TURBULENCE AND THE EMPLOYMENT EXPERIENCE OF OLDER WORKERS

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Turbulence and the Employment Experience of Older Workers∗

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Abstract

We provide a joint account of the unemployment and labor force participation patterns of older male workers during the past half-century, and of the role of institutions that have shaped their employment experience. To do so, we build an equilibrium model with labor market frictions, participation decisions and economic turbulence à la Ljungqvist and Sargent (1998). The model explains simultaneously: (i) the fall in labor force participation in the United States, (ii) the similar but more pronounced decline in Europe alongside rising unemployment rates and (iii) the concentration of these adverse employment outcomes on older workers. We show that early retirement benefits combined with stringent employment protection legislation raise tax pressure and discourage job creation in turbulent economic times, and hence that they may have exacerbated the deterioration of European labor markets.

Keywords: Job Search, Job Loss, Turbulence, European Unemployment, Labor Force Participation

JEL Codes: E24, J21, J64

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1 Introduction

The outbreak and persistence of high European unemployment since the 1970s compared with the dynamism of the US labor market have sparked a large body of research over the past decades. In his appraisal of this literature, Blanchard (2006) reached mixed conclusions as to the results so far obtained. On the positive side, there have been convergent findings pointing to the interaction between shocks and institutions as a key explanatory factor of divergent employment experiences across the Atlantic; this is often referred to as the “shocks-and-institutions” hypothesis, following Blanchard and Wolfers (2000). Meanwhile on the negative side, data accumulated over time have revealed a large heterogeneity of situations across workers and also across countries, hence raising concerns about the validity of omnibus explanations. Rogerson and Shimer (2011) echoed this diagnosis in their chapter of the Handbook of Labor Economics: lower employment in the aggregate originates from different margins – labor force participation, unemployment – depending on the demographic group considered and/or country under study. A proper account of transatlantic employment experiences is therefore challenging because it should be consistent with the role played by different margins of nonemployment and have the correct implications for the identities of the nonemployed.

In this paper, we add to this line of research by analyzing the secular employment experience of older workers on the two sides of the Atlantic. Our main contribution is to develop a life-cycle general equilibrium model with an operative labor supply margin. In contrast to models that lump all non-work activities together, this one has potential to account for changes in both labor force participation and unemployment, and measure their contribution to changes in employment. This allows for a novel evaluation of the shocks-and-institutions hypothesis: using a quantitative version of the model, we assess whether the hypothesis can explain the role of these two margins in deteriorating the employment levels of older workers. In a further step of the analysis, we employ the model to single out the effects of specific institutions (early retirement benefits, employment protection legislation) in shaping labor market outcomes late in the working life.

The key facts of interest for this paper are depicted on Figure 1. The focus in this picture is on older male workers, which allows to identify interesting patterns both in the United States and Europe: (i) labor force participation of older male workers has fallen over the past decades in the US, (ii) a more pronounced decline accompanied by rising unemployment rates occurred in European countries and (iii) unemployment and participation played a different role across countries in increasing nonemployment rates. Thus, male employment experience displays significant variations as to the importance of different nonemployment margins. Lower European employment rates among male workers, moreover, are highly concentrated on those aged 55 to 64 (see Section 2). The example of male workers is therefore also relevant to ask whether aggregate outcomes are correctly explained by the specific experience of different demographic groups. Finally, with the ageing of the baby-boom

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1 A complement to this explanation is that some institutions have evolved in response to shocks in ways that sometimes aggravated the initial effects; see e.g. Nickell et al. (2005). We discuss the latter momentarily.

2 Figure 1 reports the Hodrick-Prescott trend component instead of the raw time-series to highlight long-run changes. The graphs focus on the United States and the three largest countries in continental Europe: France, Germany and Italy. Appendix A.2 contains the corresponding figures for a larger set of European countries. In particular, a look at older workers in Spain (the 4th largest country in continental Europe) reveals qualitatively similar patterns. Spain was not included because its labor market is known to be somewhat of an extreme case.
Figure 1. Unemployment and labor force participation among older male workers

Note: Annual data from the OECD labour force statistics database (see Appendix A). HP trend component with a value of the smoothing parameter equal to 100. Figure are for male workers. Older workers are workers aged 55 to 64.

coHORTS, older workers account for an increasingly large share of the population. This provides one further motivation for understanding employment experiences towards the end of the life-cycle, as well as their effects on the aggregate labor market.

To understand the trends shown in Figure 1, we draw on Ljungqvist and Sargent (1998, 2008)’s formulation of the shocks-and-institutions hypothesis. In these and other contributions, Ljungqvist and Sargent have developed a quantitative apparatus that relates the level of economic turbulence faced by individual workers to the aggregate performance of labor markets characterized by different employment protection and social insurance schemes. Their turbulence story has proved successful in explaining the deterioration of European employment levels alongside the relatively steady performance of the US labor market. It is hence a natural candidate for a model aimed at studying this dynamic and its underlying components.

Since Ljungqvist and Sargent’s framework features only two labor market states – employment and nonemployment –, we nest their turbulence story into an environment with three distinct states. In the proposed model, idiosyncratic shocks to the utility of leisure create a meaningful distinction between nonparticipation and unemployment. The result is a rich model where labor force participation depends on several individual characteristics such as age, human capital and access to social insurance benefits. The addition of frictions à la Mortensen and Pissarides (1994) introduces a general equilibrium dimension that further allows to study the spillovers of participation decisions onto job creation and job destruction, and how this affects aggregate labor market outcomes.

The calibrated model attributes cross-country differentials in participation and unemployment in the pre-1970s period to differences in labor market policies. As in Ljungqvist and Sargent (2008), tougher employment protection explains the lower unemployment rates that used to prevail in Europe. Towards the end of the life-cycle, more generous social insurance schemes provide incentives for workers to retire earlier, consistent with differences in participation rates among older male workers on the two sides of the Atlantic, and also across European economies in Figure 1.

An increase in the level of economic turbulence – which materializes through a higher rate of skill obsolescence – produces outcomes that mirror the trends displayed in Figure 1.\textsuperscript{4,5} Low levels of welfare benefits explain why the US avoided high unemployment rates. Proximity to retirement further accounts for the fall in labor force participation among older workers with depleted skills in this country. In Europe on the other hand, generous social insurance benefits and high separation costs made workers whose skills have depreciated less employable. This triggered the high unemployment rates in Figure 1, as well as the more pronounced decline in labor force participation: lower prospects of regaining access to jobs strengthened the effects of proximity to retirement (the so-called “horizon effect”; see e.g. Chéron et al., 2011, 2013). Thus, the first of our results is that the shocks-and-institutions hypothesis can explain the contribution of participation and unemployment to the secular employment experience of older workers.

This first result motivates another set of numerical experiments. Specifically, we study the labor market effects of early retirement benefits in economies with different degrees of economic turbulence and different levels of employment protection. Consistent with evidence documented in reports by the OECD (Blöndal and Scarpetta, 1997; Duval, 2003), early retirement benefits in the model provide significant incentives to retire earlier. We find that this discourages job creation due to increased tax pressure and that the effect becomes more potent in a turbulent economic environment. Stringent employment protection legislation amplifies these negative employment effects. By making separation costlier, it induces employers to be more selective at the entry level for workers who have not yet reached the early retirement age. These workers stay unemployed longer and drop from the workforce when they become eligible to early retirement schemes. Thus, the second main result is that

\textsuperscript{4}In Ljungqvist and Sargent’s language as in the present paper, “economic turbulence” refers to a change in the rate of skill loss. Turbulence is regarded as the microeconomic counterpart of changes in the macro-environment, such as restructuring from manufacturing to the service industry or new information technologies.

\textsuperscript{5}Evidence of more turbulent economic times relative to the 1960s and 1970s come from various sources. Kambourov and Manovskii (2008) document that the fraction of workers switching occupations rose substantially in the US between the late 1960s and the 1990s. Gottschalk et al. (1994) report that uncertainty as measured by earnings volatility at the individual level and/or at the household level increased between the 1970s and 1980s. In Section 5 of the paper, we show that the model can speak to this feature of the data.
early retirement benefits can raise the potential for a high-taxes/high-unemployment/low-participation equilibrium, especially in countries with stricter employment protection legislation.

Our second finding offers an interesting complement to the shocks-and-institutions hypothesis. The latter posits an interaction between economic shocks of increasing magnitude and time-invariant labor market institutions. However, the period under study witnessed significant increases in the levels of early retirement benefits in several European countries, partly in response to persistently high levels of unemployment (see Gruber and Wise, 2010). Our model contends that these policy changes may well have exacerbated the adverse consequences of the interaction between shocks and European institutions. This is consistent with Nickell et al. (2005)’s conclusion that the evolution of some labor market institutions have contributed to the deterioration of European outcomes.

Before discussing the related literature, we comment on those demographic groups that are left out of the analysis: younger workers and women. To begin with, the secular decline in labor force participation among younger workers is largely related to the expansion of higher education, which is not under the scope of this paper. Meanwhile, we discuss in Appendix B the assumptions that would allow the model to explain lower participation rates among younger workers. As for female workers, the stark contrast between theirs and male employment experiences suggests that these are worthy of separate analyses. That is, while labor force participation has unambiguously deteriorated among older male workers, the picture is different for female workers as they have increased their involvement in the labor market over the period considered. The latter would deserve a study in its own right, potentially including the pull factors that drew women into the workforce.

As noted in the opening paragraph, explaining transatlantic differences in employment experiences is the goal of an already vast literature. This body of research is limited in its account of nonemployment because it operates within models of the labor market that only have two states. Nonparticipation and unemployment have nevertheless long been recognized as “behaviorally distinct labor force states” (Flinn and Heckman, 1983). Labor force surveys typically distinguish at least three labor market states, and nonemployment in these surveys spans a variety of situations ranging from the willingness not to work to intense job search activity (see e.g. Jones and Riddell, 1999). Thus, this paper is the first, to our knowledge, to confront the shocks-and-institutions hypothesis to a joint account of changes in labor force participation and unemployment.

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6 See, in particular, Section 1 in the chapter by Salem et al. (2010): the authors provide a case study of the French labor market and present the debates and policies that relate to labor force participation among older workers. In the same context, Behaghel et al. (2014) show that disability insurance schemes are relevant too for explaining the patterns depicted in Figure 1. We abstract from this retirement route as the effects of health shocks are not the focus of this paper.

7 Nickell et al. (2005) report that the replacement ratio of unemployment benefits and labor taxes both increased in most OECD countries between the 1960s and the 1980s. We actually find an important role of the tax burden in the numerical experiments carried out in Subsection 5.3.

8 See e.g. the series of reports titled “Education at a Glance” published by the OECD (for example OECD, 2007). In the online file, we provide several figures to characterize long-run changes in the labor market outcomes of women in the US and in Europe. Accounting for female employment experience would complicate the analysis along a number of dimensions. For instance, cross-country differences in female employment are likely to reflect cultural differences in gender roles, family arrangements, etc. Also, the example of female employment begs for an explanation of differences in hours worked, which cannot be addressed directly in the context of the model developed in Section 3.

9 A non-exhaustive list of prominent papers on this topic includes Bertola and Ichino (1995), Marimon and Zilibotti (1999), Mortensen and Pissarides (1999), den Haan et al. (2005), Hornstein et al. (2007) and the contributions by Ljungqvist and Sargent listed in this Introduction.
Heterogeneity of labor market situations among workers at different stages of their life-cycle has often been emphasized in empirical contributions to the literature on transatlantic employment experiences (see e.g. Cohen et al., 1997; Blanchard, 2006). Meanwhile, relatively few papers have attempted to account for this feature of the data by means of a quantitative model. Ljungqvist and Sargent (2008), Kitao et al. (2009) and Chéron et al. (2009) are the only papers where a model with a life-cycle structure is developed for this purpose. Our second contribution is to add to this line of research using a model where the life-cycle structure interacts with a labor supply decision. The difference is important not only from an empirical perspective, but also for labor market policy analysis. Indeed, some programs – such as subsidized early retirement benefits – have an explicit age-dependent component and are designed with the intent of altering labor force participation decisions.

Finally, this paper adds to a growing body of research outside of the shocks-and-institutions literature, which emphasizes the importance of distinguishing nonparticipation from unemployment in the modeling of frictional labor markets. This includes Garibaldi and Wasmer (2005), Pries and Røger-son (2009), Krusell et al. (2011, 2012) and Mankart and Oikonomou (2013). Due to its focus on the interaction between skill obsolescence and labor market policies over the life-cycle, the model developed here has several layers of heterogeneity. Therefore it has a richer set of implications as to the participation decisions of workers with different observable characteristics.

