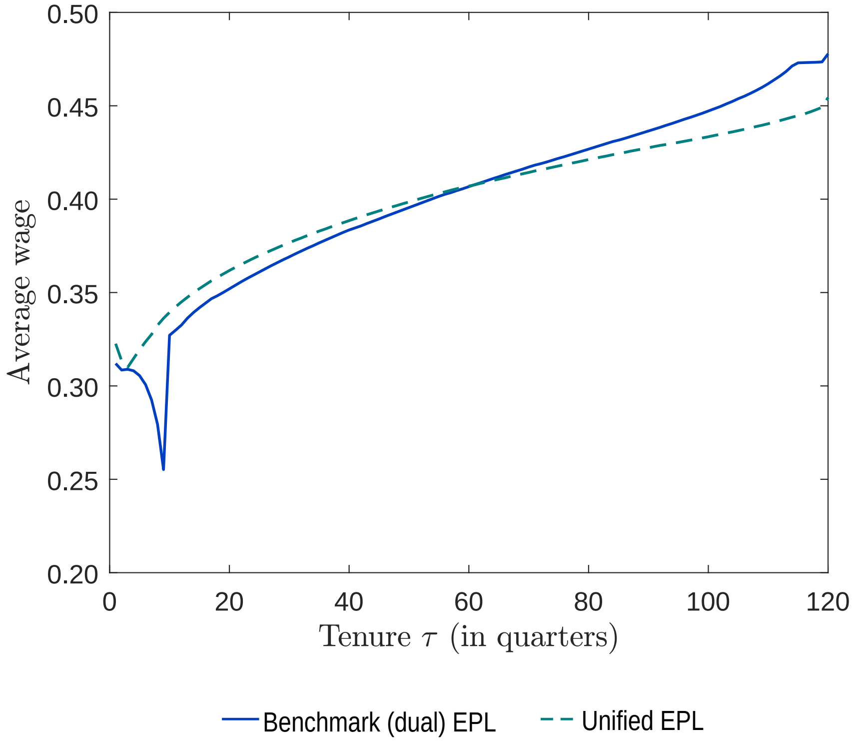

Figure 4. Average wage conditional on job tenure τ

Notes: The solid line shows the average wage conditional on job tenure in the benchmark equilibrium. The dashed line shows the average wage in the equilibrium under unified EPL.

increase by 1.52 percent in permanent income/consumption.[22] The remaining columns provide the welfare change associated with each adjustment (the bracketed figures give the relative contribution of each adjustment). As can be seen, eliminating the discontinuity by making severance payments less generous after 2 years contributes *positively* to the change in U^y (it accounts for one quarter of the increase in U^y). In other words, making the wage profile smoother more than offsets the reduction in wages prompted by the lower outside option of workers at long job tenures. Not surprisingly, the other adjustments also contribute positively to the welfare improvement. Raising the slope of the severance pay function strengthens the bargaining position of workers. Then, adjusting tightness and reducing the payroll tax increases the surplus of job matches. The latter adjustment turns out to be an important contributor to the overall change in U^y; it explains almost 30 percent of the welfare effect. This underscores the importance of making allocational improvements feed back into wages via the budget constraint of the government.

Transition Dynamics. Next, we study the dynamics of equilibrium allocations in the short run, when the partially non-retroactive EPL reform is introduced. Figure 5 shows the time path of several labour market variables during the transition from the benchmark equilibrium to the equilibrium under unified EPL.

Most of the adjustments take place during the first year of the reform. This outcome is shaped by the fact that a partially non-retroactive reform affects not only new jobs, but also existing worker-firm matches. The upper panels show the time path of the general equilibrium variables, tightness θ_t and the payroll tax κ_t. Labour market tightness acts like a jump variable: it overshoots slightly on impact and then converges quickly to its new steady-state equilibrium value. The gradual decrease in taxes, on the other hand, is explained by a more sluggish decline in non-employment after the reform. Unemployment among young workers mirrors the behaviour of tightness. The job-finding rate soars as firms create more vacancies associated with the unified EPL scheme. The decline in non-employment among older workers is more gradual since it is only driven by the inflows from employment and the exogenous outflows of workers leaving the economy. To summarise, implementing a unified EPL scheme through a partially non-retroactive reform leads to fast transitional dynamics, where most labour market variables shift towards their new steady-state equilibrium values within just a few model periods.

5.2 Distributional Implications

We now turn to the distributional implications of the unified EPL scheme for workers who are in the labour market at time t_0, i.e. when the reform is introduced. Before discussing the results, we present the details of our numerical methodology.

[22] Let U_b^y denote the lifetime utility of new labour-market entrants in the benchmark equilibrium. Similarly, denote by U_u^y their lifetime utility under the unified EPL scheme. Then

$$\left[\frac{(r+\chi)\,U_u^y + \frac{1+r}{1-\eta}\frac{r+\chi+\gamma}{r+\gamma}}{(r+\chi)\,U_b^y + \frac{1+r}{1-\eta}\frac{r+\chi+\gamma}{r+\gamma}}\right]^{\frac{1}{1-\eta}} - 1$$

gives the equivalent change in permanent consumption faced by the agents.

