Labor Market Reforms and Unemployment Dynamics[1]

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Abstract

In this paper, we quantify the contribution of labor market reforms to unemployment dynamics in nine OECD countries (Australia, France, Germany, Japan, Portugal, Spain, Sweden, the United Kingdom and the United States). We build and estimate a dynamic stochastic search-matching model with heterogeneous workers, where aggregate shocks to productivity fuel up the cycle, and unanticipated policy interventions shift structural parameters and displace the long-term equilibrium. We show that the heterogeneous-worker mechanism proposed by Robin (2011) to explain unemployment volatility by productivity shocks works well in all countries. We find that placement and employment services is the most important determinant of structural unemployment change.

JEL classification: E24, E32, J21.

Keywords: Unemployment dynamics, turnover, labor market institutions, job search, matching function.

1 Introduction

A large number of studies have sought the source of persistent differences in European and American labor market outcomes in different labor market institutions. Following Bruno and Sachs (1985), research hunted down the most effective labor market policies by running pooled cross-country time-series regressions of unemployment rates on various macroeconomic indicators (like GDP growth) and a battery of labor market institutional indices (see Nickell and Layard, 1999, for a survey). Blanchard and Wolfers (2000) and Bertola, Blau and Khan (2007) thus showed that different policy mixes induced different responses of unemployment to world-wide shocks (like an oil shock) and country-specific productivity shocks, and more recently, Bassanini and Duval (2009) emphasized the existence of complementarities between labor market policies. In parallel, in order to understand the mechanisms of these interactions, research spawned a collection of small dynamic stochastic equilibrium models focussing on one particular labor market policy at a time. For example, the influential work of Ljungqvist and Sargent (1998) emphasized the link between long-term unemployment and welfare policies, while Prescott (2004) and Rogerson (2008) more recently emphasized the role of labor taxes.

In this paper we will try to incorporate the rich reduced forms of the former approach into a small equilibrium model of the latter kind. The idea is to identify a small set of parameters of the dynamic equilibrium model governing the responses to aggregate shocks of unemployment and turnover, and channelling a wide range of labor market policies at the same time. The number of policies simultaneously examined can be large but the number of parameters through which they impact the economy should be kept small, because, for the model to be identified, the number of intervention channels should be less than the number of independent series used in the analysis. Specifically, if we use series of unemployment stocks and flows, and vacancies, as labor market variables, we argue that it will be difficult to identify more than three separate channels for policy intervention.[1]

[1]The change in unemployment is the difference between the inflow and the outflow. So stocks and flows are not independent series.

We develop a dynamic stochastic search-matching model with heterogeneous workers, where aggregate shocks to productivity fuel up the cycle, and unanticipated policy interventions displace the stationary stochastic equilibrium by shifting structural turnover parameters. It is estimated in nine different countries (Australia, France, Germany, Japan, Portugal, Spain, Sweden, the United Kingdom and the United States) over the period 1985-2007 using the following two-step procedure. First, a version without policy interventions is estimated with detrended series by the Simulated Method of Moments, and aggregate shocks are filtered out by minimizing the sum of squared differences between actual and simulated aggregate output series. Second, policy effects are introduced into the model, and estimated by minimizing the sum of squared residuals for the series of actual unemployment rates (i.e. trend plus cycle), unemployment flows and job vacancies.

The model builds on Mortensen and Pissarides (1994, henceforth MP). Yet, it is immune to Shimer's (2005) critique. Shimer showed that in the MP model Nash bargaining converts most of the cyclical volatility of aggregate productivity into wage volatility, leaving little room for change to the key variable driving unemployment, market tightness. In the same issue, Hall (2005) presented a calibration showing that the unemployment volatility puzzle could indeed be solved by wage rigidity.[2] However, his argument was recently contested by Pissarides (2009), who presented empirical evidence that the volatility of wages in new jobs, those that proceed from vacancies, is large compared to the volatility of ongoing wages. Finally, it is important to mention Hagedorn and Manovskii's (2008) solution to the puzzle, which also does not require wage rigidity. However, it is a rather unrealistic calibration of the MP model with a very large value of non market time.

Our model extends the model of Robin (2011) by endogenizing labor demand through a matching function and vacancy creation. It has two main ingredients that make it distinct from the MP model, namely heterogenous worker abilities[3] and a different wage setting mechanism. First, workers differ in ability. In good states of the economy, all matches are profitable and all workers are employable. In bad states, low-skill workers fail to generate

[2]See also Hall and Milgrom (2008) and Gertler and Trigari (2009).