The rest of the paper unfolds as follows. Section 2 summarizes the empirical facts of interest for the paper. Section 3 presents the model economy used to interpret these facts. In Section 4 we calibrate the model and characterize some of its outcomes in tranquil economic times. The main results are contained in Section 5: we use the calibrated model to analyze the implications of a turbulent economic environment and the effects of early retirement benefits. Section 6 concludes.

2 Some facts

This section briefly reviews the empirical facts of interest for the paper. Most of these have been extensively discussed elsewhere in the literature, and thus this section is kept to a minimum. Appendix A contains additional figures and details to complement this section.

2.1 Employment experiences in the aggregate

The quantitative models developed in the shocks-and-institutions literature typically aim at relating three stylized facts about transatlantic employment experiences, all described in the classic studies of European unemployment by Blanchard (2006) and Layard et al. (2005). Fact no. 1: unemployment was persistently lower in Europe than in the United States before the late 1970s and became persistently higher from that period onwards. Unemployment in Europe rose from an average of 2% in the 1960s to an average of more than 8% in the 1980s. Fact no. 2: the increase was accompanied by a rise in the duration of unemployment in Europe. For instance, long-term unemployment (more than a year) as a percentage of total unemployment rose from less than 30% in 1979 to more than 50% in ten years in several countries of the European Community. Fact no. 3: there are important differences across the Atlantic in those institutional features that (are presumed to) interact with unemployment.
Both before and after the 1970s, European labor markets were characterized by stronger employment protection and more generous social insurance schemes.

The longer duration of unemployment spells (Fact no. 2) reflects a decline in unemployment-to-employment transitions, but a look at employment-to-unemployment transitions is further needed to understand the outbreak of high unemployment rates. Time-series that would span a long period of time for these flows are rare, partly due to limitations in the design of European labor force surveys. An early investigation by Bean (1994) suggested that employment-to-unemployment flows had remained stable across periods. Recently, Elsby et al. (2013) confirmed this finding by means of a new methodology. Their study provides some figures that will inform the calibration in Section 4: they find that the monthly transition probability from employment into unemployment is about half lower in several European countries relative to the United States, where it averages 2% (in line with previous estimates for this country). The model developed in the next section will attribute these differences to the levels of employment protection that prevail in Europe.

2.2 The employment experience of older workers

The shift towards high unemployment in Europe was pervasive across individuals belonging to different demographic groups. Centering the analysis on male workers aged 55 to 64, Figure 1 confirms that high unemployment rates became common as of the late 1970s. Fact no. 2 also holds true for them: for instance Machin and Manning (1999) report that the composition of unemployment among older workers is skewed towards spells with long durations in most European countries.

Less well-documented is the deterioration of labor market outcomes amongst older workers with respect to the other nonemployment margin, namely labor force participation. As pictured in the lower graph in Figure 1, the downward trend started before the 1970s and was common to the two sides of the Atlantic. In Europe, the trend ended as aggregate unemployment reached a plateau in the mid-1990s; in the US the trend came to an end a decade earlier. The joint dynamics of the nonemployment margins in Figure 1 is a key fact of interest for this paper.

Is the decline in labor force participation specific to older (male) workers? Figures reported in Appendix A.1 show that there is a clear “no” answer to this question: labor force participation has been falling in most age groups of male workers, with larger declines for younger and older workers. As emphasized in the introduction, the analysis does not seek to explain the reduction in labor force participation among younger and prime-age workers. As for younger workers, this feature of the data is likely explained by factors which we abstract from, such as the secular increase in educational attainment. On the other hand the reduction of labor force participation among prime-age workers was more modest, and the numerical experiments in Section 5 actually produce a similar outcome. We highlight in the discussion (Subsections 5.2 and 5.3) that this is a by-product of the analysis rather than an outcome targeted by the experiments.

One can further show that: (i) poor employment performances in the aggregate tend to be concen-

\footnote{This pattern holds true for France and Germany but is less apparent for Italy. It holds true for the larger set of European countries described in Appendix A.2. A caveat with the filtered time-series used in Figure 1 is that it makes the decadal difference between Europe and the US less visible.}
Figure 2. Male employment in the aggregate and relative employment rate of different age groups
NOTE: Annual data from the OECD labour force statistics database (see Appendix A). Employment rate of a specific age group divided by the aggregate (male) employment rate. Circles are for workers aged 15-24; Squares are for workers aged 25-54; Diamonds are for workers aged 55-64. All figures are for male workers.

To begin with, Figure 2 reports the respective employment rates of younger, prime-age and older workers as a ratio of aggregate male employment in France, Germany, Italy and in the US. The x-axis on the graphs is aggregate male employment (i.e. the denominator of the ratio). The graphs illustrate two main facts. First, lower employment levels are concentrated on workers at the two ends of the life-cycle; this pattern holds true across periods and in the four countries under study. Second, differences in the employment rates of younger and older workers account for the bulk of the employment gap between Europe and the US. What is actually remarkable is that, even in times of lower aggregate employment, European countries maintain employment levels among prime-age workers that are similar to the US ones.\(^{12}\) A third pattern is also apparent in Figure 2: lower employment is more

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12 This feature of the data is thoroughly documented in Blundell et al. (2013): they report the age-by-age life-cycle profile of employment for the US, the UK and France in 1977 and 2007. Their graphs demonstrate that the (male)
Table 1. Contributions of unemployment and participation to changes in male employment

<table>
<thead>
<tr>
<th>Countries</th>
<th>Prime-age workers</th>
<th>Older workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>log (1 - u_{a,t})</td>
<td>log (p_{a,t})</td>
</tr>
<tr>
<td>France</td>
<td>73.6</td>
<td>26.4</td>
</tr>
<tr>
<td>Germany</td>
<td>66.6</td>
<td>33.4</td>
</tr>
<tr>
<td>Italy</td>
<td>33.4</td>
<td>66.6</td>
</tr>
<tr>
<td>Norway</td>
<td>48.8</td>
<td>51.2</td>
</tr>
<tr>
<td>Portugal</td>
<td>62.3</td>
<td>37.7</td>
</tr>
<tr>
<td>Spain</td>
<td>82.4</td>
<td>17.6</td>
</tr>
<tr>
<td>Sweden</td>
<td>59.4</td>
<td>40.6</td>
</tr>
<tr>
<td>United-States</td>
<td>40.7</td>
<td>59.3</td>
</tr>
</tbody>
</table>

NOTE: Own calculations based on data from the OECD labour force statistics database (see Appendix A). For each age group, the first (resp. second) column reports the percentage of the variance of log \((e_{a,t})\) explained by the covariance between log \((e_{a,t})\) and log \((1 - u_{a,t})\) (resp. explained by the covariance between log \((e_{a,t})\) and log \((p_{a,t})\)). “Prime-age workers” refers to workers aged 25 to 54; “Older workers” refers to workers aged 55 to 64. The underlying time-series for Norway, Portugal and Spain span a shorter period of time. All figures are for male workers.

concentrated on older workers in France and in Germany. This does not hold for Italy.\(^{13,14}\)

We can measure the contribution of participation and unemployment to the employment rates of Figure 2 as follows. Let \(e_{a,t}, u_{a,t}\) and \(p_{a,t}\) be the employment, unemployment and participation rates, respectively, for age group \(a\) in year \(t\); those are related by the identity \(e_{a,t} = (1 - u_{a,t}) p_{a,t}\). Taking logs, the variance of log \((e_{a,t})\) is the sum of: the covariance between log \((e_{a,t})\) and log \((1 - u_{a,t})\) (resp. explained by the covariance between log \((e_{a,t})\) and log \((p_{a,t})\)). Thus, the variance of log-employment can be decomposed into its two components to measure the quantitative significance of each nonparticipation margin. Table 1 reports the results of this decomposition exercise for the four countries of Figure 2 and also for Norway, Portugal, Spain and Sweden.

The findings from Table 1 are readily summarized. For all countries in the table, changes in the employment rate of older workers are predominantly driven by changes in labor force participation: the variance in log-employment originates almost entirely from the covariance between log-employment and log-participation. On the other hand, the explanatory power of unemployment with respect to the employment rate of these workers is very limited (except for Sweden, the ratio in the left column is never higher than 25 percent). Conversely, the participation margin plays a more marginal role in explaining the employment rates of prime-age workers.

To summarize, (i) weaker employment performances for male workers are highly concentrated on those aged 55 to 64 and (ii) the participation margin is highly significant to the explanation of their employment experience. In Appendix A.3, we further show that changes in participation among older

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\(^{13}\)In this respect, Italy is more similar to Portugal and Spain where lower employment in the aggregate originates disproportionately from lower employment rates among younger workers (see Appendix A.2).

\(^{14}\)The three facts just described are for male workers. The online file shows a much different picture for women. First, the age distribution of female employment is distinct from that of male employment. Second, it is less clear-cut how the respective employment rates of younger and older female workers respond to changes in aggregate employment.
workers have contributed to a decline in aggregate male employment by 2 to 5 percentage points, depending on the country considered. Over the same period, changes in their unemployment rates have had a relatively small effect.

3 The model

This section presents the model economy which we use to analyze the joint dynamics of participation and unemployment. The model is an extension of Ljungqvist and Sargent (2008): (i) we augment it with an operative labor supply margin and (ii) cast it within the standard search-matching framework with endogenous job destruction (Mortensen and Pissarides, 1994).

3.1 Economic environment

Individuals

One side of the market is populated by a continuum of workers, each of whom belongs to a given age class $a \in \{1, \cdots, A\}$. Workers age stochastically and the transition probability from age class $a$ to age class $a'$ is denoted by $\alpha(a,a')$. Ageing occurs sequentially: $\alpha(a,a') = 0$ if $a' \neq a + 1$ and workers survive until retirement: $\alpha(a,a) + \alpha(a,a + 1) = 1$ for all $a \in \{1, \cdots, A - 1\}$. Generations overlap and entries equal exits so that the measure of the labor force remains constant and is set to unity. Thus, at each point in time the mass of workers entering the labor force is equal to the fraction $1 - \alpha(A,A)$ of the mass of workers in age class $A$ who retire.

Workers have their momentary utility function defined over consumption and leisure. Consumption $c_t$ equals disposable income in period $t$. Leisure $n_t$ is an indicator that takes the value of one if the individual chooses not to participate in the labor force in period $t$ and is zero otherwise. Workers are endowed with a time-varying utility of leisure $z_t$ which they enjoy when out of the labor force. This feature of preferences is introduced in order to explain participation decisions.\footnote{In Appendix B.2, we discuss the relationship between this time-varying utility component and entry costs to the labor market that one could introduce as an alternative modeling device.}

Denoting by $\beta$ the subjective discount factor, workers maximize

$$E_0 \sum_{t=0}^{+\infty} \beta^t (c_t + z_t n_t)$$ (1)

$E_0$ denotes mathematical expectation conditional on information at time 0. $z_t$ is idiosyncratic to the worker, is allowed to depend on age $a$ (i.e. $z_t \equiv z_t(a_t)$) and evolves according to a first-order Markov process. $F(z'|z)$ denotes the transition function for $z$, i.e. $F(z'|z) = \Pr\{z_{t+1} < z'| z_t = z\}$.

On the other side of the market, there is a continuum of infinitely-lived employers who maximize

$$E_0 \sum_{t=0}^{+\infty} \beta^t (c_t - \eta v_t)$$ (2)
\(v_t\) denotes vacancies and \(\eta\) is the unit cost of an unfilled job. At any point in time, an employer has either a filled job or a vacant position, in which case she/he looks for a potential employee.

**Search-matching frictions**

Workers can be in one of three mutually exclusive labor market states: nonparticipation, unemployment and employment. They cannot search for jobs while out of the labor force or when they are employed. When unemployed, workers meet employers stochastically: a constant returns-to-scale matching function determines the probability that a randomly chosen job-seeker meets a randomly chosen employer. The number of contacts per period is given by

\[
m(u_t, v_t) = M u_t^{\kappa} v_t^{1-\kappa}
\]

where \(u_t\) is the number of unemployed and \(v_t\) is the number of vacancies. Letting \(\theta_t \equiv v_t/u_t\) denote labor market tightness, the job-finding probability for a worker is \(f(\theta_t) = M \theta_t^{1-\kappa}\) and the job-filling probability for an employer is \(f(\theta_t)/\theta_t = M \theta_t^{-\kappa}\).