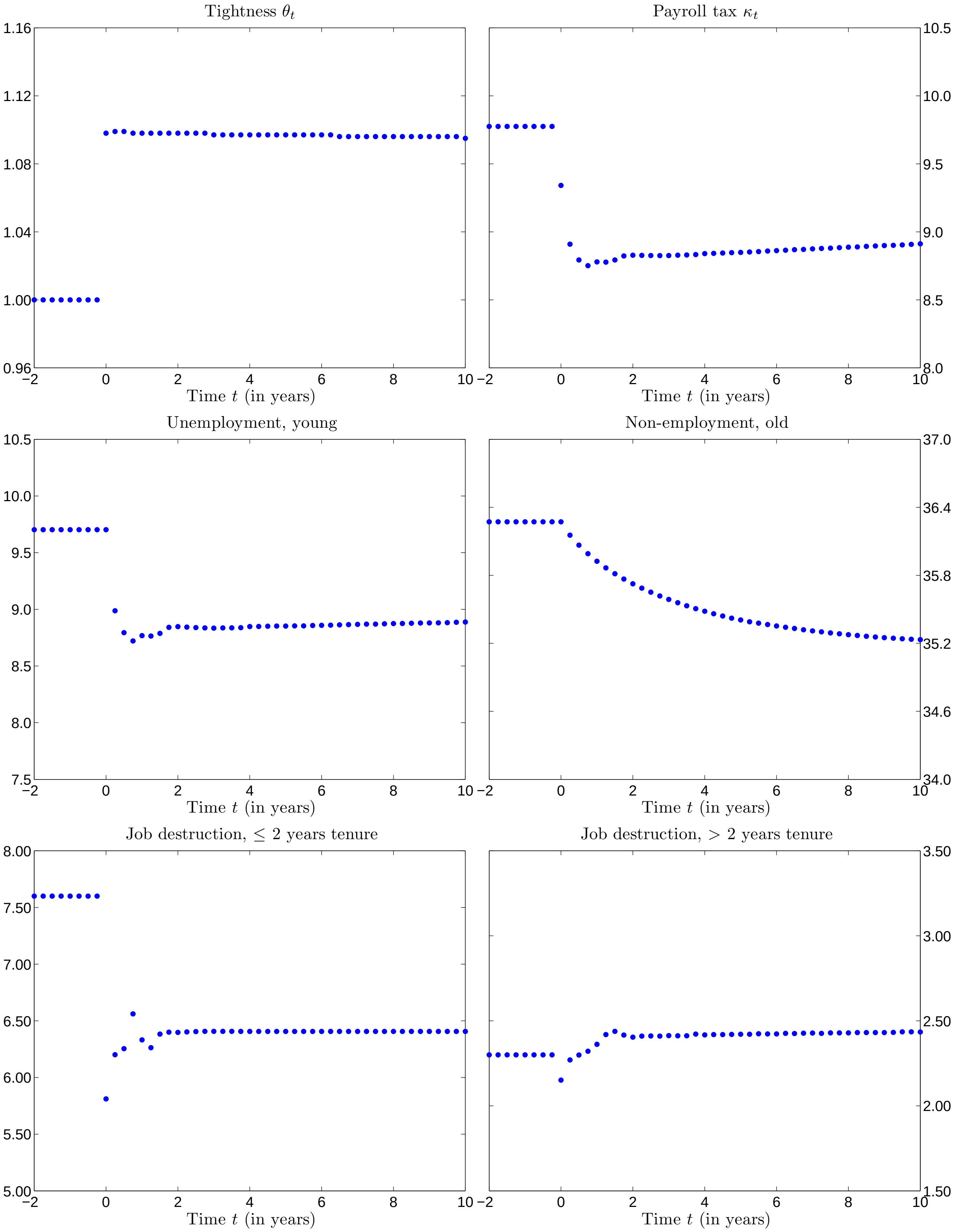

Figure 5. Transition dynamics towards the unified EPL scheme

Notes: The charts display the time path of several labour market variables during the transition towards the unified EPL scheme under a partially non-retroactive reform. Except for labour market tightness θ, 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 unified EPL scheme, which occurs in period 0.

Numerical Methodology. We focus primarily on two outcomes of agents' labour market trajectories: the net present value of lifetime income and the volatility (measured by the standard deviation) of income over the lifetime. We use our model as a laboratory to construct these individual outcomes under the unified EPL scheme and the benchmark scheme. Specifically, we create a large panel (25,000 individuals) of young workers drawn from the cross-sectional distribution of the economy at the time of the EPL reform. We simulate for each worker her individual income trajectory after the reform until she leaves the economy, and we also trace out her trajectory had the reform not been put in place.[23] We use the same sequence of random numbers to simulate the two trajectories of a given individual. Consequently, any difference between trajectories is driven only by changes in wages and transition rates (which come from changes in the EPL scheme), and not by different random draws.

As just mentioned, in the experiments we simulate the trajectories of young workers. Owing to the stochastic ageing structure of the model, these workers face an expected lifetime duration of 40 years conditional on not being hit by the demographic shock γ. The trajectory of older workers, on the other hand, is of lesser interest: the majority of them are already in long-term employment relationships, and they remain non-employed until they leave the economy once laid-off.[24] In the sequel, however, we do report a statistics measuring the welfare change experienced both by young and older agents, namely by studying the change in their asset value caused by the EPL reform. We express the latter in terms of the equivalent change in permanent income (hence consumption).[25] We do not need numerical simulation in order to calculate welfare changes: we can readily compare the asset values computed in the initial steady-state equilibrium and those computed at time t_0 of the transition path.

Results. Table 4 presents the distributional consequences of introducing the unified scheme replacing dual EPL. Firstly, Panel A shows that workers experience a decrease in the net present value of lifetime labour income of 0.5 percent on average, and that they benefit from a reduction by 2.2 percent in the standard deviation of income over the lifetime. The reduction in income stems mostly from having a weaker outside option under the unified EPL scheme. The lower volatility of the income paths, on the other hand, comes from eliminating the "EPL gap" (Figure 3): workers transit less frequently through unemployment, and the profile of the wage schedules with respect to job tenure becomes smoother. In addition, Panel A reveals a vast heterogeneity of situations following the policy change. For a large share of the population (two quintiles, i.e. 40 percent of workers), on average the net present value of lifetime income shifts positively or negatively by about 10 to 15 percent. The results for the standard deviation of income are even larger: the average change is almost -45 percent in the bottom quintile, and 60 percent in the top

[23] We simulate each pair of individual trajectories for up to 800 periods. An agent faces an expected duration of her lifetime of 40 years, meaning that on average she leaves the economy after 160 model periods.

[24] Older workers who are already non-employed at time t_0 are not impacted at all by the policy change.

[25] See Footnote 22 for the relevant formula for young workers. For older workers, denote by U_b^o (resp. U_u^o) their asset value under the benchmark (resp. unified) EPL scheme. Then

$$\left[\frac{(r+\chi)\,U_u^o + \frac{1+r}{1-\eta}}{(r+\chi)\,U_b^o + \frac{1+r}{1-\eta}}\right]^{\frac{1}{1-\eta}} - 1$$

gives the equivalent change in permanent consumption experienced by older workers.

Table 4. Distributional effects of introducing a unified EPL scheme

A. Present value and volatility of income

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-0.541	-13.70	-2.690	0.494	2.522	10.66
Std. deviation	-2.209	-43.43	-22.12	-7.629	3.073	59.36

B. Cross-sectional distribution

	Unemployed	Employed			
		0 to 2 years	2 to 5 years	5 to 10 years	More than 10 years
Net present value	1.213	1.172	0.741	0.422	-1.031
Std. deviation	-12.83	-9.724	-9.534	-6.744	1.003

C. Permanent income/consumption

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Young workers	1.195	0.619	1.010	1.126	1.347	1.676
Older workers	-0.782	-2.096	-1.392	-0.834	0.003	0.407

Notes: Panel A and B report the percentage change of the net present value of income, and of the standard deviation of income over the lifetime following the EPL reform. The numbers are based on simulated trajectories for young workers (see text for details). Panel C reports the change in permanent income (hence consumption) of young and older workers utility following the EPL reform. The numbers are based on the asset values computed in the steady-state allocation and the transition path. In Panels A and C, the first column reports the average change across the distribution, while the other columns report the average change within each quintile of the distribution of the variable under study. In Panel B, the first column reports the average change among unemployed workers, while the other columns report the average change within cells of the distribution of job tenure. All entries are expressed in percentage points.