[3]In this simple version of the model, we abstract from firm heterogeneity in production. For an extension of the model with heterogeneous firms, see Lise and Robin (2013).

positive surplus and are thus laid off or stay unemployed longer. With a thick left tail of the ability distribution, small adverse shocks to the economy lead a disproportionately high number of low-skill workers into the negative surplus region and into unemployment. We show that this amplification mechanism fits unemployment volatility well in all nine major OECD countries used in the empirical analysis.

We also assume that wage contracts are long term contracts that can only be renegotiated by mutual agreement (see Postel-Vinay and Robin, 2002). Wage renegotiation is either induced by on-the-job search and Bertrand competition between employers, or by aggregate shocks big enough to threaten match disruption. As a consequence, wages in new jobs are more volatile than ongoing wages.[4] This assumption also tremendously simplifies the form of the Bellman equation defining the surplus of a match with a worker of a given type in a given state of the economy, and it thus makes the dynamic stochastic equilibrium very easy to solve.

Ultimately, we use our model to assess the impact of labor market reforms on the actual (i.e. not detrended) rate of unemployment by way of counterfactual simulation. We find over the period 1985-2007 a significant effect of active labor market policies — especially placement and employment services, nearly a full percentage point of unemployment. All other policies have a more limited impact, between a fifth and a third of a percentage point.

The paper is organized as follows. In Section 2, a dynamic sequential-auction model with heterogeneous workers and identical firms is developed. Section 3 describes the data and Section 4 the estimation procedure. In Section 5, the business cycle version of the model is estimated on nine OECD countries. In Section 6, labor market policy effects are estimated. The last section concludes.

[4] Hall and Krueger (2012) emphasize the empirical relevance of on-the-job search to explain wage formation.

2 The model

Time is discrete and indexed by $t \in \mathbb{N}$. The global state of the economy is an ergodic Markov chain $y_t \in \{y_1 < ... < y_N\}$ with transition matrix $\mathbf{\Pi} = (\pi_{ij})$. We use y_t to denote the random variable and y_i or y_j to denote one of the N possible realizations. There are M types of workers and ℓ_m workers of each type, with $\ell_1 + ... + \ell_M = 1$. Workers of type m have ability x_m and $x_m < x_{m+1}$. All firms are identical. Workers and firm are paired into productive units. The per-period output of a worker of ability x_m when aggregate productivity is y_i is denoted as $y_i(m)$.

2.1 Turnover and unemployment

Matches form and break at the beginning of each period. Let $u_t(m)$ denote the proportion of unemployed in the population of workers of ability x_m at the end of period $t-1$, or at the beginning of period t, just before revelation of the aggregate shock for period t, and let $u_t = u_t(1)\ell_1 + ... + u_t(M)\ell_M$ define the aggregate unemployment rate. Let $S_t(m)$ denote the surplus of a match with a worker of type x_m at time t, that is, the present value of the match minus the value of unemployment and minus the value of a vacancy (assumed to be nil). Only matches with positive surplus $S_t(m) \geq 0$ are viable.

At the beginning of period t, y_t is realized and a new value $S_t(m)$ is observed for the match surplus. An endogenous fraction $\mathbf{1}\{S_t(m) < 0\}[1 - u_t(m)]\ell_m$ of employed workers is immediately laid off if the match surplus becomes negative, and another fraction $\delta\mathbf{1}\{S_t(m) \geq 0\}[1 - u_t(m)]\ell_m$ is otherwise destroyed. In addition, a fraction $\lambda_t\mathbf{1}\{S_t(m) \geq 0\}u_t(m)\ell_m$ of employable unemployed workers meet with a vacancy. Finally, we also allow employees to meet with alternative employers, and move or negotiate wage increases (more on this later).

Aggregate shocks thus determine unemployment by conditioning job destruction and the duration of unemployment. The law of motion for individual-specific unemployment rates is

$$u_{t+1}(m) = \begin{cases} 1 & \text{if } S_t(m) < 0, \\ u_t(m) + \delta(1 - u_t(m)) - \lambda_t u_t(m) & \text{if } S_t(m) \geq 0. \end{cases}$$

The dynamics of unemployment by worker type depends on the dynamics of the whole match surplus, not on how the surplus is split between the employer and the worker.