**Production**

The unit of production is a matched worker-entrepreneur pair. Each pair produces a flow quantity \(y\) and is subjected to various idiosyncratic shocks. First of all, a match is destroyed if the worker is hit by the retirement shock (that is, the worker is in age group \(A\) and retires exogenously with probability \(1 - \alpha(A, A)\)). Second, a match is destroyed exogenously with per-period probability \(\lambda\); we explain the interpretation of this shock momentarily. Finally, when none of these events occur, the productivity of the match evolves according to a first-order autoregressive process:

\[
y_{t+1} = (1 - \rho) \bar{y}_h + \rho y_t + \epsilon_{t+1}
\]

\(\rho \in (0, 1)\) is the persistence of the process, \(\epsilon \sim N(0, \sigma^2_\epsilon)\) is the innovation and \(h \in \{0, H\}\) is the skill level of the worker (details follow). It is assumed that \(\bar{y}_0 < \bar{y}_H\): productivity of matches with workers of higher skill levels is higher on average. Hereafter \(G_h(y'|y)\) denotes the transition function for \(y\) when the skill level of the worker is \(h\), i.e. \(G_h(y'|y) = \Pr\{y_{t+1} < y'|y_t = y, h_t = h\}\).

The timing of employment relationships is as follows. Upon meeting, an employer and a worker with human capital \(h\) draw a productivity \(y\) from a distribution \(G_h^0(y') = G_h(y'|\bar{y}_h)\). They decide whether to start producing or to walk away. In the latter event, they are returned to the pool of unmatched agents. If they choose to stay together, \(y_t\) evolves according to the sequence of events just described. Production stops when either one of the following occurs: the match is hit by an exogenous shock (retirement in age group \(A\) or the \(\lambda\) shock) or the two parties endogenously dissolve the match. Note that both the \(\lambda\) shock and endogenous destruction can be followed by a transition into nonparticipation.

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\(\bar{G}_h^0(y') = G_h(y'|\bar{y}_h), \bar{G}_h^0(y)\) dominates \(G_h^0(y)\) in a first-order stochastic sense. Individual skill dynamics is thus similar to the dynamics proposed by den Haan et al. (2005): matching with more experienced workers yields a higher average initial draw for productivity.
Skill dynamics

Each individual worker is endowed with a certain amount of skills denoted by $h$, which takes on two values: low (0) and high ($H$). Initially, a worker is endowed with the lowest skill level. Thereafter, his human capital evolves according to his own idiosyncratic labor market trajectory. This is captured by three first-order Markov processes, with $\mu^e(h,h')$, $\mu^o(h,h')$ and $\mu^\ell(h,h')$ denoting the transition probability from $h$ to $h'$ for a worker who retains his job ($e$ for employment), for a worker without a job ($o$ for out-of-work) and for an exogenously displaced worker ($\ell$ for laid off), respectively. The latter are identified to those workers who are separated from their job by the $\lambda$ shock.\footnote{In an earlier version of this paper, we were considering a grid with many more points for $h$. It turns out that the results are qualitatively similar when we allow for only two skill levels. The results are also similar quantitatively if we allow for full depreciation of human capital in the version of the model with many levels of $h$. We reverted to the two skill version of the model since it reduces the computational burden significantly. This makes it possible to carry out more precise numerical experiments in Section 5.}

Accumulation of human capital occurs gradually in employment and depreciation takes place when the worker is out of employment. The specification of the two Markov processes governing transition in skill levels conditional on not being laid-off thus boils down to two probabilities $\mu^e$ and $\mu^o$. That is (with some abuse of notation):

$$
\mu^e(h,h') \sim \begin{bmatrix} 1 - \mu^e & \mu^e \\ 0 & 1 \end{bmatrix}
$$

$$
\mu^o(h,h') \sim \begin{bmatrix} 1 & 0 \\ \mu^o & 1 - \mu^o \end{bmatrix}
$$

The third Markov process, $\mu^\ell(h,h')$, is meant to capture the notion of economic turbulence. We shall adopt a specification similar to (5b) for $\mu^\ell(h,h')$ to parametrize the risk of losing accumulated skills. As in Ljungqvist and Sargent (1998), we let laid-off workers retain their human capital under tranquil economic times: that is, $\mu^\ell(H,H) = 1$. On the other hand, in turbulent times we allow for $\mu^\ell(H,H) < 1$ (see Subsection 5.1).

Government-mandated programs

Anticipating on the comparison of labor market performance on the two sides of the Atlantic, employment protection and social insurance schemes are introduced alongside the other defining features of the environment. An economy with these features is referred to as a Welfare state (WS hereafter) economy, as opposed to a Laissez-faire (LF hereafter) economy.

Employment protection is modeled as a lump-sum tax $\Omega$ on job destruction paid by the employer.\footnote{Critically, we let quitters retain their human capital level in the period when they leave the job. This assumption relates to the debate between Ljungqvist and Sargent (2004) and den Haan et al. (2005). The latter assume that voluntary quitters also suffer skill obsolescence, so that times of economic turbulence deter workers from leaving their job. This results in lower inflows into unemployment and a negative relationship between turbulence and the unemployment rate. We instead adopt the interpretation of turbulence put forward by Ljungqvist and Sargent (2008), which draws on the association between skill loss and disruptive labor market experiences (exogenous separations). Their formulation has proved robust to a variety of modeling environments (see e.g. Ljungqvist and Sargent, 2007).}
It is assumed that the government does not observe whether a destruction occurs for exogenous or endogenous reasons, and therefore the tax is enforced for both types of separations.\textsuperscript{19} It is also assumed that the proceeds of the tax are not rebated towards workers after job separation: as is well known since Lazear (1990)’s seminal study of job-security provisions, such transfers would be undone by efficient employer-employee bargains. The preferred interpretation of $\Omega$ is that it encompasses those costs of barriers to exit and regulations that deter job destruction in Europe. Accordingly, $\Omega$ is modeled as a deadweight loss for the economy.

Social insurance schemes are meant to include various safety nets such as unemployment compensation and subsidized early retirement benefits. For brevity, the exposition in the rest of this section focuses on the former only: a worker with skill level $h$ who becomes unemployed collects the benefit payment $b(h)$.\textsuperscript{20} In the calibrated model, individuals out of the labor force will be allowed to collect part of the benefit they would receive if unemployed (see Sections 4 and 5). The payment $b(h)$ is calculated as a replacement ratio $\gamma$ times $\bar{y}_h$, the mean productivity of matches for workers with skill level $h$. Thus, $\gamma$ summarizes the generosity of the social insurance system. This system is financed through a flat-rate tax $\tau$ raised on the product of active matches.

**Two-tier labor market**

In the WS economy, employment protection and social insurance schemes give rise to a two-tier labor market structure for two reasons. First, there is a nondegenerate match formation decision: if the employer does not hire the worker after observing the initial productivity level drawn from $G_0$, the tax $\Omega$ is waived (no job was created). Second, upon meeting an employer, an unemployed worker may be collecting benefits payments $b$ that will differ from the payments to which she will be entitled after starting the new job. For these two reasons, the match formation stage ($i = 0$) needs to be distinguished from subsequent continuation stages ($i = +$).

### 3.2 Bellman equations

A system of autonomous Bellman equations describes the behavior of workers and employers who populate the economy.\textsuperscript{21} Making use of the index $i \in \{0, +\}$ and denoting by $v^n$, $v^u$ and $v^e$ the value of being in nonparticipation, unemployment and employment, respectively, and by $v^o(.) \equiv \max \{v^n(.), v^u(.)\}$ the value of being out of work, workers’ decisions are governed by:

$$v^n(b, h, z, a) = z(a) + \beta \sum_{a'} \alpha(a, a') \sum_{h'} \mu^o(h, h') \int v^o(b, h', z', a') dF(z'|z)$$

---

\textsuperscript{19}On the other hand, the tax is waived if the match is dissolved because the worker is in age group $A$ and retires exogenously from the labor market.

\textsuperscript{20}To simplify the analysis of social insurance benefits, it is assumed that a worker whose skill increase from $h$ to $h'$ is immediately entitled to the new benefit level $b(h')$ if he chooses to separate from his current job. Otherwise, workers who have been working at least one period with their new skill level need to be distinguished from those who have just experienced an upgrade in skills, which is an unnecessary complication of the model.

\textsuperscript{21}The description is formulated in recursive form; therefore we drop the time subscript in the remainder of the section.
\[
v^\mu(b, h, z, a) = b + \beta \sum_{a'} \alpha(a, a') \sum_{h'} \mu^\mu(h, h') \int \left[ (1 - f(\theta)) v^\phi(b, h', z', a') + f(\theta) \int \max \left\{ \nu^\phi(y', b, h', z', a'), \nu^\phi(b, h', z', a') \right\} dG^0_h(y') \right] dF(z'|z) \tag{7}
\]

\[
v^\nu(y, b, h, z, a) = w_0(y, b, h, z, a) + \beta \sum_{a'} \alpha(a, a') \int \left[ \lambda \sum_{h'} \mu^\nu(h, h') v^\phi(b(h), h', z', a') + (1 - \lambda) \sum_{h'} \mu^\nu(h, h') \int \max \left\{ \nu^\varepsilon(y', h', z', a'), v^\phi(b(h'), h', z', a') \right\} dG^1_h(y'|y) \right] dF(z'|z) \tag{8}
\]

\[
v^\varepsilon(y, h, z, a) = w_+(y, h, z, a) + \beta \sum_{a'} \alpha(a, a') \int \left[ \lambda \sum_{h'} \mu^\varepsilon(h, h') v^\phi(b(h), h', z', a') + (1 - \lambda) \sum_{h'} \mu^\varepsilon(h, h') \int \max \left\{ \nu^\varepsilon(y', h', z', a'), v^\phi(b(h'), h', z', a') \right\} dG^1_h(y'|y) \right] dF(z'|z) \tag{9}
\]

In equations (8) and (9), \( w_0(\cdot) \) and \( w_+(\cdot) \) are the wages paid in the corresponding labor market state (to be determined below). Assuming that there is free entry of firms, employers’ values \( \nu^\nu \) and \( \nu^\varepsilon \) of being matched to a worker are given by:

\[
v^\nu_0(y, b, h, z, a) = (1 - \tau) y - w_0(y, b, h, z, a) + \beta \sum_{a'} \alpha(a, a') \int \left[ -\lambda \Omega \right. \]

\[
+ \left. (1 - \lambda) \sum_{h'} \mu^\nu(h, h') \int \max \left\{ \nu^\varepsilon(y', h', z', a'), -\Omega \right\} dG^1_h(y'|y) \right] dF(z'|z) \tag{10}
\]

\[
v^\varepsilon_+(y, h, z, a) = (1 - \tau) y - w_+(y, h, z, a) + \beta \sum_{a'} \alpha(a, a') \int \left[ -\lambda \Omega \right. \]

\[
+ \left. (1 - \lambda) \sum_{h'} \mu^\varepsilon(h, h') \int \max \left\{ \nu^\varepsilon(y', h', z', a'), -\Omega \right\} dG^1_h(y'|y) \right] dF(z'|z) \tag{11}
\]

Match formation and continuation decisions can be derived from the maximization operator in the above set of Bellman equations, assuming that workers and employers Nash-bargain over the surplus of the match between them.

### 3.3 Nash bargaining

Denoting by \( \phi \in [0, 1] \) the bargaining power of workers, the two-tier wage contract under Nash bargaining and free-entry of firms is pinned down by:
The free-entry condition thus reads:

\[
\begin{align*}
w_0(y, b, h, z, a) & = \arg \max_w \left\{ (v^\prime_0(y, b, h, z, a) - v^\phi(b, h, z, a))^{1-\phi} v^\phi_0(y, b, h, z, a) \right\} \\
w_+(y, h, z, a) & = \arg \max_w \left\{ (v^\prime_+(y, h, z, a) - v^\phi(b(h), h, z, a))^{1-\phi} \left( v^\phi_+(y, h, z, a) + \Omega \right) \right\} 
\end{align*}
\]

We can use the first-order conditions associated with (12) and (13) to obtain the joint match formation and continuation decisions \(\tilde{y}_0(b, h, z, a)\) and \(\tilde{y}_+(h, z, a)\):

\[
\begin{align*}
v^\prime_{\tilde{y}_0}(b, h, z, a), b, h, z, a) & = 0 \\
v^\prime_{\tilde{y}_+}(h, z, a), h, z, a) & = -\Omega
\end{align*}
\]

### 3.4 Participation margin

The outside option of workers is \(v^\phi(\cdot)\), which is the maximum of \(v^\phi(\cdot)\) and \(v^\mu(\cdot)\). This delivers workers’ labor force participation decision as the reservation rule \(\tilde{z}(b, h, a)\) pinned down by:

\[
v^\mu(b, h, \tilde{z}(b, h, a), a) = v^\phi(b, h, \tilde{z}(b, h, a), a)
\]

### 3.5 Free-entry

Employers create new vacancies until the net present discounted value of doing so is exhausted. At the time of posting a vacancy, employers observe the distribution of unemployed persons across \(b, h, z, a\), but by the time of meeting the worker these characteristics have evolved according to their own law of motion. The free-entry condition thus reads:

\[
\eta = \beta \frac{\theta f(\theta)}{\theta} \sum_{b,h,a} \int \left[ \sum_{a'} \alpha(a, a') \sum_{h'} \mu^\phi(h, h') \int \max \left\{ v^\phi_0(y', b, h', \tilde{z}', a') \right\}, 0 \right] dG^0_h(y') dF(\tilde{z}'|z) \frac{\phi_u(b, h, z, a)}{u} dz
\]

where \(\phi_u(b, h, z, a)\) is the beginning-of-period measure of unemployed persons with characteristics \(b, h, z, a\), and \(u = \sum_{b,h,a} \int \phi_u(b, h, z, a) dz\) is the size of the unemployment pool.