Table 5. Joint distribution of the present value and the volatility of income

		Standard deviation of income				
		1st	2nd	3rd	4th	5th
Net present value of income	1st	7.319	4.496	2.192	1.400	4.591
	2nd	4.011	4.831	3.542	3.018	4.608
	3rd	2.477	3.157	5.087	5.640	3.648
	4th	2.58	3.509	5.098	5.857	2.945
	5th	3.609	4.000	4.083	4.089	4.217

Notes: The table reports the joint distribution of workers across the quintiles of changes in the net present value of income (across the rows of the table) and the quintiles of changes in the standard deviation of income (across the columns of the table). All entries are expressed in percentage points.

quintile. These very large numbers reflect the fact that workers in the most stable employment relationships in the benchmark equilibrium experience almost no volatility in their income. We analyse the extent of heterogeneity of these effects below in our discussion of Panel C.

To give a more precise account of the results, we break down the numbers by employment status and job tenure at the time of the EPL reform.[26] Panel B of Table 4 confirms that the benefits of a unified EPL scheme are concentrated on labour-market outsiders – unemployed workers and employed workers with little tenure on their current job –, who experience an increase in the net present value of lifetime income in addition to facing less income volatility. This is not surprising: in order to construct the unified EPL scheme, we maximised the steady-state lifetime utility of new labour-market entrants – hence paying attention to the trajectory of outsiders –, and the economy moves quickly along the transition path towards the equilibrium allocation that prevails at time t_1. Meanwhile, the correlation between the two outcome variables we focus on is far from being perfect. This can be seen by looking at their joint distribution presented in Table 5. While there is a positive correlation between the net present value of lifetime income and the standard deviation of income at the bottom of the two marginal distributions, the distribution appears somewhat close to uniform in the upper parts. This finding illustrates well the heterogeneity of situations that we highlighted previously.

In Panel C of Table 4, we calculate welfare changes in consumption equivalent units – again, bearing in mind that agents in the model do not have access to savings. The goal is to appreciate the extent of heterogeneity in the impact of the EPL reform. Among young workers, the average welfare gain by 1.2 percent masks substantial cross-sectional dispersion. In the bottom quintile, the average gain is 'only' 0.62 percent, which is three time lower than the gain experienced by the top quintile (1.7 percent). As per our analysis of Panel B, workers with a long tenure at their current job are more likely to be found in the bottom quintile, whereas labour-market outsiders tend to be concentrated in the top quintile of the treatment effects of the policy. We report the same outcomes calculated among older workers to give some perspective.[27] The vast majority of them (about two thirds) suffers from the policy change: the average loss is by 0.78 percent, and the loss incurred by the bottom quintile is 2.1 percent.

In sum, whether or not a worker gains from the EPL reform depends on the changes induced in the levels of the labour income received over her lifetime, and on the induced volatility of the income process. The correlation between these outcome variable is very dispersed, potentially leading to heterogeneous effects among workers. The source of this heterogeneity can be traced out to the dual EPL system, which makes employment situations highly uneven across workers.

5.3 Economics of the Results

We perform a number of variations on the actual implementation of the EPL reform and on the parameter values to gain additional insights into the economics of the results.

[26]Since wages increase with job tenure, one can think of the results as heterogeneous effects along the wage distribution. The reason we avoid references to wages is that the terminology 'low-wage workers', 'high-wage workers', etc. is usually related to *ex ante* worker heterogeneity. It would thus be misleading in the context of our model, which only features *ex post* heterogeneity across workers.

[27]Notice that the (expected) horizon underlying the calculation of permanent consumption units is 40 years for young workers and 10 years for older workers.