Define the exit rate from unemployment (or job finding rate) as the product of the meeting rate and the share of employable unemployed workers,

$$f_t = \lambda_t \frac{\sum_m u_t(m)\ell_m \mathbf{1}\{S_t(m) \geq 0\}}{u_t}. \tag{1}$$

Define also the job destruction rate as the sum of the exogenous and the endogenous layoff rates,

$$s_t = \delta + (1 - \delta)\frac{\sum_m (1 - u_t(m))\ell_m \mathbf{1}\{S_t(m) < 0\}}{1 - u_t}. \tag{2}$$

Aggregate unemployment then satisfies the usual recursion:

$$u_{t+1} = u_t + s_t(1 - u_t) - f_t u_t.$$

It is important to stress here that both the job finding rate f_t and the job destruction rate s_t mix structural parameters (in λ_t and δ) with endogenous variables: the share of employable unemployed workers ($\frac{\sum_m \mathbf{1}\{S_t(m) \geq 0\} u_t(m)\ell_m}{u_t}$) and the share of unemployable employed workers ($\frac{\sum_m \mathbf{1}\{S_t(m) < 0\}(1 - u_t(m))\ell_m}{1 - u_t}$). For that reason, standard least-squares estimates of matching functions or layoff rates will not provide consistent estimators. A structural estimation is required.

2.2 Rent sharing

We assume that employers have full monopsony power with respect to unemployed workers. They keep the whole surplus in this case and unemployed workers leave unemployment with a wage that is only marginally greater than their reservation wage. The assumption that unemployed workers have zero bargaining power relative to employers is mainly technical: it makes the dynamics of unemployment independent of wages. As the focus of this paper is on unemployment dynamics and worker flows, we believe that this decoupling is justified. Note however that we could easily allow for Nash bargaining between unemployed workers and firms, but this would complicate the model a lot for a very small gain.

Employed workers search on the job. When the search for an alternative employer is successful, we assume that Bertrand competition between the incumbent and the poacher transfers the entire surplus to the worker. The worker is indifferent between staying or moving. We assume that job-to-job mobility is then decided by coin tossing. Employer heterogeneity would eliminate this indeterminacy, at the cost of great additional complexity (Lise and Robin, 2013).

2.3 Vacancy creation and market tightness

Firms post vacancies v_t until ex ante profits are exhausted. The total vacancy cost is cv_t. Vacancies can either randomly meet with an unemployed worker or with an employed worker.[5] However, only the meetings with unemployed workers generate a profit to the firm. Free entry then ensures that

$$cv_t = \lambda_t \sum_{m=1}^{M} u_t(m)\ell_m S_t(m)^+, \tag{3}$$

where we denote $x^+ = \max(x, 0)$.

Define market tightness as the ratio of vacancies and workers' aggregate search intensity,

$$\theta_t = \frac{v_t}{u_t + k(1 - u_t)}, \tag{4}$$

where k is the relative search intensity of employees with respect to unemployed.[6] The

[5] We assume that firms cannot direct search towards specific workers (the unemployed), as this feature would bring the model too close from a competitive labor market, which is unlikely to be verified empirically.

[6] We use $k = 0.12$ as in Robin (2011) but imposing a zero search intensity for employees has little influence on the estimation outcome.

meeting rate λ_t is related to market tightness via the meeting function, $\lambda_t = f(\theta_t)$, where f is an increasing function, likely concave.

2.4 The value of unemployment and the match surplus

Let $U_i(m)$ denote the present value of remaining unemployed for the rest of period t for a worker of type m if the economy is in state i. It solves the following linear Bellman equation:

$$U_i(m) = z_i(m) + \frac{1}{1+r}\sum_j \pi_{ij} U_j(m). \tag{5}$$

This equation is understood as follows. An unemployed worker receives a flow-payment $z_i(m)$ for the period. At the beginning of the next period, the state of the economy changes to y_j with probability π_{ij} and the worker receives a job offer with some probability. We have assumed that employers offer unemployed workers their reservation wage on a take-it-or-leave basis, thus effectively reaping the whole surplus. As a consequence, the present value of a new job to the worker is only marginally better than the value of unemployment. Hence, the continuation value is the value of unemployment in the new state j whether the workers remains unemployed or not.