### 3.6 Equilibrium

Having described the environment, Bellman equations and equilibrium conditions, we are in a position to introduce this definition:

**Definition.** An equilibrium is a list of value functions \(v^\mu(b, h, z, a)\), \(v^\phi(b, h, z, a)\), \(v^\prime_0(y, b, h, z, a)\), \(v^\prime_+(y, h, z, a)\), a set of rules for match formation and continuation decisions \(\tilde{y}_0(b, h, z, a)\) and \(\tilde{y}_+(h, z, a)\) and for participation \(\tilde{z}(b, h, a)\), a list of wage functions \(w_0(y, b, h, z, a)\) and \(w_+(y, h, z, a)\), a value for labor market tightness \(\theta\), a distribution of workers across states of na-
tute \( \varphi_n(b, h, z, a) \), \( \varphi_d(b, h, z, a) \), \( \varphi_0(y, b, h, z, a) \) and \( \varphi_+(y, h, z, a) \) (where the \( \varphi_i \)'s are the measures of workers in employment with \( i \in \{0, +\} \) and \( \varphi_n \) is the measure of workers in nonparticipation) and a value for the tax rate \( \tau \) such that:

1. Optimal match decisions: Given \( \theta \), \( \tau \) and the value functions \( v^f_0(y, b, h, z, a) \) and \( v^f_+(y, h, z, a) \), \( \tilde{y}_0(b, h, z, a) \) and \( \tilde{y}_+(h, z, a) \) solve equations (14) and (15), respectively.

2. Optimal participation decisions: Given \( \theta \), \( \tau \) and the value functions \( v^n(b, h, z, a) \), \( v^u(b, h, z, a) \), \( \tilde{z}(b, h, a) \) solves equation (16).

3. Nash bargaining: Given \( \theta \), \( \tau \) and the value functions \( v^n(b, h, z, a) \), \( v^u(b, h, z, a) \), \( v^e_0(y, b, h, z, a) \), \( v^e_0(y, b, h, z, a) \) and \( v^e_+(y, h, z, a) \) and \( w_0(y, b, h, z, a) \) and \( w_+(y, h, z, a) \) are given by equations (12) and (13), respectively.

4. Time-invariant distribution: Given \( \theta \), the decision rules \( \tilde{z}(b, h, a) \), \( \tilde{y}_0(b, h, z, a) \) and \( \tilde{y}_+(h, z, a) \) and the laws of motion for \( y, b, h, z, a, \varphi_n(b, h, z, a), \varphi_d(b, h, z, a), \varphi_0(y, b, h, z, a) \) and \( \varphi_+(y, h, z, a) \) are time-invariant and they add up to one.

5. Free-entry: Given the measure of unemployed workers \( \varphi_d(b, h, z, a) \) and the discounted present value of match formation \( v^f_0(y, b, h, z, a) \), \( \theta \) solves the free-entry condition (17).

6. Balanced budget: given \( \varphi_n(b, h, z, a) \), \( \varphi_d(b, h, z, a) \), \( \varphi_0(y, b, h, z, a) \) and \( \varphi_+(y, h, z, a) \), \( \tau \) balances the government’s budget.

The following assumptions complete the description of the equilibrium distribution (condition 4): initially, newborn workers are out of work, they are entitled to the lowest level of social insurance benefits and they draw an initial opportunity cost of participation from the distribution \( F(\cdot|\tilde{z}) \). As explained in the calibration section, the latter assumption is largely innocuous for the equilibrium.

## 4 Calibration and outcomes in tranquil times

This section details the calibration of the LF and WS economies to tranquil economic times (\( \mu^f(H, H) = 1 \)). Subsection 4.1 describes parameters that pertain to both the LF and WS economies. Subsection 4.2 explains the calibration of parameters that are specific to each economy. Finally, Subsection 4.3 characterizes some key outcomes that result from the calibration.

### 4.1 Common parameters

For most of the analysis, we assume that all parameters are common across economies, except the vacancy creation cost, \( \eta \), and the parameters governing labor market policies in the WS economy. Thus, the working hypothesis throughout is the same as Ljungqvist and Sargent (1998, 2008), i.e. effectively we assume that transatlantic differences in labor market dynamism are accounted for by differences in government-mandated programs. We use micro-level evidence on labor market outcomes in the United States to calibrate those parameters that are common across economies.
Demography and preference parameters

The model period is chosen to be half a quarter. The discount factor \( \beta \) is 0.9951 to accord with an annualized interest rate of 4 percent. The working life of individuals is divided into the following periods. While in the age bracket 20-49, individuals transit across six 5-year long consecutive age groups.\(^{22}\) The probability of remaining in each of these groups is 0.975. The subsequent age bracket, 50-54, has five 1-year long age groups; the corresponding probability is 0.875. The last age bracket 55-64 is composed of twenty 6-month age groups. The probability of remaining in each of these groups is 0.750. This decomposition of the life-cycle allows to maintain smooth transitions between age groups while significantly reducing the memory requirements of the computations.

Before parametrizing the utility of leisure, it is appropriate to discuss what the model cannot do. Consider the role of human capital for wage growth over the life-cycle. This creates a strong incentive for younger workers to participate in the labor market. As a result, it would take a very large utility of leisure to rationalize the fact that their labor force participation rate is lower than one. Unless the value of leisure declines with age, this in turn would yield a large fall in labor force participation for workers in their late-forties and fifties, which is at odds with the data. In sum, the model is not tailored to account for nonparticipation among younger workers.\(^{23}\) It is thus reasonable to shut down the labor supply decision for those workers aged 20 to 24 in the model.

In light of these remarks, we posit the following relationship between the value of leisure and age:

\[
z(a) = z \times \frac{a - 1}{A - 1}
\]

That is, the value of leisure is always zero for workers aged 20 to 24 and then grows linearly as workers enter the subsequent age brackets \((a > 1)\).\(^{24}\) We assume linear growth for parsimony and we specialize the Markov process for \(z\) as follows: with probability \(\pi\) a new value \(z\) is drawn from a uniform distribution over \([0, \sigma_z]\), while with probability \(1 - \pi\) the value of leisure remains unchanged. The upper bound \(\sigma_z\) is calibrated to match the labor force participation rates of older workers relative to that of prime-age workers, and \(\pi\) is chosen to reproduce the rise in labor force exit rates between the ages of 55-59 and 60-64 in the US.\(^{25}\) This calibration procedure yields \(\sigma_z = 2.75\) and \(\pi = 0.25\), implying that \(z\) is resampled on average after 6 months.

\(^{22}\)Since the model does not speak to the specific employment experience of younger workers, we do not introduce any such category in the calibrated model. That is, we assume that workers enter the labor market at age 20 and lump them together with workers aged 25 to 49 and 50 to 54 to form an extended group of prime-age workers.

\(^{23}\)An alternative would be to modify the structure of the model for newborn workers. Appendix B.1 provides a discussion of the modifications that would enable the model to explain their participation behaviors.

\(^{24}\)Observe that since the value of leisure is zero when \(a = 1\), the distribution from which newborn workers initially draw their own idiosyncratic utility \(z\) has virtually no effect on equilibrium allocations.

\(^{25}\)\(\sigma_z\) and \(\pi\) are jointly calibrated using the following. Labor force participation rates in the pre-1970s period among workers aged 55 to 64 were 92 percent lower than labor force participation rates of prime-aged workers. The model implies that workers in the age bracket 20-49 always participate. Therefore we calibrate \(\sigma_z\) to achieve a labor force participation rate among older workers of 92 percent. As for \(\pi\), monthly CPS data from the early 1980s show that the transition rates from unemployment to nonparticipation and from employment to nonparticipation increase at least sixfold between the ages of 55-59 and 60-64. The value of \(\pi\) in the calibrated model makes these transition rates jump from 0.67 percent to 5.19 percent and from 0.15 percent to 1.32 percent, respectively.
Technology parameters

The laws of motion for skill accumulation and decumulation are constructed as follows. We set the probability \( \mu^e \) of upgrading skills to the value 0.00625. That is, conditional on being employed continuously, a worker moves from the low to the high skill level on average after 20 years. This source of wage growth in the model is consistent with the life-cycle earnings profiles observed in the data: those typically reach a plateau when workers are in their mid-forties. We follow Ljungqvist and Sargent (1998, 2008) in making the depreciation of human capital stochastically twice as fast as accumulation and set \( \mu^o \), the probability of losing skills, equal to 0.0125.

The unconditional mean of the two productivity processes, \( \overline{y}_0 \) and \( \overline{y}_H \), are set to the values 1.0 and 2.0, respectively. The motivation for these parameters is to make workers on average twice as productive as in the beginning of their career (unconditionally) when they reach the plateau for human capital. It turns out that these values imply almost a doubling of the average wage when comparing newborn and prime-age workers, which accords well with empirical observations. The persistence of idiosyncratic productivity \( \rho \) is set equal to 0.975. This results in individual wage processes with an annual persistence around 0.75; this is within the range of typical wage-earnings equations.

The sources of match destruction (other than the exogenous retirement shock) are parametrized as follows. First, the probability of exogenous destruction \( \lambda \) is set equal to 0.0125: a production unit is hit by the \( \lambda \) shock on average after 10 years. Second, the standard error of innovations, \( \sigma_\varepsilon \), is calibrated to make monthly transitions from employment to unemployment average 2 percent for workers in the age bracket 20-49. This also turns out to be the aggregate separation rate from employment because older workers move less often into unemployment but more into nonparticipation. Given the value assigned to \( \lambda \), this procedure yields \( \sigma_\varepsilon = 0.210 \).

Finally, following standard practices, workers’ share of total match surplus is set to 50 percent, i.e. \( \phi = 0.50 \). The elasticity of the job-filling rate with respect to labor-market tightness, \( \kappa \), is set equal to \( \phi \) to accord with the Hosios-Pissarides condition. The aggregate efficiency of the matching function \( M \) is chosen to be 0.455. Normalizing labor market tightness to one, this value for \( M \) is consistent with a 2 percent (monthly) separation rate and an average duration of unemployment of 3 months, as observed in the United States over the long run (recall that the model period is half a quarter). The matching function of the calibrated model is thus: \( m(u, v) = 0.455u^{0.5}v^{0.5} \).