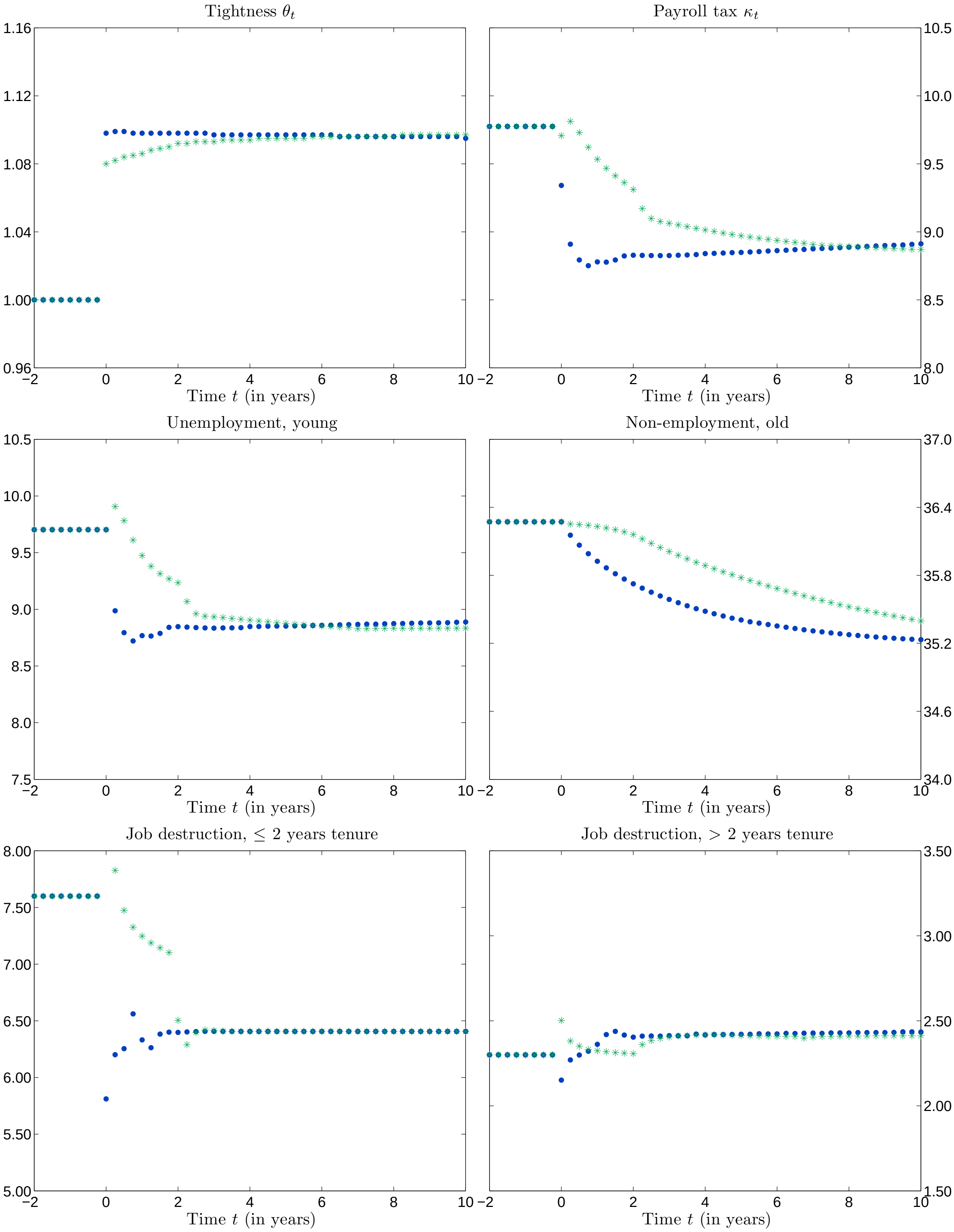

Figure 6. Transition dynamics: non-retroactive vs. *statu-quo* reforms

Notes: The charts display the time path of several labour market variables during the transition towards the unified EPL scheme. The stars (resp. circles) correspond to the *statu-quo* (resp. partially non-retroactive) reform. Except for labour market tightness θ, 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 unified EPL scheme, which occurs in period 0.

Implementing the Reform. Structural EPL reforms require fine-tuned rules for workers who are already employed at the time of reform. Our model can shed light on this issue. To illustrate this, we consider a scenario alternative to the partially non-retroactive reform analysed in the previous sections. We call this alternative scenario the *statu-quo* reform: it allows workers already employed at time t_0 to remain employed under the terms of the old EPL scheme. To change to the unified EPL scheme, they therefore have to dissolve their current employment relationship first and search for a new job (thus, only young workers have the option of eventually being employed under the terms of unified EPL). Unemployed workers who become matched to a firm at any date $t \geq t_0$ are subject to the new EPL scheme, as in the benchmark reform.

Figure 6 contrasts the transition dynamics of a *statu-quo* reform (marked with stars) with the benchmark partially non-retroactive reform (marked with the circles taken from Figure 5). The transition phase is slower after a *statu-quo* reform, and there are some detrimental effects in the short run. Foremost, many job-matches with a short tenure are destroyed immediately to take advantage of the unified EPL scheme. This is also the case, albeit to a lesser extent, for low-productivity job-matches held by workers with longer tenure. These effects explain the sluggish decline in non-employment rates among both young and older workers. As a result, the payroll tax rate falls more slowly under a *statu-quo* reform.

Turning to the distributional consequences of the reform, Table 6 illustrates interesting quantitative properties. A *statu-quo* reform limits the gains or losses that may be experienced by workers in the most stable employment relationships. This can be seen by the changes in the net present value of lifetime income and in income volatility measured in the bottom and top parts of the distribution: these are lower than the changes obtained under the benchmark reform (Panel A of Table 5). Of course, this complicates the comparison between the two reforms with respect to average numbers calculated across the whole distribution. If we consider welfare changes in permanent consumption units (Panel B of Table 6), we find that a *statu-quo* reform achieves a slightly higher gain for younger workers, mainly by reducing the heterogeneity of the impact: it avoids the welfare losses at long job tenure entailed by a partially non-retroactive reform. The results suggest that an appropriately designed implementation can go a long way towards limiting the losses entailed by EPL reforms.

The Rationales for EPL. In our model, EPL can be justified on the grounds that it helps workers increase consumption during unemployment, as their other means to achieve this are limited. To understand how this role shapes the results, we repeat the analysis using different targets for the generosity of UI benefits. We consider a replacement ratio for young workers of either 50 percent or 65 percent vs. 57.5 percent in the benchmark equilibrium (see Appendix C). We find, first of all, that a unified EPL scheme has a shorter (resp. longer) initial eligibility period when UI benefits are less (resp. more) generous. For instance, under less generous UI benefits, the minimum service tenure for eligibility is 2 months vs. 5 months in the benchmark equilibrium. Second, the unified EPL scheme has a flatter slope when UI benefits are lower (17 d.w.y.s. rather than 20 d.w.y.s.), and a steeper slope in the converse scenario (24 d.w.y.s.). These are slight differences, but nevertheless we believe they are informative. When UI benefits are less generous, workers benefit from gaining access to some minimum level of job protection earlier in

Table 6. Distributional effects under a *statu-quo* reform

A. Present value and volatility of income

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-0.366	-12.86	-1.585	0.835	2.269	9.515
Std. deviation	-1.148	-39.63	-16.92	-1.967	3.144	49.61

B. Permanent income/consumption

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Young workers	1.294	1.158	1.206	1.268	1.352	1.481
Older workers	0.210	0.153	0.194	0.223	0.237	0.243

Notes: Panel A reports the percentage change of the net present value of income, and of the standard deviation of income over the lifetime following the *statu-quo* EPL reform. The numbers are based on simulated trajectories for young workers (see text for details). Panel B reports the change in permanent income (hence consumption) of young and older workers utility following the EPL reform. The numbers are based on the asset values computed in the steady-state allocation and the transition path. In both panels, the first column reports the average change across the distribution, while the other columns report the average change within each quintile of the distribution of the variable under study. All entries are expressed in percentage points.

the employment relationship (lower τ_u). Should they become unemployed, what matters most is to return to employment rapidly. To achieve this, one needs to promote job creation by reducing the expected costs of firing a worker (lower ρ_u). This seems to line up well with the so-called "flexicurity" paradigm.

The model also rationalises the increase of the stringency of EPL with job tenure, as workers who have been employed longer are more likely to face deteriorated employment opportunities. We investigate the role of this mechanism by changing the expected duration of the older-age phase (during which workers do not receive job offers). Shortening the expected duration of the no-search period from 10 years to 5 years leads to a flatter slope of 12 d.w.y.s, while increasing it to 15 years leads to a steeper slope of 32 d.w.y.s. (Appendix C). The minimum service tenure required for eligibility is not much different across the two scenarios, as it changes from 7 to 9 months. These results confirm, firstly, that workers' valuation of EPL as a means to foster job security increases if employment opportunities near retirement deteriorate more rapidly. Second, when considering a much less generous unified EPL scheme (namely the EPL scheme under an older-age phase with an expected duration of 5 years), we find that the impact of the EPL reform has higher cross-sectional dispersion. In our view, these findings should motivate studying the sources of non-employment near retirement, which remain exogenous in the model. For instance, it seems likely that stronger EPL induces workers to invest in specific rather than general human capital, and as a result that it might exacerbate the employability problem of older workers who get laid off. Such mechanisms could be key to amplifying the heterogeneity of the impact of structural EPL reforms.