Let us now turn to the match surplus. After a productivity shock from i to j all matches yielding negative surplus are destroyed. Then, either on-the-job search delivers no bite, and the match surplus only changes because the macroeconomic environment changes; or the worker is poached and Bertrand competition gives the whole match surplus to the worker, whether she moves or not. As everything that the worker expects to earn in the future contributes to the definition of the current surplus, the surplus of a match with a worker of type m when the economy is in state i thus solves the following (almost linear) Bellman equation:

$$S_i(m) = y_i(m) - z_i(m) + \frac{1-\delta}{1+r}\sum_j \pi_{ij} S_j(m)^+. \tag{6}$$

This almost-linear system of equations can be solved numerically by value function iteration. As for the unemployment value, the match surplus only depends on the state of the economy.

2.5 Steady-state equilibrium

If the economy stays in state i for ever, the equilibrium unemployment rate for group m is

$$u_i(m) = \frac{\delta}{\delta + \lambda_i}\mathbf{1}\{S_i(m) \geq 0\} + \mathbf{1}\{S_i(m) < 0\} = 1 - \frac{\lambda_i}{\delta + \lambda_i}\mathbf{1}\{S_i(m) \geq 0\},$$

where $\lambda_i \equiv f(\theta_i)$. The aggregate unemployment rate is

$$u_i = \sum_{m=1}^{M} u_i(m)\ell_m = 1 - \frac{\lambda_i}{\delta + \lambda_i}L_i,$$

where $L_i = \sum_{m=1}^{M} \ell_m \mathbf{1}\{S_i(m) \geq 0\}$ is the number of employable workers. Lastly, the free entry condition takes the following form:

$$c\theta_i = \lambda_i \sum_{m=1}^{M} \frac{u_i(m)\ell_m}{u_i + k(1 - u_i)} S_i(m)^+ = \frac{\delta\lambda_i}{\delta + [1 - L_i + k(1 - \delta)L_i]\lambda_i}\overline{S}_i^+,$$

with $\overline{S}_i^+ = \sum_{m=1}^{M} \ell_m S_i(m)^+$ being the aggregate surplus value. Therefore, the exit rate from unemployment is the following fixed point:

$$\lambda_i = f\left(\frac{\delta\lambda_i}{\delta + [1 - L_i + k(1 - \delta)L_i]\lambda_i}\frac{\overline{S}_i^+}{c}\right).$$

The steady-state equilibrium is thus characterized as a fixed point of a simple nonlinear function that can be solved by iterating the function.

2.6 Parameterization and functional forms

Unemployment exit rate and the matching function. The meeting rate, and hence the unemployment exit rate, are related to market tightness θ_t via a Cobb-Douglas matching technology:

$$\lambda_t = f(\theta) = \phi\theta^\eta. \tag{7}$$

A standard cross-country OLS regression of job finding rates on tightness (in logs) simply defined as v/u delivers estimates of matching efficiency $\phi = 0.712$ and matching elasticity $\eta = 0.289$, in tune with the empirical literature (Murrain and de Serres, 2013).

Aggregate shocks. We assume that aggregate productivity follows a Gaussian AR(1) process:

$$\ln y_t = \rho \ln y_{t-1} + \sigma \varepsilon_t, \tag{8}$$

where innovations are iid-normal $N(0, 1)$. Note that the aggregate productivity shock y_t is a latent process that does not a priori coincide with observed output or output per worker. Indeed, observed output is the aggregation of match output $y_t(m)$ across all active matches, say

$$Y_t = \sum_m [1 - u_t(m)]\, \ell_m\, y_t(m), \tag{9}$$

and is thus endogenous. Therefore, the structural parameters (ρ, σ) cannot be directly inferred from the observed series of aggregate output.

We discreetness the aggregate productivity process y_t as follows. Let F denote the estimated equilibrium distribution of y_t.[7] The joint distribution of two consecutive ranks $F(y_t)$ and $F(y_{t+1})$ is a copula C (i.e. the CDF of the distribution of two random variables with uniform margins). To discreetness the aggregate productivity processes we first specify a grid $a_1 < ... < a_N$ on $[\epsilon, 1-\epsilon] \subset (0, 1)$ of N linearly spaced points including end points ϵ and $1-\epsilon$. Then we set $y_i = F^{-1}(a_i)$ and $\pi_{ij} \propto c(a_i; a_j)$, where c denotes the copula density and we impose the normalization $\sum_j \pi_{ij} = 1$. In practice, we use $N = 150$, $\epsilon = 0,002$; F is a log-normal CDF and c is a Gaussian copula density, as implied by the Gaussian AR(1) specification.