4.2 Model-specific parameters

Before assigning a value to the unit cost of vacancy creation \( \eta \), there remains to parametrize those programs enforced by the government in the WS economy. First, we set the job destruction tax \( \Omega \) equal to 10. This amounts to about 8 months of output per worker in the equilibrium of the WS economy and makes the separation rate lower by about 60 percent relative to the LF economy. The latter is consistent with the difference between Europe and the US discussed in Section 2. Second, the replacement ratio of unemployment benefits \( \gamma \) is chosen to be 0.45. This results in values for \( b(h) \) that amount to 47 percent of the average wage earned by low-skill and high-skill workers, respectively. These values line up well with the generous unemployment systems that prevail in Europe, taking
Table 2. Parameter values (one model period is half a quarter)

<table>
<thead>
<tr>
<th>Comments</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preference parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta = 0.9951$</td>
</tr>
<tr>
<td>Probability of resampling leisure utility</td>
<td>$\pi = 0.250$</td>
</tr>
<tr>
<td>Upper bound for leisure utility</td>
<td>$\sigma_z = 2.75$</td>
</tr>
<tr>
<td><strong>Technology parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Probability of upgrading skills</td>
<td>$\mu^e = 0.00625$</td>
</tr>
<tr>
<td>Probability of losing skills</td>
<td>$\mu^o = 0.01250$</td>
</tr>
<tr>
<td>Lower and upper mean of productivity</td>
<td>$\bar{y}_0 = 1.0, \bar{y}_H = 2.0$</td>
</tr>
<tr>
<td>Persistence of idiosyncratic productivity</td>
<td>$\rho = 0.975$</td>
</tr>
<tr>
<td>Standard deviation of idiosyncratic shocks</td>
<td>$\sigma_e = 0.210$</td>
</tr>
<tr>
<td>Rate of exogenous job destruction</td>
<td>$\lambda = 0.0125$</td>
</tr>
<tr>
<td>Matching function</td>
<td>$m(u,v) = 0.455u^{0.5}v^{0.5}$</td>
</tr>
<tr>
<td>Bargaining power of workers</td>
<td>$\phi = 0.5$</td>
</tr>
<tr>
<td><strong>Policy parameters (WS economy)</strong></td>
<td></td>
</tr>
<tr>
<td>Job destruction tax</td>
<td>$\Omega = 10.0$</td>
</tr>
<tr>
<td>Replacement ratio</td>
<td>$\gamma = 0.45$</td>
</tr>
</tbody>
</table>

into account that unemployment benefits have infinite duration in the model. Finally, anticipating on the analysis of early retirement benefits, we allow workers to consume 50 percent of their social insurance benefits when out of the labor force (see Subsection 5.3).

To pin down values for $\eta$ in the steady-state of each economy, we normalize labor market tightness $\theta$ to one under tranquil economic times and use the free-entry condition. This procedure gives $\eta = 1.876$ in the LF economy and $\eta = 0.988$ in the WS economy. Not surprisingly, free-entry of firms requires a lower vacancy posting cost in the WS economy because unemployment benefits and employment protection reduce the capitalized value of jobs. The difference with the LF economy is reduced when vacancy posting costs are expressed relative to output per worker or relative to the average wage since those are also lower in the WS economy.

### 4.3 Key model outcomes

In this subsection, we describe a set of outcomes characterizing the LF and WS economy. Firstly, in Figure 3 we report the match formation and continuation decisions $\tilde{y}_0$ and $\tilde{y}_+$, restricted to age 50 and above to focus the attention on the last third of the working life. The upper panel (a) for the LF economy has only two graphs because the policy functions coincide in the absence of public intervention. Observe that, on the other hand, the vertical axis is different in panels (b) and (c) for the WS economy where these decisions are distinct. Finally, as indicated on the vertical axis, the different plots show the policy functions $\tilde{y}_i$ (with $i \in \{0, +\}$) taken as deviation from $\bar{y}_h$ (with $h = 0$ for the left and $h = H$ for the right graphs). This adjustment allows to give a sense of the likelihood of a match.
being formed (or destroyed) at each level of human capital.26

To begin with, in the LF economy we notice that worker-firm pairs are more selective about the quality of the match when the worker has high rather than low skills. Low skill workers have a weaker bargaining position in this environment, and thus they are willing to take almost any job. On the other hand the persistence of the productivity process entails a high opportunity cost to accept a poor initial productivity draw for a high-skill worker. Hence the higher thresholds on the right plot of panel (a). Finally, as workers approach the retirement age, their valuation of leisure increases. This raises the productivity thresholds for both low and high skill workers in the north corner of the two plots (combinations of high \( z \) and high \( a \)).

The ordering of the productivity thresholds at the entry level for low and high skill workers is reversed in the WS economy (panel (b) in Figure 3). Low skill workers can afford to stay unemployed longer relative to the LF economy. As a result, the initial quality of the match matters more than under laissez-faire. As for high-skill workers, a poor initial productivity draw is not as harmful as under laissez-faire because separation decisions are delayed, which raises the probability that the productivity of the match will revert to higher values. Turning to panel (c) of Figure 3, we see that the job destruction tax \( \Omega \) shifts the thresholds downwards for continuation decisions since it forces employers to retain their workers more often. Finally, in both panels (b) and (c) productivity thresholds increase in the north corner of the plots. The gradient of the increase with \( z \) and \( a \) is somewhat higher than in panel (a) of Figure 3.

Another population category in the WS economy contains those nonemployed workers whose skills have depreciated but who are entitled to high unemployment benefits due to their past work experience (high \( b \), low \( h \)). We do not report match formation and continuation decisions for them because they represent a very small share of the population in tranquil economic times. Indeed, skill depreciation occurs only during prolonged spells of nonemployment when \( \mu^f(H, H) = 1 \) (the duration of unemployment spells is about 3.5 months in tranquil economic times). Meanwhile, as the discussion of panel (b) indicates, these workers are typically less employable because their bargaining position does not align with their current productivity. Proximity to retirement can only reinforce this effect, as demonstrated by the experiments in Section 5.

Figure 4 shows the labor force participation decisions for workers aged 45 and above in the LF and WS economies. That is, workers choose not to participate when their current value of leisure is higher than the threshold value on the graph. The lines begin at the upper bound \( \sigma_z \) for leisure because prime-age workers always participate in the labor market. In the LF economy (left graph), we observe that low-skill workers have lower thresholds relative to high-skill workers. Their expected returns to staying in the workforce are reduced, which makes them willing to retire earlier. In the WS economy (right graph), the picture is compounded by the fact that workers cannot consume the full value of unemployment benefits when they move out of the workforce. This induces low skill/benefits workers to stay in the labor market longer in the age range 45 to 58. This potentially counterfactual outcome

---

26Recall that the productivity of a match is higher on average when the worker has accumulated some human capital. Therefore to compare values of \( \bar{y}_0(h, z, a) \) or \( \bar{y}_+ (h, z, a) \) for different skill levels \( h \), one has to control for the upward shift in the interval in which \( y \) resides. In the computations using Tauchen (1986)'s method to approximate the autoregressive processes in (4), the intervals indexed by \( h \) are of the form

\[
\left[ \bar{y}_h - \frac{2\sigma}{\sqrt{1-p^2}}, \bar{y}_h + \frac{2\sigma}{\sqrt{1-p^2}} \right].
\]
Figure 3. Policy functions for match formation and match continuation (workers aged 50 and above)

NOTE: The upper graphs (a) show match formation and continuation decisions in the LF economy. The middle graphs (b) show match formation decisions in the WS economy. The lower graphs (c) show match continuation decisions in the WS economy. The vertical axis is different in panels (b) and (c) to make the graphs more legible.
is eliminated when we relax this assumption in Section 5; we explore alternative parametrizations which make social insurance schemes interfere more with the participation margin.\textsuperscript{27}

5 Quantitative analysis of turbulent times

This section studies the implications of turbulent times for the equilibrium allocations of the LF and WS economies (Subsection 5.2). In Subsection 5.3, we further consider the effects of varying early retirement benefits and how this interferes with other institutions. Before discussing these experiments, Subsection 5.1 outlines the turbulence experiment and shows that the model can rationalize findings that attest that labor markets have become more turbulent since the late 1970s.

5.1 The turbulence experiment

The turbulence experiment confronts workers with a risk of immediate skill loss in the event of a layoff, the magnitude of which increases with the degree of economic turbulence. Specifically, we replace the assumption that $\mu^\ell (H, H) = 1$ by letting the probability $\mu^\ell (H, H)$ takes values between 0 and 1. That is, we vary $\mu^\ell (H, 0)$ in the $[0, 1]$ interval. Accordingly, we refer to $\mu^\ell (H, 0)$ as the “degree of economic turbulence”.

\textsuperscript{27}In the benchmark WS economy, participation decisions would be more sensitive to unemployment benefits if workers were losing these benefits upon leaving the labor force. It is however unclear whether one should assume that the monitoring technology of the unemployment agency is perfect, i.e. that it can remove compensations from those who do not search for jobs. One can also interpret the model as one in which workers save their benefits after job loss, drop out temporarily from the workforce and then use their savings to finance job search when they re-enter the labor market. See Appendix B.2 for further discussion about re-entry into the labor market.
Figure 5. The turbulence story: volatility of earnings and earnings losses of displaced workers

NOTE: The upper graph shows the distribution of the permanent component of log-earnings in the LF economy. The middle graph shows the distribution of the transitory component of log-earnings in the LF economy. In the upper and middle graphs, the solid bars correspond to a degree of turbulence of 0.10 and the dashed bars correspond to a degree of turbulence of 0.60. See footnote 28 for details. The lower graph shows the earnings losses of displaced workers in the LF economy. The solid line shows the earnings of a typical cohort of workers in the LF economy. The dashed line shows the earnings of a cohort of workers displaced at time 0. See footnote 29 for details.
As in Ljungqvist and Sargent (1998, 2008), the relevance of the turbulence story can be gauged by studying how the LF economy rationalizes Gottschalk et al. (1994)’s finding that earnings volatility in the United States rose between the 1970s and the 1980s. To this end, in the upper and middle graphs of Figure 5, we report the distributions of the permanent and transitory components of earnings obtained in environments with different degrees of economic turbulence. More turbulent times effectively result in more dispersed distributions for the permanent and transitory components of earnings. As in Ljungqvist and Sargent (1998, 2008), the model cannot generate as much dispersion in earnings as there prevails in the data, and there are also differences in the regions of the distributions that are shifted by the increase in economic turbulence. This said, the experiment is successful in that wages in the model are determined endogenously and their response to economic turbulence is consistent with Gottschalk et al. (1994)’s findings.

Another “over-identifying” test of the model compares the earnings losses of displaced workers in the model to those losses documented by Jacobson et al. (1993). A displaced worker in the model is an individual who loses her/his accumulated skills after being laid-off. The lower graph of Figure 5 shows that these workers suffer large and persistent drops in earnings: a fall by almost 25 percent, half of which is not recovered after five years. This accords well with what Jacobson et al. (1993) found in their data. In this respect too, the model appears as a relevant construct to study the employment experience of older workers.

5.2 1st experiment: Trends in participation and unemployment

In this subsection, we assess whether varying the degree of economic turbulence in the LF and WS economies has potential to explain the different dynamics of participation and unemployment in the US and in Europe. First, we consider Europe as a whole, and focus on the patterns that are common across the “big three” of continental Europe. We then discuss differences between European countries.

Differences between the United States and Europe

Table 3 reports the effects of raising the degree of turbulence in the LF and WS economies. Looking first at the bottom of the table, the two model economies reproduce Ljungqvist and Sargent (1998, 2008)’s finding that the high European unemployment rates since the late 1970s can be imputed to the Welfare state’s lower ability to cope with more turbulent times. Tougher employment protec-

---

28 To obtain these graphs, the labor market trajectories of 5,000 individuals are simulated over their entire working lives, organized into a panel dataset and aggregated to an annual frequency to resemble the dataset analyzed by Gottschalk et al. (1994). Then a standard permanent-transitory decomposition of the log of their annual earnings is performed – in the decomposition of $\log(w_{it}) = \mu_i + \eta_{it}$, where $w_{it}$ is the wage of individual $i$ at time $t$, $\mu_i$ is the permanent component and the variance of $\eta_{it}$ is the transitory component. The analysis is repeated twice: the first environment has a degree of turbulence equal to 0.10 and the second environment has a degree of turbulence equal to 0.60.