Other Robustness Checks. We conducted extensive sensitivity analysis with respect to the choice of parameters in the model. In Appendix C, we report results from two other robustness checks. First, we assume that exogenous separations (triggered by the shock δ described in Section 4) do not entitle workers to severance pay. In this scenario, the entry phase increases to 12 months, and, more importantly, the slope of the unified EPL scheme becomes 28 d.w.y.s. (vs. 20 d.w.y.s. in the benchmark equilibrium). The intuition is that it becomes less likely that severance pay helps workers increase consumption during unemployment. As a result, conditional on benefiting from EPL, the severance package should be more generous. Second, we consider the effects of adding red-tape costs by assuming that only half of the severance pay, $\phi(\tau)$, is rebated towards the worker (the other half of severance pay is sunk). We find that the minimum service for eligibility barely changes, and that the slope of the unified EPL scheme decreases only slightly to 16 d.w.y.s. This underscores the importance of the job security motive in the model, viz. deterring firms from firing workers too often by raising the stringency of EPL.

6 Conclusions

This paper provides a computationally tractable approach to study the allocational and distributional consequences of reforming employment protection legislation. We advance a model rationalising the properties of the unified EPL scheme that features prominently in European policy debates. First, risk-averse agents value a smooth consumption stream, and therefore they dislike the discontinuities in income flows coming from EPL gaps. Second, workers who have been employed longer are more likely to face deteriorated employment opportunities, meaning that the generosity of EPL should increase with job tenure. A unified EPL scheme meeting these requirements could replace the highly dual EPL systems that characterise segmented labour markets, which is the crux of our analysis. An important feature is that we can take account of the transition path between the two EPL systems, and thereby evaluate the consequences of a unified EPL scheme for workers who populate the dual labour market when the reform is introduced. Our framework is thus well suited to draw quantitative inference, and to provide figures that would inform real-life labour market policies.[28]

We focus on the Spanish labour market to illustrate our approach. We consider the unified EPL scheme that would be preferred by new labour-market entrants; from their perspective, the dual EPL scheme ruling in Spain (and in the benchmark equilibrium of our model) is undesirable, allowing us to consider a large shift in EPL systems in our main numerical experiments. We first show that, despite these large differences, the allocational changes propelled by the unified EPL scheme are quantitatively limited. The reason is that most adjustments go through a change in wages. Second and related, we find that the effects with respect to labour income display substantial heterogeneity. For instance, among workers who benefit from the policy change (young workers in our model), the average welfare gain in the top quintile is about three times

[28] An alternative consists in using our model to study the transition dynamics to an arbitrary fixed EPL scheme. For instance, one could ask how the labour market of country A would behave if it adopted the EPL system of country B. Similarly, the model can be used to analyse the transition dynamics between an old EPL scheme to a new scheme within a given country, as we do in Appendix B. Finally, another possibility is to investigate the effects of non-linear relations between the stringency of EPL and job tenure, as our model can accommodate non-linear severance pay schedules, $\phi(\tau)$. We focus on piecewise-linear functions which seems to be the empirically-relevant case (e.g., OECD [2004], Boeri et al. [2017]).

higher than that experienced by the lower quintile. This cross-sectional dispersion could be key to understanding resistance to structural EPL reforms.

The analysis presented in this paper can be extended to address a number of related issues. One interesting question is how to limit the uncertainty associated with workers' appeal to labour courts in order to obtain higher redundancy pay for unfair dismissals. For example, exploring the possibility of having a fast-track compensation, as in the recent Jobs Act in Italy, and its implications could be a fruitful line of future research (see Sestito and Viviano [2015]). Another question worth pursuing is whether existing EPL schemes can be rationalised as maximising some particular social welfare function, and/or how to design a socially-optimal unified EPL scheme. We only get a first grip on this issue, by focusing on a criterion based on the steady-state lifetime utility of agents who are prevented access to savings. We leave a fuller analysis for future work. Finally, our model can be used to delve into further political economy issues of reforming EPL in dual labour markets. Modelling political influence and lobbying by certain groups (e.g. labour unions) could help explain the observed inertia to reform the extant regulations, and shed new light on the interplay between insiders' and outsiders' preferences and actions.

A Model Appendix

This appendix contains four subsections. The first one is an appendix to Section 3 presenting the equilibrium stock-flow equations of the model. In Appendix A.2, we provide an algorithm to compute a steady-state equilibrium of the economy. Appendix A.3 contains the proof of Proposition 1. Finally, in Appendix A.4, we provide an algorithm to compute a transition path of the economy.

A.1 Stock-flow Equations

Using labour market tightness θ_t and job separation decisions $\overline{z}_t^i(\tau)$, we can write the set of stock-flow equations that governs the evolution of population distributions from one period to the next.

Firstly, new hires are given by:

$$\lambda_{t+1}^y(z_0, 0) = \theta_t q(\theta_t)(1-\gamma)\sum_\tau \mu_t^y(\tau) \tag{25}$$

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

$$\lambda_{t+1}^y(z', \tau') = \sum_z \mathbb{1}\left\{z' \geq \overline{z}_{t+1}^y(\tau')\right\}\pi_{z,z'}(1-\gamma)\lambda_t^y(z,\tau), \tag{26}$$

$$\lambda_{t+1}^o(z', \tau') = \sum_z \mathbb{1}\left\{z' \geq \overline{z}_{t+1}^o(\tau')\right\}\pi_{z,z'}\left(\gamma\lambda_{t+1}^y(z,\tau) + (1-\chi)\lambda_{t+1}^o(z,\tau)\right). \tag{27}$$

For the evolution of the non-employment pool, recall that new workers enter the economy in every period. With our stochastic life cycle, there are $\frac{\gamma}{\chi+\gamma}$ older workers in the workforce; a fraction χ of them leaves the economy every period, and the same number of individuals enters to keep the size of the workforce at a constant level. Therefore we have:

$$\mu_{t+1}^y(0) = \chi\frac{\gamma}{\chi+\gamma} + (1-\theta_t q(\theta_t))(1-\gamma)\mu_t^y(0) \tag{28}$$

and, for all $\tau' > 0$,

$$\mu_{t+1}^y(\tau') = (1-\theta_t q(\theta_t))(1-\gamma)\mu_t^y(\tau') + (1-\gamma)\sum_z \mathbb{1}\left\{z' < \overline{z}_{t+1}^y(\tau')\right\}\pi_{z,z'}\lambda_t^y(z,\tau). \tag{29}$$

Among older non-employed workers with tenure level τ' at the time of dismissal from the previous job, the law of motion is:

$$\mu_{t+1}^o(\tau') = \gamma\mu_t^y(\tau') + (1-\chi)\mu_t^o(\tau') + \sum_z \mathbb{1}\left\{z' < \overline{z}_{t+1}^o(\tau')\right\}\pi_{z,z'}\left(\gamma\lambda_t^y(z,\tau) + (1-\chi)\lambda_t^o(z,\tau)\right). \tag{30}$$