Worker heterogeneity. Match productivity is specified as $y_i(m) = y_i x_m$, where $(x_m, m = 1, ..., M)$ is a grid of M linearly spaced points on the interval $[C, C+1]$. The choice of the support does not matter much provided that it is large enough and contains one. A

[7] That is, with white-noise innovations, $\ln y_t \sim N\left(0, \frac{\sigma^2}{1-\rho^2}\right)$.

beta distribution is assumed for the ability distribution, namely

$$\ell_m \propto \text{betapdf}\left(x_m, \nu, \mu\right), \tag{10}$$

with the normalization $\sum_m \ell_m = 1$. The beta distribution allows for a variety of shapes for the density (increasing, decreasing, non monotone, concave or convex). We use a very dense grid of $M = 500$ points to guarantee a good resolution in the left tail.

Leisure and vacancy costs. The opportunity cost of employment $z_i(m)$ (aggregating the utility of leisure, unemployment insurance and welfare) is specified as a constant z.

Labor market institutions. Because of the feed-back effects implied by the model, it is important for identification that we restrict the channels of policy interventions. For example, any policy that directly impacts matching efficiency (ϕ) immediately changes the meeting rate (λ_t) and, subsequently, the number of created vacancies (v_t) via the free entry condition. Both effects contribute to changing the job finding rate (f_t). If one makes the cost of posting a vacancy (c) a concurrent intervention channel for this policy, then the policy affects vacancy creation in two ways, which evidently reduces the chances that the model be identified.

Because we only have independent data information on turnover flows (f_t and s_t) and vacancies (v_t) we decided to introduce labor market policies (henceforth LMPs) through only three structural parameters: matching efficiency (ϕ) via equation (1), the job destruction rate (δ) via equation (2), and the cost of posting a vacancy (c) via equation (3). Formally, we let parameters ϕ, δ and c in country n at time t be log-linear indices of country-specific institutional variables $X_{nt}^1, ..., X_{nt}^K$:

$$\phi_{nt} = \phi_n^0 \exp\left(\sum_k \phi^k X_{nt}^k\right), \quad \delta_{nt} = \delta_n^0 \exp\left(\sum_k \delta^k X_{nt}^k\right), \quad c_{nt} = c_n^0 \exp\left(\sum_k c^k X_{nt}^k\right).$$

In these equations, the LMP semi-elasticities (ϕ^k, δ^k, c^k) are common to all countries. However, intercepts $(\phi_n^0, \delta_n^0, c_n^0)$ are country-specific. This framework thus identifies institutional effects from policy *variations*.

Table 1: Unemployment and Turnover Cycle - Descriptive Statistics

	Period	Unemployment				Job Destruction Rate			Job Finding Rate		
		mean	std	std		mean	std		mean	std	
				trend	cycle		trend	cycle		trend	cycle
Australia	1979Q1-2009Q4	5.69	2.62	1.19	1.10	3.78	0.36	0.23	47.74	6.62	5.69
Germany	1984Q1-2010Q1	6.09	2.72	1.27	1.06	1.81	0.06	0.52	18.71	0.88	2.71
Spain	1978Q1-2010Q2	12.76	4.10	1.94	2.78	3.88	0.73	0.16	21.67	8.04	5.55
France	1976Q1-2010Q1	6.18	3.33	1.58	0.77	2.41	0.43	0.16	22.59	3.64	2.78
UK	1967Q2-2010Q1	6.25	2.74	1.86	1.29	3.06	0.48	0.60	43.87	15.22	5.35
Japan	1978Q1-2007Q4	2.65	1.31	0.92	0.49	1.51	0.27	0.22	42.78	4.21	4.83
Portugal	1987Q1-2010Q2	5.70	2.29	0.84	1.22	1.45	0.20	0.42	20.58	0.99	3.55
Sweden	1972Q1-2010Q1	4.81	3.03	2.20	1.85	2.84	0.75	0.27	56.06	10.14	6.31
US	1960Q1-2010Q2	5.95	1.54	0.75	1.14	4.82	0.68	0.66	76.59	6.03	5.21

Notes: All figures are in percent. Series were detrended using the HP-filter with smoothing parameter 10^5.