29 The two cohorts of Figure 5 are taken from the LF economy with a degree of turbulence equal to 1.0. They both comprise 5,000 individuals whose labor market trajectories are simulated and organized into a dataset aggregated to a quarterly frequency. The displacement shock occurs when the cohort enters its 25-th year. The earnings reported in Figure 5 are the period-$t$ cohort average of quarterly earnings, which we multiply by $3.2 \times $1,000 to make them comparable to earnings in the study by Jacobson et al. (1993).
Table 3. Labor markets of the LF and WS economies in turbulent times: aggregate outcomes

<table>
<thead>
<tr>
<th>Degree of economic turbulence</th>
<th>0.00</th>
<th>0.20</th>
<th>0.40</th>
<th>0.60</th>
<th>0.80</th>
<th>1.00</th>
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</thead>
<tbody>
<tr>
<td>Tax rate $\tau$</td>
<td>2.89</td>
<td>4.02</td>
<td>5.17</td>
<td>6.15</td>
<td>7.24</td>
<td>8.11</td>
</tr>
<tr>
<td>Output (a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF</td>
<td>1.630</td>
<td>1.545</td>
<td>1.481</td>
<td>1.431</td>
<td>1.391</td>
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<tr>
<td>WS</td>
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<td>1.489</td>
<td>1.397</td>
<td>1.320</td>
<td>1.260</td>
<td>1.213</td>
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<td>Average skill level</td>
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</tr>
<tr>
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<td>1.465</td>
<td>1.397</td>
<td>1.344</td>
<td>1.302</td>
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<tr>
<td>WS</td>
<td>1.561</td>
<td>1.466</td>
<td>1.395</td>
<td>1.340</td>
<td>1.296</td>
<td>1.261</td>
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<tr>
<td>Average wage</td>
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<td></td>
<td></td>
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</tr>
<tr>
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<td>1.606</td>
<td>1.562</td>
<td>1.527</td>
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<td>1.412</td>
<td>1.343</td>
<td>1.285</td>
<td>1.237</td>
<td>1.199</td>
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<td>Labor force participation rate</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF</td>
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<td>97.46</td>
<td>96.91</td>
<td>96.47</td>
<td>96.15</td>
<td>95.85</td>
</tr>
<tr>
<td>WS</td>
<td>96.18</td>
<td>94.14</td>
<td>92.47</td>
<td>91.19</td>
<td>90.11</td>
<td>89.24</td>
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<tr>
<td>Unemployment rate</td>
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</tr>
<tr>
<td>LF</td>
<td>6.33</td>
<td>6.66</td>
<td>6.95</td>
<td>7.24</td>
<td>7.53</td>
<td>7.77</td>
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<td>5.64</td>
<td>7.03</td>
<td>8.36</td>
<td>9.34</td>
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<td>11.54</td>
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<tr>
<td>Separation from employment (b)</td>
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<tr>
<td>LF</td>
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<td>2.16</td>
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<td>2.22</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>LF</td>
<td>2.98</td>
<td>3.00</td>
<td>3.09</td>
<td>3.19</td>
<td>3.30</td>
<td>3.40</td>
</tr>
<tr>
<td>WS</td>
<td>3.63</td>
<td>4.53</td>
<td>5.38</td>
<td>6.14</td>
<td>6.92</td>
<td>7.53</td>
</tr>
</tbody>
</table>

NOTE: Tax rates, labor force participation rates and unemployment rates are expressed in percentage points.\(^{(a)}\) Total output net of the cost of job creation. \(^{(b)}\) Monthly flows out of employment, expressed as a percentage of employment. \(^{(c)}\) Average duration measured in months.

More generous social insurance schemes, on the other hand, made workers with depleted skills less employable because they accept to give up their unemployment compensations only if they find a high productivity match. These workers are more numerous under times of economic turbulence and they stay unemployed longer: the mean duration of unemployment spells in the WS economy increases by more than 50 percent. The LF economy proves more resilient to adverse shocks because past labor market history does not affect the outside option of unemployed workers.\(^{31}\)

Moving up in Table 3, we note that the addition of an operative labor supply margin allows to explain why labor force participation simultaneously diminished in the United States and in Europe.\(^{32}\)

\(^{30}\) A closer look at the age distribution of employment reveals that the WS economy achieves higher employment rates among prime-age workers and that the pattern is reversed for older workers (Figure B1 in the appendix). This is consistent with observed differences between US and European labor markets.

\(^{31}\) Observe that unemployment increases slightly in the LF economy because of the endogenous job creation process.

\(^{32}\) Labor force participation among workers aged 20 to 49 is 100 percent in both economies. As a result, the levels of participation in the table are not directly comparable to the data. When looking at statistics in the aggregate, we focus on the relative trends in labor force participation rates.
It is also worth emphasizing that the LF and WS economies have similar labor force participation rates under tranquil time – in line with the beginning-of-period mild differences – and that the subsequent decline is more pronounced in the WS economy. One can conjecture that the trend in the aggregate is accounted for by the outcomes of older workers. This will be verified in Table 4.

The upper part of the table allows to gauge the implications of the turbulence experiment with respect to average skill levels, wages and output. By construction, a higher degree of economic turbulence deteriorates the value of these variables. The various changes are not as interpretable as those in Figure 5 since the variables are displayed in their raw units of measurement. We keep this format to underline two differences between the LF economy and the WS economy. First, output is lower in the WS economy because the job destruction tax $\Omega$ entails a less efficient allocation of labor. Second, the average wage is also lower in the WS economy, because of $\Omega$ too. The two economies nevertheless generate similar degrees of heterogeneity in labor earnings over the life-cycle. This dimension is important for drawing quantitative conclusions from the models.\(^{33}\)

Before commenting on Table 4, in Figure 6 we give a visual sense of the ability of the model to replicate US-Europe differences for older workers. On average across the three largest European economies, unemployment for workers aged 55 to 64 rose about 2.5 times compared to US levels in the pre-1970s period (left graphs). As for labor force participation, it was about 10 percent lower in the pre-1970s period in Europe. In the US, it has declined by about 15 percent during the period considered; the corresponding fall in Europe was an order of magnitude larger, from 0.87 to 0.55. As can be seen in the right graphs of Figure 6, the LF and WS economies produce quantitatively similar outcomes. True, unemployment among older workers in the WS economy is already higher in tranquil economic times. However, as we show in the next paragraphs, this pattern can be overturned by using a different parametrization of preferences and labor market policies. As for the LF economy, it understates the decline in labor force participation in the US only slightly. Overall, the experiment is successful in replicating the order of magnitude of changes in these two variables.

Table 4 complements Figure 6 with a set of statistics characterizing the employment experience of older workers. Instead of the relative trends in participation and unemployment displayed on Figure 6, the table reports the actual figures of the different series. These statistics reiterates the finding that the problem of Welfare state unemployment stems from long-term unemployment, not from separations from employment into unemployment. The bottom of the table shows that lower labor force participation rates reflect larger inflows into nonparticipation from both employment and unemployment. This can be interpreted as decisions to retire earlier from the workforce because most workers do not re-enter the labor force before the exogenous retirement shock occurs.\(^{34}\)

Finally, piecing together Tables 3 and 4, the two economies explain why lower employment rates in the aggregate are disproportionately concentrated on older workers. Three factors make the interaction between shocks and institutions have more potent effects among these workers. First, accumulating human capital is a time-consuming process, and therefore skill obsolescence falls more heavily on

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\(^{33}\)Reproducing large variations in earnings over the life-cycle proved to be a quantitatively-relevant issue in the calibration debate between den Haan et al. (2005) and Ljungqvist and Sargent (2004).

\(^{34}\)When out of the labor force, workers’ skills also deteriorate which exacerbates their employability problem and contributes to the fact that they do not return to the labor market.
Figure 6. Unemployment and labor force participation among older workers: Model vs. data

Note: The left graphs (a) are based on the HP trend component reported in Figure 1 in the Introduction. The lines for Europe are obtained by taking the (unweighted) average of the figures for France, Germany and Italy. The right graphs (b) are based on computations of equilibria for the LF and WS economies for one hundred equally-spaced values of $\mu^*(H, 0)$ in the $[0, 1]$ interval. To facilitate comparison, unemployment rates and labor force participation rates are expressed relative to their values in tranquil economic times in the US (left graphs) and in the LF economy (right graphs).

Workers who are entitled to the most generous benefit payments. Second, older workers are relatively more impatient, which makes them less willing to give up their unemployment compensations. Third, proximity to retirement makes older workers a poor match from an employer’s perspective because this diminishes the time horizon to recoup the cost of job creation. The LF economy with its almost steady unemployment rates among workers aged 55 to 64 reproduces the fact that nonparticipation matters quantitatively more than unemployment for explaining the employment rates of older workers. This result is also present in the WS economy, but unemployment also plays an important role in this economy.

In sum, this first numerical experiment shows that the shocks-and-institutions story embedded in the model is consistent with (i) the role of different nonemployment margins in the US and Europe and (ii) the concentration of adverse employment outcomes on older workers.
### Table 4. Labor markets of the LF and WS economies in turbulent times: outcomes of older workers

<table>
<thead>
<tr>
<th>Degree of economic turbulence</th>
<th>0.00</th>
<th>0.20</th>
<th>0.40</th>
<th>0.60</th>
<th>0.80</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor force participation rate</td>
<td>LF</td>
<td>92.00</td>
<td>88.56</td>
<td>86.09</td>
<td>84.11</td>
<td>82.68</td>
</tr>
<tr>
<td></td>
<td>WS</td>
<td>82.98</td>
<td>74.42</td>
<td>67.57</td>
<td>62.30</td>
<td>58.05</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>LF</td>
<td>5.16</td>
<td>5.45</td>
<td>5.75</td>
<td>6.01</td>
<td>6.27</td>
</tr>
<tr>
<td></td>
<td>WS</td>
<td>5.54</td>
<td>8.03</td>
<td>10.32</td>
<td>12.31</td>
<td>14.41</td>
</tr>
<tr>
<td>Separation from employment(^{(a)})</td>
<td>LF</td>
<td>2.00</td>
<td>2.17</td>
<td>2.30</td>
<td>2.39</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td>WS</td>
<td>1.09</td>
<td>1.11</td>
<td>1.12</td>
<td>1.15</td>
<td>1.17</td>
</tr>
<tr>
<td>Duration of unemployment spells(^{(b)})</td>
<td>LF</td>
<td>2.86</td>
<td>2.84</td>
<td>2.88</td>
<td>2.95</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td>WS</td>
<td>3.96</td>
<td>5.09</td>
<td>5.83</td>
<td>6.28</td>
<td>6.61</td>
</tr>
<tr>
<td>Transition into nonparticipation From employment(^{(c)})</td>
<td>LF</td>
<td>0.66</td>
<td>0.88</td>
<td>1.04</td>
<td>1.16</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>WS</td>
<td>0.52</td>
<td>0.63</td>
<td>0.73</td>
<td>0.82</td>
<td>0.88</td>
</tr>
<tr>
<td>From unemployment(^{(d)})</td>
<td>LF</td>
<td>2.43</td>
<td>3.18</td>
<td>3.73</td>
<td>4.13</td>
<td>4.44</td>
</tr>
<tr>
<td></td>
<td>WS</td>
<td>8.09</td>
<td>10.30</td>
<td>11.54</td>
<td>12.21</td>
<td>12.63</td>
</tr>
</tbody>
</table>

**NOTE:** Labor force participation rates and unemployment rates are expressed in percentage points. \(^{(a)}\) Monthly flows out of employment, expressed as a percentage of employment. \(^{(b)}\) Average duration measured in months. \(^{(c)}\) Monthly flows from employment to nonparticipation, expressed as a percentage of employment. \(^{(d)}\) Monthly flows from unemployment to nonparticipation, expressed as a percentage of unemployment.

### Differences between European countries

Does the WS economy help explain heterogeneity across European countries in Figure 1? To address this question, we consider different parametrizations of those variables that affect labor force participation and unemployment among older workers. Specifically, to maximize labor force participation among them, we remove access to social insurance benefits when out of the labor force. In so doing, we mean to replicate the experience of Germany in Figure 1: this country maintained higher participation rates among older workers throughout the period. On the other hand to minimize changes in unemployment, we reduce the generosity of unemployment benefits in the WS economy by lowering $\gamma$ from 0.45 to 0.25. This change is designed to capture the experience of Italy in Figure 1. Finally, since this country had lower participation rates throughout, we increase the upper bound $\sigma_z$ for leisure from 2.75 to 3.50 to replicate this outcome. We label these alternative versions the WS\(_G\) economy and the WS\(_I\) economy, respectively.\(^{35}\)

Table 5 reports the effects of varying the degree of economic turbulence in these alternative wel-

\(^{35}\)See Appendix B.3 for further discussion on the relationship between benefits and leisure utility. The purpose of these parametrizations is illustrative. That is, linear preferences over consumption and leisure make it difficult to use the WS economy to infer exact values for benefits and leisure utility. Thus, we refrain from interpreting these as “structural” parameters that would characterize the value of actual retirement benefit schemes and the value of leisure time in Germany and in Italy.
fare state economies. The upper panel of the table report values computed on average across all age
groups. The bottom panel focuses on the relevant outcomes among older workers.

Table 5 shows that different parametrizations of the WS economy have potential to explain hetero-
geneity in employment experiences across Europe. For instance the $W_SG$ economy has no government-
mandated program to “conceal” unemployment; as a result, it suffers a large increase in unemploy-
ment, along with changes in labor force participation that are more similar to those in the LF economy.
On the other hand the $WS_I$ economy avoids high unemployment rates but it experiences a drop in labor
force participation by almost 30 percentage points.\textsuperscript{36} Thus, with some deviations from the benchmark
calibration, the shocks-and-institutions explanation can be accommodated to explain the experience
specific to a given European country on Figure 1.