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

$$\sum_{\tau}\sum_{z}\left(\lambda_t^y\left(z,\tau\right)+\lambda_t^o\left(z,\tau\right)\right)+\sum_{\tau}\left(\mu_t^o\left(\tau\right)+\mu_t^y\left(\tau\right)\right)=1. \tag{31}$$

A.2 Computing Steady States

We omit the time subscript in this subsection to indicate that the economy is in steady state. Computing a steady state is not trivial because the continuation values in certain labour market states are unknown. Specifically, $U^y\left(\Delta,\tau\right)$, $W^y\left(z,T\right)$, $W^o\left(z,T\right)$, $J^y\left(z,T\right)$, $J^o\left(z,T\right)$, as well as $w^y\left(z,T\right)$, $w^o\left(z,T\right)$ are the solution to fixed-point problems. Our algorithm is as follows:

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

   (a) Set initial guesses $\widehat{W}^o\left(z,T\right)$, $\widehat{J}^o\left(z,T\right)$, $\widehat{w}^o\left(z,T\right)$, where we use $\widehat{\cdot}$ to indicate a guess.

   (b) Compute the reservation wage of the worker $\underline{w}^o\left(z,T\right)$ and that of the firm $\overline{w}^o\left(z,T\right)$ associated with $\widehat{W}^o\left(z,T\right)$ and $\widehat{J}^o\left(z,T\right)$ using equations (17) and (18).

   (c) If $\underline{w}^o\left(z,T\right)\leq\overline{w}^o\left(z,T\right)$, then solve for the wage w using the first-order condition of the generalised Nash product:

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

   and update $\widehat{w}^o\left(z,T\right)$ using this value (observe that $U^o\left(T\right)$ is completely determined, as per equation (6)). This is a non-linear equation that can be solved using the bisection method. If, on the other hand, $\overline{w}^o\left(z,T\right)<\underline{w}^o\left(z,T\right)$, set $\widehat{w}^o\left(z,T\right)=\frac{1}{2}\left(\overline{w}^o\left(z,T\right)+\underline{w}^o\left(z,T\right)\right)$.

   (d) Update $\widehat{W}^o\left(z,T\right)$, $\widehat{J}^o\left(z,T\right)$ using equations (9) and (11).

   (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 $W^o\left(z,\tau\right)$, $J^o\left(z,\tau\right)$, $w^o\left(z,\tau\right)$ recursively from $\tau=T$. That is:

   (a) Compute the reservation wage of the worker $\underline{w}^o\left(z,\tau\right)$ and that of the firm $\overline{w}^o\left(z,\tau\right)$ using equations (17) and (18). Notice that the continuation values only involve $\tau+1$, which allows to compute $\underline{w}^o\left(z,\tau\right)$ and $\overline{w}^o\left(z,\tau\right)$.

   (b) If $\underline{w}^o\left(z,\tau\right)\leq\overline{w}^o\left(z,\tau\right)$, then solve for the Nash-bargained wage using the first-order condition (14). The continuation values in this equation depend on $\tau+1$ only, and the outside option of the worker $U^o\left(\tau\right)$ is pre-determined.

   (c) Compute the value functions $W^o\left(z,\tau\right)$ and $J^o\left(z,\tau\right)$ from equations (9) and (11).

3. Solve for $U^y\left(\Delta,\tau\right)$, $W^y\left(z,\tau\right)$, $J^y\left(z,\tau\right)$, $w^y\left(z,\tau\right)$ using the following steps:

(a) Set an initial guess for $\widehat{U}^y(\Delta,\tau)$.

(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 analogue of step (1b) to obtain the reservation wage of the worker and the reservation wage of the firm.

   iii. Use the analogue of step (1c) to update the wage. Observe that $\widehat{U}^y(\Delta,T)$ 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 (8) and (10).

   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 $\widehat{U}^y(\Delta,\tau)$ is required to compute the Nash-bargained wage.

(d) Use the Bellman equation of a young unemployed worker to update $\widehat{U}^y(\Delta,\tau)$. If initial and updated guesses are close enough, then we are done. Otherwise, go back to step (3a) using the updated $\widehat{U}^y(\Delta,\tau)$.

The algorithm above builds on the observation that, in a steady state, the value functions $U^y(\Delta,\tau)$, $W^y(z,T)$, $W^o(z,T)$, $J^y(z,T)$ 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 (θ,κ) and the expected duration of a jobless spell Δ. Therefore, the algorithm above is nested into two outer loops to iterate on the tuple (θ,κ). First, we fix the payroll tax κ and iterate to solve for labour market tightness θ. At a given θ, the expected duration Δ is fixed and known since the economy is at a steady state (see equation (34) in Appendix A.3). Second, we solve for the time-invariant distribution, calculate the budget-clearing payroll tax and update κ accordingly.

Finally, notice that the severance pay function $\phi(\tau)$ is specified as a function of the average wage $\widetilde{w}$. Since this is an equilibrium object, we add an outer loop to iterate on $\widetilde{w}$.

A.3 Proof of Proposition 1

At date t_1, the economy is at a steady-state equilibrium. For *any* Δ, we can solve for $U^y_{t_1}(\tau,\Delta)$ in the steady-state counterpart of equation (5). This yields:

$$U^y_{t_1}(\tau,\Delta) = \frac{1}{r+\gamma\left(1-\theta_{t_1}q\left(\theta_{t_1}\right)\right)+\theta_{t_1}q\left(\theta_{t_1}\right)}\Big[(1+r)\,u(a^y(\Delta,\tau)+b^y) + (1-\gamma)\,W^y_{t_1}(z_0,0)+\gamma\widetilde{U}^o_{t_1}(\tau,\Delta)\Big]. \quad (32)$$

$\widetilde{U}^o_{t_1}(\tau,\Delta)$ is trivial to compute and $W^y_{t_1}(z_0,0)$ can be computed using the approach described in Appendix A.2. Next, using the sequence $\left(W^y_t(z_0,0)\right)_{t=t_0,\ldots,t_1}$ and combining equations (5) and (32) enables us to construct $\left(U^y_t(\Delta,\tau)\right)_{t=t_0,\ldots,t_1}$ backwards for any Δ. Notice that, on the other hand, $\widetilde{U}^o_t(\tau,\Delta)$ does not change over time, i.e. $\widetilde{U}^o_t(\tau,\Delta)=\widetilde{U}^o_{t_1}(\tau,\Delta)$ for all t.