5.3 2nd experiment: Effects of early retirement benefits

Having established the good quantitative performance of the model for explaining long-run trends
in participation and unemployment, we go on to study the effects of early retirement benefits. The
motivation for analyzing this policy tool is twofold. First, as shown in several reports by the OECD,
these benefits are effective in providing incentives to retire from the labor market earlier. Second,
they are pervasive in European economies and their generosity has generally been increased during
the period considered. In France for instance, such changes were introduced in the 1980s partly for
the purpose of decreasing unemployment numbers (see e.g. Blanchard, 2006).

Different labor market policies

We model early retirement benefits as an age-dependent benefit targeted to those out of the labor force:
in the new WS economy, nonparticipants with state variables $b$ and $a$ can consume a benefit $\gamma(a) \times b$.
Specifically, we keep $\gamma(a)$ to the value of 50 percent before the age of 54, as in the benchmark WS
economy. Between the age of 55 and 59, we increase $\gamma(a)$ to the value of 75 percent; we let $\gamma(a)$ be
100 percent between the age of 60 and 64.

The effects of early retirement benefits are examined in environment with different degrees of
economic turbulence and different levels of employment protection. The latter is relevant because
employment protection is typically analyzed in conjunction with tenure, which correlates with age.
As shown in e.g. the study by Behaghel et al. (2008), costly layoff procedures can weigh heavily
against the employment of older workers.

Results

Figure 7 shows the effects of increasing the degree of economic turbulence in economies with dif-
ferent values for the job destruction tax $\Omega$.\textsuperscript{37} The upper graphs report changes in the tax rate $\tau$ and

\textsuperscript{36} These effects need not be mechanical only: congestion externalities make the size of the unemployment pool affect
the job finding rate, which in turn matters for labor force participation decisions. Thus, incentives to maintain older
workers in the workforce can be partly undone by the fact that employment decreases in turbulent times.

\textsuperscript{37} We maintain the calibration procedure described in Section 4. That is, for each level of $\Omega$, we normalize $\theta$ to one
and adjust $\eta$ to obtain free-entry of firms in the steady-state equilibrium under tranquil economic times.
Table 5. Comparing two WS economies in turbulent times: outcomes in the aggregate (panel A) and outcomes of older workers (panel B)

<table>
<thead>
<tr>
<th>Degree of economic turbulence</th>
<th>0.00</th>
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<th>0.40</th>
<th>0.60</th>
<th>0.80</th>
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<tr>
<td><strong>A. Aggregate outcomes</strong></td>
<td></td>
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<tr>
<td>Tax rate $\tau$</td>
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<td>$W_{SG}$</td>
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<td>6.89</td>
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<td>1.25</td>
<td>1.26</td>
<td>1.27</td>
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<tr>
<td>$W_{SI}$</td>
<td>1.23</td>
<td>1.24</td>
<td>1.24</td>
<td>1.25</td>
<td>1.27</td>
<td>1.27</td>
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<tr>
<td>Duration of unemployment spells$^b$</td>
<td></td>
<td></td>
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<tr>
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<td>4.52</td>
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<tr>
<td><strong>B. Outcomes among older workers</strong></td>
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<tr>
<td>Labor force participation rate</td>
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<tr>
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<tr>
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<td>1.19</td>
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<td>1.24</td>
<td>1.26</td>
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<tr>
<td>Duration of unemployment spells$^b$</td>
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<td></td>
<td></td>
<td></td>
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<td>$W_{SG}$</td>
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<td>Transition into nonparticipation</td>
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<tr>
<td>From employment$^c$</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>$W_{SG}$</td>
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<tr>
<td>$W_{SG}$</td>
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<td>8.14</td>
<td>8.76</td>
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<tr>
<td>$W_{SI}$</td>
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<td>11.94</td>
<td>13.04</td>
<td>13.82</td>
<td>14.44</td>
</tr>
</tbody>
</table>

NOTE: Tax rates, labor force participation rates and unemployment rates are expressed in percentage points. $^a$Monthly flows out of employment, expressed as a percentage of employment. $^b$Average duration measured in months. $^c$Monthly flows from employment to nonparticipation, expressed as a percentage of employment. $^d$Monthly flows from unemployment to nonparticipation, expressed as a percentage of unemployment.
tightness $\theta$, which are key for equilibrium allocations. The graphs in the middle show the evolution of the unemployment rate and labor force participation rates, both computed on average across all age groups. Finally, the bottom graphs display the evolution of unemployment and labor force participation among older workers.

Qualitatively, the different economies reproduce the outcomes of the benchmark WS economy: economic turbulence discourages job creation, which results in higher unemployment and lower labor force participation especially among older workers. Employment protection has potential to reduce unemployment in tranquil economic times by reducing job destruction rates. Early retirement benefits, on the other hand, have potential to induce workers to retire earlier from the workforce by making nonparticipation relatively more attractive.

The main remarks concern the quantitative results of the experiment: times of economic turbulence are substantially more detrimental to economies with tougher employment protection. The economy with $\Omega = 15$ actually shuts down when the degree of turbulence is raised to 0.95 (this is indicated by a circle on the different graphs). The outcome of interest in Figure 7 is the sudden shift in the different lines as the rate of skill depreciation increases.\(^{38}\) That is, the different economies transition to a high-taxes/high-unemployment/low-participation equilibrium.\(^{39}\) In the rest of this section, we discuss this result in detail.

The mechanism underlying Figure 7 is the following. Early retirement benefits generate strong incentives to retire earlier for workers aged 55 and above. As the number of recipients of early retirement benefits increases, the tax rate $\tau$ also increases. Employers adjust by reducing job creation efforts, which lowers $\theta$ and the job-finding rate and thus induces more numerous workers to drop from the labor market earlier. This creates a loop (or trap) of nonemployment, which is reached more rapidly when separation costs are high. The actual figures for unemployment seem implausibly large because the model magnifies the fiscal effects of having more individuals who drop out from the workforce. They would be lower if the government decided to run a deficit.

Why does employment protection exacerbate the negative interaction between shocks and other labor market institutions? Due to exogenous retirement, the job destruction tax is ineffective in making older workers stay longer in employment. On the other hand, it makes employers more selective at the entry level, even for workers who have not yet reached the early retirement age. In turbulent economic times, this lengthens the duration of unemployment for these workers. Eventually, they drop from the workforce when they reach entitlement to early retirement schemes. Observe that, in addition to these effects, the job destruction tax distorts the allocation of labor. This has potential to lower output and thus to further reduce the revenues raised by the flat-rate tax $\tau$.

Overall, the second experiment highlights the adverse consequences of using early retirement benefits to make workers drop from the workforce.\(^{40}\) That is, the general equilibrium effect (balanced

\(^{38}\)For each value of $\Omega$, we compute the equilibrium of the WS economy at one hundred, equally-spaced values for the parameter $\mu^H (H, 0)$. Thus, the break observed in each line is not a “one-off” change in steady-state equilibria. Instead, as $\mu^H (H, 0)$ is increased, the economy transitions through equilibria with intermediate values for the tax rate $\tau$.

\(^{39}\)This is not a multiple-equilibria argument since we compute every equilibria by looking for the lowest tax rate $\tau$ consistent with the balanced budget condition. That is, we initialize the computations by picking the value $\tau = 0$ and we update it very slowly after obtaining the value of $\theta$ implied by the free-entry condition.

\(^{40}\)We obtained similar effects after varying the generosity of unemployment benefits (and early retirement benefits thereof) and after changing the value of leisure utility. Quantitatively, the effects are more modest when we vary the
Figure 7. Labor market effects of early retirement benefits

Note: The upper graphs (a) show the equilibrium tax rate $\tau$ (left) and equilibrium labor market tightness $\theta$ (right). The middle graphs (b) show the unemployment rate (left) and labor force participation rate (right) on average across all age groups. The lower graphs (c) show the unemployment rate (left) and labor force participation rate (right) among older workers. The different lines in each graphs indicate different levels of employment protection, where the solid line is for the lower level of employment protection ($\bar{\Omega} = 5.0$). The circle in the different graphs indicate the degree of economic turbulence which causes the WS economy with $\bar{\Omega} = 15.0$ to shut down. The $\bar{\Omega}$ lines are based on computations of equilibria for the LF and WS economies for one hundred equally-spaced values of $\mu_x ^{(H, 0)}$ in the $[0, 1]$ interval.
budget) is increased taxation on the product of active matches and a decrease in job creation. This has potential to overturn the reduction in unemployment numbers for older workers.

6 Conclusion

This paper provided a joint account of trends in labor force participation and unemployment on the two sides of the Atlantic premised on Ljungqvist and Sargent (1998, 2008)’s turbulence story. By nesting their construct into a general equilibrium model with an operative labor supply margin, we showed that the turbulence story can simultaneously explain: (i) a reduction in labor force participation among older workers in the United States, (ii) a more pronounced decline in Europe along with rising unemployment rates, (iii) a concentration of these adverse employment outcomes on older workers. Accommodating the model with cross-country differences in certain policies, we also found that it has the potential of explaining the different role of the participation and unemployment margins across European countries. Finally, we employed the model to highlight some adverse consequences of policies that foster early retirement so as to decrease unemployment numbers.

The general equilibrium model we used offers avenues for future research. A first candidate application relates to the effects of retraining policies. The turbulence experiment naturally lends itself to questioning the role of these programs. An operative participation margin adds an interesting mechanism in that the objective of retraining policies is partly to maintain workers with depleted skills in the workforce. In the present model for instance, the unemployment effects of a policy that restores the skills of laid-off workers are unclear: unemployment numbers may well increase simply because workers drops from unemployment into nonparticipation less often. The model can serve as a structural framework for assessing these effects, which are typically difficult to capture in the context of reduced-form evaluations of labor market programs. Second, the model would fruitfully be extended to a political economy environment where labor market programs are determined by workers/voters. The experiments point to heterogeneous effects of specific labor market programs across workers in different age groups. Thus, an intriguing question is whether such programs can be supported by a majority of workers/voters in equilibrium. Finally, while the focus of the paper was on male workers throughout, it is natural to ask what lessons could be drawn from the model regarding the secular employment experiences of women. To accord with the data, the model would need a pull factor drawing more women into the workforce. As for the turbulence story, it would help explain why female employment rates over the past half-century have increased less in France, Germany or Italy than in the United States.

value of leisure utility in ways that increase nonparticipation. This is because although benefits and leisure utility are both relevant for participation decisions, only the former need to be financed by the tax $\tau$. 
Appendices

A Data and additional figures

This appendix contains additional figures and results to complement Section 2. In Subsection A.1 we report the time-series of labor force participation for younger and prime-age workers, in addition to the time-series for older workers. In Subsection A.2, we report figures for a larger set of countries: two Southern countries, Portugal and Spain, and two Scandinavian countries: Norway and Sweden. Finally, in Subsection A.3, we report results from an accounting exercise whereby we measure the contribution of unemployment and participation among older workers to aggregate male employment.

Data

The data come from the OECD labour force statistics database (http://stats.oecd.org/). The OECD provides statistics on labor force, unemployment and employment that are harmonized for the purpose of cross-country comparisons. These data are available as aggregates as well as by gender and age groups. The disaggregated data are not Census-based, however: they are taken from labor force surveys which usually span a shorter period of time. Therefore the different graphs are obtained after adjusting data in the early years of the period for some countries:

- For Germany, Italy, Sweden and the United States, data is available for the whole period (1968-2007) in all sub-groups. No adjustment needs to be made, except for a break in the time-series for Italy in 1983. The correction aligns pre-1983 levels on their post-1983 counterparts.

- For France, the OECD database contains data only from 1983 onwards. Pre-1983 figures are computed directly from the French labor force survey. The 1968-1982 waves of the survey are obtained from the repository of the Réseau Quetelet (see http://www.reseau-quetelet.cnrs.fr/).

- For Spain, Portugal and Norway, data coverage begins in the mid-1970s. This is close to the start of the period under study and therefore we chose not to adjust the raw data on Figure A2.

A.1 Labor force participation by age groups

Figure A1 plots the time-series of labor force participation for younger, prime-age and older (male) workers. The first remark pertains to differences between continental Europe and the US. As evidenced by the graphs, discrepancies between Europe and the US come from workers at the two ends of life-cycle. Labor force participation rates of prime-age workers, on the other hand, are similar across the four countries considered. This feature dovetails with the decision to mute the participation margin for prime-age workers in the calibrated model.