Finally, to compute the outside option and the continuation values of employed workers, we need Δ_t and Δ_{t+1} (see, for instance, equation (16)). The expected duration of a jobless spell during the transition path satisfies the following dynamic equation:

$$\Delta_t = (1-\gamma)\left[\theta_t q(\theta_t) + (1-\theta_t q(\theta_t))(1+\Delta_{t+1})\right] + \frac{\gamma}{\chi}. \tag{33}$$

Thus, we can use the sequence $(\theta_t)_{t=t_0,\dots,t_1}$ to obtain $(\Delta_t)_{t=t_0,\dots,t_1}$: just like θ_t, Δ_t is a forward-looking variable. Notice that equation (33) yields the following relationship between Δ and θ when the economy is at a steady state:

$$\Delta = \frac{1-\gamma+\frac{\gamma}{\chi}}{\gamma(1-\theta q(\theta)) + \theta q(\theta)}. \tag{34}$$

A.4 Computing Transition Paths

The transition path eliminates the infinite horizon problem analysed in Appendix A.2 since all the continuation values depend on $t+1$. Another key observation is that, instead of keeping track of all the sequences of the transition path (cf. Definition 2), we require 'only' the following objects: the cross-sectional distribution of agents at t_0, the sequences $(W_t^y(z_0, 0))_{t=t_0,\dots,t_1}$, $(w_t^y(z,\tau,\epsilon),\ w_t^o(z,\tau,\epsilon))_{t=t_0,\dots,t_1}$, $(\overline{z}_t^y(\tau,\epsilon),\ \overline{z}_t^o(\tau,\epsilon))_{t=t_0,\dots,t_1}$ and $(\theta_t)_{t=t_0,\dots,t_1}$, as well as the time-path $(\kappa_t)_{t=t_0,\dots,t_1}$. In these notations, in line with Proposition 2, there is an additional state variable $\epsilon \in \{0,1\}$ indicating whether the worker-firm pair already exists when the reform is introduced ($\epsilon = 0$) or not ($\epsilon = 1$, which results in the ϕ_1 function in equation (22)).

Our methodology to construct the transition path is as follows:

1. Compute the equilibrium allocation of the economy in period t_1.
2. Guess a path for the payroll tax $(\widehat{\kappa}_t)_{t=t_0,\dots,t_1}$.
3. Solve for value functions, wages, separation decisions and labour market tightness backwards from t_1 until t_0 as follows:
   (a) Compute the severance pay function for workers in $\epsilon = 0$ using Proposition 2.
   (b) Compute labour market tightness consistent with free entry at time t, and store it.
   (c) Use Proposition 1 to compute $U_t^y(\Delta_t, \tau)$ and $U_{t+1}^y(\Delta_{t+1}, \tau)$. Notice that these require the sequences of Δ_t and $W_{t+1}^y(z_0, 0, 1)$ from t onwards, which we have at hand.
   (d) Solve for the wage functions of older and younger workers at time t, store them, and compute the associated value functions. Finally, compute the job separation decisions at time t and store them.
4. Set the initial distribution of agents to the cross-sectional distribution of agents at t_0.
5. Using $(\theta_t)_{t=t_0,\dots,t_1}$, $(w_t^y(z,\tau,\epsilon),\ w_t^o(z,\tau,\epsilon))_{t=t_0,\dots,t_1}$ and $(\overline{z}_t^y(\tau,\epsilon),\ \overline{z}_t^o(\tau,\epsilon))_{t=t_0,\dots,t_1}$ and the stock-flow equations described in Appendix A.1 (augmented to include the state variable ϵ), compute the evolution of the cross-sectional distribution from t_0 until t_1 . Each period, compute the budget-clearing value of the payroll tax κ_t to obtain $(\kappa_t)_{t=t_0,\dots,t_1}$.

6. If $(\widehat{\kappa}_t)_{t=t_0,\ldots,t_1}$ and $(\kappa_t)_{t=t_0,\ldots,t_1}$ 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 coincides with the t_1 payroll tax, we allow for a very large number of periods between t_0 and t_1. In our applications, we set the number of period to 1,000 (250 years). After 500 periods, the measure of workers who remain in state $\epsilon = 0$ is 0.0001.

B The 2012 EPL reform

In February 2012, Spain underwent an EPL reform (Decree Law 3/2012), whereby severance pay during the first two years of tenure was raised from 8 to 12 d.w.y.s. while severance pay for longer-tenured workers was lowered from 45 to 33 d.w.y.s. (with a cap of 24 months, lower than the previous cap of 42 months). Figure B1 depicts the post-2012 profiles of severance pay, in addition to the pre-2012 scheme characterising the benchmark equilibrium.

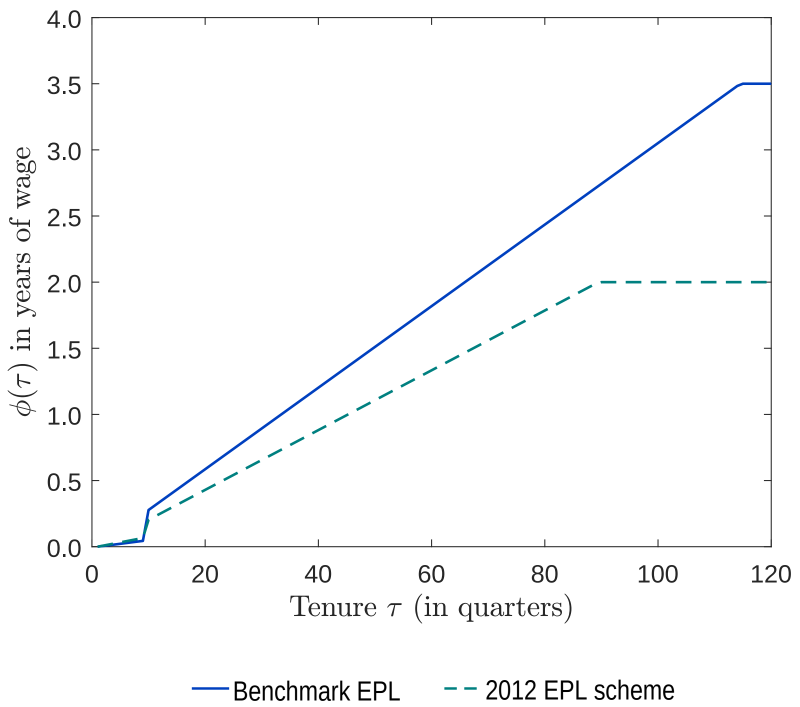

Figure B1. Severance payments: benchmark vs. 2012 EPL scheme

Notes: The solid line shows the severance pay function of the benchmark equilibrium. The dashed line shows the severance pay function reproducing the 2012 EPL scheme.