Second, Figure A1 shows that the decline in labor force participation was pervasive across workers belonging to the three age groups considered in the graphs. The decline was more pronounced for
Figure A1. Labor force participation in different age groups (male workers)

NOTE: Annual data from the OECD labour force statistics database. HP trend component with a value of the smoothing parameter equal to 100. Figures are for male workers. Magenta lines are for workers aged 15-24; Green lines for workers aged 25-54; Blue lines for workers aged 55-64.

older and younger workers than for prime-age workers. Arguably, the reasons for the decrease in labor force participation at the two ends of the life cycle are different. Declining labor force participation among younger workers is discussed in greater detail in Appendix B. The model in the body of the paper, on the other hand, is designed to explain changes in labor force participation towards the end of the life cycle. Finally, changes in labor force participation among prime-age workers obtained in the numerical experiments of Section 5 are consistent with the trends observed in Figure A1. As we explain in the text, this is a by-product of the experiments rather than a target outcome.

A.2 Comparison with other European countries

Figures A2 and A3 extend the analysis to a larger set of European countries: Portugal, Norway, Spain and Sweden. To begin with, Figure A2 shows that the outbreak of high unemployment rates and reduced labor force participation was not confined to the “big three” of continental Europe. Indeed,
they also affected older workers in the four countries included in the figure. The experience of Spain (the 4th largest country in continental Europe) is most similar to that of France, Germany and Italy: the unemployment rate of older male workers reached a plateau of 11 percent in the mid-1980s and their labor force participation rate declined steadily until the mid-1990s.

Lower (male) employment rates in the aggregate are heavily concentrated on workers aged 15 to 24 and 55 to 64, as illustrated in Figure A3. Like France, Germany and Italy, the other European countries in the figure achieve employment rates among prime-age workers that are in the order of magnitude of those in the US. Times of weaker employment performances affect younger and older workers more and this explains the discrepancy with the US. Finally, the contribution to lower male employment rates of each of these two groups is not as balanced in the countries of Figure A3 as it is in France and Germany. In this respect, Portugal and Spain are similar to Italy: shifts in

---

41 This is especially true for Sweden: employment rates among older workers are slightly lower than the aggregate
Figure A3. Male employment in the aggregate and relative employment rate of different age groups

Note: Annual data from the OECD labour force statistics database. Employment rate of a specific age group divided by the aggregate (male) employment rate. Circles are for workers aged 15-24; Squares are for workers aged 25-54; Diamonds are for workers aged 55-64. All figures are for male workers.

Male employment rates towards very low levels (70 percent) are associated with a significantly lower employment for younger workers relative to older workers.

A.3 Contribution to aggregate male employment

As shown in Subsection 2.2, a variance decomposition of log-employment into its two components demonstrates that nonparticipation is highly significant to the employment experience of older workers. Another possibility to establish the relative importance of unemployment and participation is to consider counterfactual time-series that result from holding constant one of these two margins. In employment rate, whereas employment among workers aged 15 to 24 can be sometimes as low as 60 percent of the aggregate employment rate.

\[^{42}\]In the body of the paper, we rely on a variance decomposition to measure the role of each margin in explaining the evolution of employment in an accounting sense. We prefer this method over the exercise based on counterfactual time-series because the latter assumes that one margin could have remained fixed independently of the behavior of the
this section, we report the results from this accounting exercise. As in Subsection 2.2, denote by \( e_{a,t} \), \( u_{a,t} \), and \( p_{a,t} \), the employment, unemployment, and participation rates of male workers, respectively, for age group \( a \) in year \( t \). In addition, denote by \( \omega_{a,t} \) the population share of age group \( a \) in year \( t \) relative to the population of male individuals of working age. A key indicator of labor market performance is the aggregate employment rate, given by

\[
e_t = \sum_a \omega_{a,t} p_{a,t} \left(1 - u_{a,t}\right)
\]

(19)

The two counterfactual time-series we consider hold either \( u_{55-64,t} \) or \( p_{55-64,t} \) constant to an early period \( t_0 \), where \( u_{55-64,t} \) or \( p_{55-64,t} \) are for workers aged 55 to 64. Since in Figures 1 and A2, both unemployment and participation rates have deteriorated, the exercise results in higher counterfactual employment rates if \( t_0 \) is set to the first years of the period, i.e. the late 1960s. Thus, in Table A1 we report the difference between the counterfactual time-series and the actual time-series of aggregate male employment. Both are expressed in percentage points.

In all countries considered, changes in labor force participation among older workers have had a more negative impact on aggregate employment relative to changes in their unemployment rates. By the late 1990s, male employment rates would have been higher by 5 percentage points in France, Germany, Norway and Portugal had older male workers not withdrawn from the labor force. The corresponding figure is 3 p.p. for Italy and Spain, and 2 p.p. for Sweden and the US. The figure for the first set of countries are large in absolute terms. For example, the average male employment rate was 67 percent in France by the end of the 1990s. Thus, it would have been higher by almost 8 percent if labor force participation among older workers had remained unchanged relative to the late 1960s. This said, the main result from Table A1 is that unemployment among older male workers is of lesser importance to explain the long-run evolution of labor market performance. In countries where unemployment among older workers mattered the most (Germany and Portugal), Table A1 indicates a 1.5 p.p effect on the employment rate measured in the late 1990s. This is less than a third of the effect of labor force participation. Finally, in most countries, we see that the effect of unemployment among older workers is less than a percentage point.

B Discussion of modeling choices

B.1 Employment and participation among younger workers

The model constructed in Section 3 is designed to account for labor market outcomes towards the end of the life-cycle. In this appendix, we explain how the model can be accommodated to explain features that pertain to the other end of the life-cycle. For this purpose, it is useful to examine the life-cycle employment profile that the model generates. As can be seen in Figure B1, the two economies predict an inverted U-shaped pattern. This is qualitatively consistent with the data (see e.g. Blundell et al., 2000). Other margin. This assumption is unlikely (for example, because of mechanisms captured by the model of Section 3) and thus, in the discussion that follows, the results should not be interpreted as causal effects.

\[\sum_a \omega_{a,t} = 1 \text{ for all } t \] since we measure the employment rate in the working-age population.

38
Table A1. Contribution of unemployment and participation to changes in aggregate male employment

<table>
<thead>
<tr>
<th>Contribution to changes in $e_t$ explained by:</th>
<th>Percentage point difference,</th>
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<tr>
<td></td>
<td>1970s</td>
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<tr>
<td>France</td>
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<tr>
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<td>$p_{a,t}$</td>
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<td>$p_{a,t}$</td>
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</table>

**Note:** Own calculations based on data from the OECD labour force statistics database. For each country, the first (resp. second) row reports the percentage point difference between the counterfactual time series holding $u_{a,t}$ (resp. $p_{a,t}$) constant to its late 1960s level and the actual employment rate of all male workers $e_t$. $u_{a,t}$ (resp. $p_{a,t}$) is the unemployment (resp. participation) rate among male workers aged 55 to 64. Figures for changes by the late 1970s, 1980s and 1990s are computed by averaging values for the last 3 years of the decade. Figures for the 2000 decade are computed by averaging values for 2005 to 2007 to avoid any confounding effect of the Great Recession. For Norway, Portugal and Spain the counterfactual time-series are computed using the first data point since the OECD for these country span a shorter period of time.
Moreover, they also reproduce the fact that European countries perform relatively well in terms of employment among prime-age workers. We now discuss two discrepancies between this figure and the data, as well as modeling assumptions to resolve them.

**Employment** In Figure B1, the increase in employment rates at the beginning of the life-cycle reflects the fact that newborn workers are initially nonemployed. Once in the workforce, the labor market friction embedded in the model is the only force that prevents them from moving immediately into employment. For this reason, the increase in employment is quantitatively too large, i.e. unemployment declines too quickly with age.

Addressing this problem amounts to generate more transitions in and out of employment for younger workers. This can be achieved by means of a form of job churning that would induce younger workers to return several times to unemployment to search for a different job. Suppose for instance that workers first need to find a “career” in the spirit of the study by Neal (1999), i.e. jobs that would allow them to accumulate human capital and thereby receive higher wages. In the context of Section 3, this means that the technology $\mu (h, h')$ is only available for workers who have discovered their career pathway. Thus, this phenomenon could be captured by assuming that: (i) younger workers initially cannot accumulate human capital, (ii) a job gives a worker access to a career only with probability $\chi$ and (iii) after this event is realized, a worker faces the same environment as in Section 3. Under these assumptions, younger workers would initially experience repeated transitions into and out of employment until landing a career. The parameter $\chi$ would be calibrated to match the decline of employment-to-unemployment transitions over the life-cycle.

**Participation** Another discrepancy in Figure B1 is that employment rates at the beginning of the life-cycle are only the converse of unemployment rates, i.e. younger workers always participate in the labor force. This is not consistent with the data because a very large fraction of workers aged 15 to 24 are enrolled in education. In labor force surveys, education is typically one of the main category used to classify individuals out of the labor force.

To replicate this feature of the data, one possibility is to introduce ex ante heterogeneity across individuals that would capture the role of education. For instance, we could have a number of individual types that differ with respect to their permanent component of productivity and assume that more productive individuals enter the labor market with a delay. The permanent component of productivity would shift the unconditional mean of the productivity process of jobs, $y_h$, i.e. yield more productive jobs for more productive individual types.

Another (not exclusive) possibility is to exploit the idea of “career” put forward in the previous paragraph. Assume that upon entering the labor market, newborn workers draw an idiosyncratic cost of participating in a program that would enable them to discover their career pathway. This program can be interpreted as education, vocational training, etc. and thus it cannot be completed instantaneously. As a result, workers who enter the program would delay entry into the labor force. Initially, these workers are classified as out of the labor force, but after completing the program they move directly into their career pathway (i.e. they have access to the technology $\mu^c (h, h')$ when on the job) and face the same environment as in Section 3.
Figure B1. Life-cycle employment profile (benchmark calibration)

NOTE: The graph shows the employment rate of a cohort of workers followed over their entire working lives in the LF economy (circles) and in the WS economy (squares). The figures are reported for every year of the working life by taking averages of the semi-quarterly values (one model period is half a quarter).

B.2 Leisure utility vs. entry costs

We have assumed that participation decisions are driven by a time-varying utility of leisure (among other factors). That is, when workers choose to participate in the labor force, they forego the utility derived from their current \( z_t \). This suggests that the utility component includes the potential entry costs that workers pay to return to the labor market. Specifically, suppose that there is a fixed cost \( \delta \) incurred by workers who move from nonparticipation to unemployment. Thus, the Bellman equation for nonparticipants (6) becomes

\[
v^n(b, h, z, a) = z(a) + \beta \sum_{a'} \alpha(a, a') \sum_{h'} \mu^o(h, h') \int \max \{ v^n(b, h', z', a'), v^u(b, h', z', a') \} \text{d}F(z'|z)
\]

After defining \( \tilde{v}^n(.) \equiv v^n(.) + \delta \) and \( \tilde{z}(.) \equiv z(.) + (1 - \beta) \delta \), we note that the above equation (20) can be rewritten as

\[
\tilde{v}^n(b, h, z, a) = \tilde{z}(a) + \beta \sum_{a'} \alpha(a, a') \sum_{h'} \mu^o(h, h') \int \max \{ \tilde{v}^n(b, h', \tilde{z}', a'), \tilde{v}^u(b, h', \tilde{z}', a') \} \text{d}F(z'|z)
\]

In particular, the relationship between \( z(.) \) and \( \tilde{z}(.) \) supports the idea that the utility of leisure in the initial model encompasses potential re-entry costs that could be incorporated in another model.

Our motivation for using the utility of leisure component instead of entry costs to rationalize participation decisions is as follows. In the data, we observe a large increase in transitions into nonparticipation towards the end of the life-cycle, both from employment and from unemployment. This feature is more easily explained by making nonparticipation more attractive as workers age rather than by varying entry costs over the life-cycle.
B.3 Benefits and leisure utility

As discussed in Subsection 5.2, a model with linear preferences does not allow to separate benefits and leisure utility. Thus, there are many combinations of parameter values for benefits and leisure utility that would produce similar equilibrium allocations. A key difference between benefits and leisure utility, however, is that the provision of benefits is financed by means of a tax on output. In turn, this implies that the distribution of nonemployed workers between unemployment and nonparticipation matters for the equilibrium budget constraint. This is illustrated by the behavior of the $WS_G$ and $WS_I$ economies in Subsection 5.2. The latter has a lower equilibrium tax rate because nonemployed workers are more often out of the labor force. In turbulent economic times, this economy experiences a more modest increase in unemployment relative to the $WS_G$ economy.

References