Through the lens of our model, it is worth studying the 2012 EPL scheme as an alternative to the unified scheme considered in Section 5. We follow a similar line of analysis. Firstly, in Table B1 we gauge long-run effects by studying steady-state allocations. Qualitatively, the 2012 reform changes labour market variables in ways similar to the unified EPL scheme: it lowers the job separation rate at short tenure, increases it at longer job tenures, and raises labour market tightness. From a quantitative standpoint, these changes are limited relative to those propelled by the unified EPL reform. This is intuitive because the unified EPL scheme seems to strike a balance between promoting job creation (reducing the costs of firing a worker at longer job

Table B1. Benchmark vs. 2012 EPL scheme: Steady-state comparison

Description	Benchmark	2012 EPL scheme
Unemployment rate, young *	9.70	9.34
Non-employment rate, old *	36.3	35.8
Non-employment rate, all *	16.3	15.9
Average wage, young	0.38	0.39
Average wage, old	0.36	0.33
Average productivity, young	0.47	0.47
Average productivity, old	0.53	0.52
Job destruction rate, $\leq$ 2 years of job tenure *	7.64	6.88
Job destruction rate, $>$ 2 years of job tenure *	2.30	2.35
Job finding rate *	40.0	40.4
Labour market tightness	1.00	1.02
Payroll tax *	9.76	9.44

Notes: The table reports statistics comparing the steady-state allocations of the benchmark equilibrium and of the equilibrium under the 2012 EPL scheme. Entries marked with an asterisk (*) are expressed in percentage points.

Table B2. Distributional effects of the 2012 EPL reform

	Average	Average in each quintile				
A. Present value and volatility of income						
		1st	2nd	3rd	4th	5th
Net present value	-0.902	-11.99	-1.852	0.191	1.225	7.908
Std. deviation	-1.782	-35.99	-15.12	-4.607	0.751	46.01
B. Permanent income/consumption						
	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Young workers	0.832	0.457	0.711	0.805	1.000	1.176
Older workers	-0.551	-1.275	-0.864	-0.668	-0.167	0.233

Notes: Panel A reports the percentage change of the net present value of income, and of the standard deviation of income over the lifetime following the 2012 EPL reform. The numbers are based on simulated trajectories for young workers (see text for details). Panel B reports the change in permanent income (hence consumption) of young and older workers utility following the EPL reform. The numbers are based on the asset values computed in the steady-state allocation and the transition path. In both panels, the first column reports the average change across the distribution, while the other columns report the average change within each quintile of the distribution of the variable under study. All entries are expressed in percentage points.

tenures) and fostering job stability even at short tenure. We then consider the distributional implications of the 2012 reform in Table B2. The policy change lowers the net present value of lifetime income as well as the standard deviation of income. The reduction in the net present value of lifetime income is larger than under the unified EPL scheme, while the opposite holds true for the average change in the standard deviation. Consequently, in what concerns changes in permanent consumption, the 2012 reform achieves lower welfare gains relative to the unified EPL scheme. Consider for instance the average change occurring when the reform is implemented. In the benchmark experiment, the gain amounts to 0.85 percent on average across young and older workers (the numbers in Table 4 are respectively at 1.19 and -0.78 percent). Under the 2012 reform, the corresponding number is 0.59 percent on average.

C Robustness Checks

Panel A of Table C1 reports the parameter values used in the alternative calibrations of the model discussed in Subsection 5.3. The alternatives considered 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) exogenous separations (viz. job separations triggered by the shock δ) do not entitle the worker to a severance payment; (4) red-tape costs waste half of the total severance package; (5) shortening the expected duration of the older-age phase (governed by γ) to 5 years; (6) increasing this duration to 15 years.

In the robustness checks analysed in Table C1, we also find that the criterion defining a unified EPL is concave with respect to τ_u and ρ_u. It seems that, with only two parameters, we reduce the likelihood of having local maxima in the objective function (U^y). Panel B of Table C1 displays the values for τ_u and ρ_u obtained in each calibration, and in Table C2, we report the distributional effects (the impact on the net present value of lifetime income and the standard deviation of income over the lifetime).

Table C1. Parameter values (one model period is one quarter), robustness checks

Description	Parameter	Benchmark	Robustness checks					
			(1)	(2)	(3)	(4)	(5)	(6)
A. Parameters matching data moments								
Vacancy cost	k	0.2201	0.2185	0.2234	0.2623	0.2246	0.2280	0.2356
Unemployment income	b^y	0.2203	0.1635	0.2803	0.2432	0.2370	0.2600	0.1948
Unemployment income	b^o	0.1617	0.1482	0.1753	0.1443	0.1862	0.2285	0.1336
Exogenous separation	δ	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Initial productivity	z_0	0.2800	0.2200	0.3400	0.2900	0.3100	0.3600	0.2400
S.d. of productivity draws	$\sigma_{\overline{z}}$	0.0440	0.0440	0.0440	0.0550	0.0440	0.0440	0.0440
B. Parameters of the EPL scheme								
Entry phase (in months)	τ_u	5	2	8	12	6	7	9
Tenure profile (in d.w.y.s.)	ρ_u	20	17	24	28	16	12	32

Notes: Panels A reports the parameter values used for the benchmark equilibrium and in sensitivity analyses (see text for details). Panel B reports the parameters of the unified EPL scheme obtained in each of the economies considered.

Table C2. Distributional effects of introducing a unified EPL scheme, robustness checks

A. Lower UI benefits

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-0.131	-12.17	-2.139	0.700	2.538	10.42
Std. deviation	-4.659	-40.83	-20.00	-7.078	-1.822	42.78

B. Higher UI benefits

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-1.043	-14.05	-2.628	0.371	2.167	8.933
Std. deviation	-1.943	-43.26	-21.62	-6.295	4.175	57.28

C. Quits vs. layoffs

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-0.757	-10.76	-1.139	0.517	1.676	5.922
Std. deviation	-0.585	-24.08	-7.889	-0.674	5.419	30.15

D. Red-tape costs

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-0.723	-14.39	-2.929	0.512	2.714	10.48
Std. deviation	-2.213	-45.47	-21.49	-6.172	3.615	58.55

E. Shorter older-age phase

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-1.575	-17.94	-4.528	0.223	2.819	11.55
Std. deviation	-13.11	-56.58	-36.50	-21.43	-3.143	52.12

F. Longer older-age phase

	Average	Average in each quintile				
		1st	2nd	3rd	4th	5th
Net present value	-0.492	-10.01	-1.218	0.430	1.573	6.764
Std. deviation	-0.859	-27.74	-9.623	-1.157	3.195	31.04

Notes: The table reports the percentage change of the net present value of income, and of the standard deviation of income over the lifetime following the EPL reform. In each panel the first column reports the average change across the distribution, while the other columns report the average change within each quintile of the distribution of the variable under study. The different panels correspond to different sets of parameter values: Panels A to F are based on the parameter values reported in the columns numbered respectively (1) to (6) in Table C1. All entries are expressed in percentage points.

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