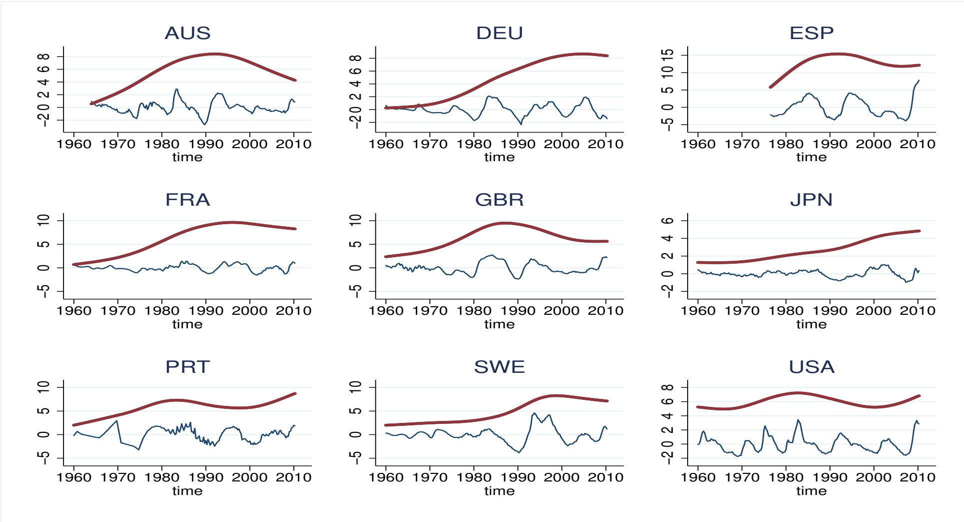
3 The data

We have assembled data on labor market outcomes and institutions for nine OECD countries: Australia, France, Germany, Japan, Portugal, Spain, Sweden, United Kingdom and Unites States, over the period 1985-2007. These data and their sources are described in detail in Appendix A.

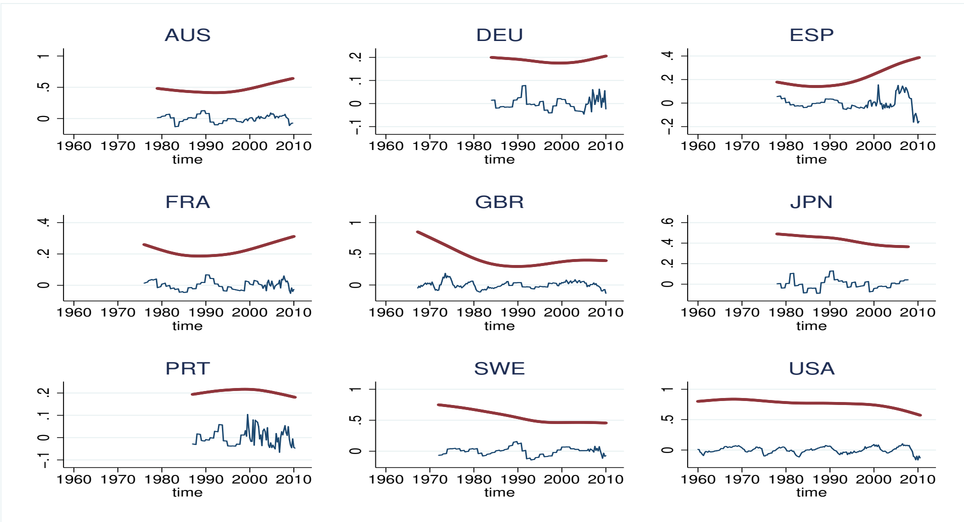
3.1 Unemployment and turnover cycle

Table 1 provides descriptive statistics on the rate of unemployment as well as the probability of entering and exiting unemployment. All series are quarterly. The trend and cyclical components were extracted by HP-filtering the log-transformed series with a smoothing parameter equal to 10^5, as in Shimer (2005), and re-exponentiating. The volatility of unemployment and of turnover are very different across countries. Japan displays lower and less volatile unemployment, due to lower job destruction rates, than any other country. The US exhibit more turnover and higher exit rates from unemployment. France, and Japan to a lesser extent, display particularly low cyclical volatility in unemployment turnover.

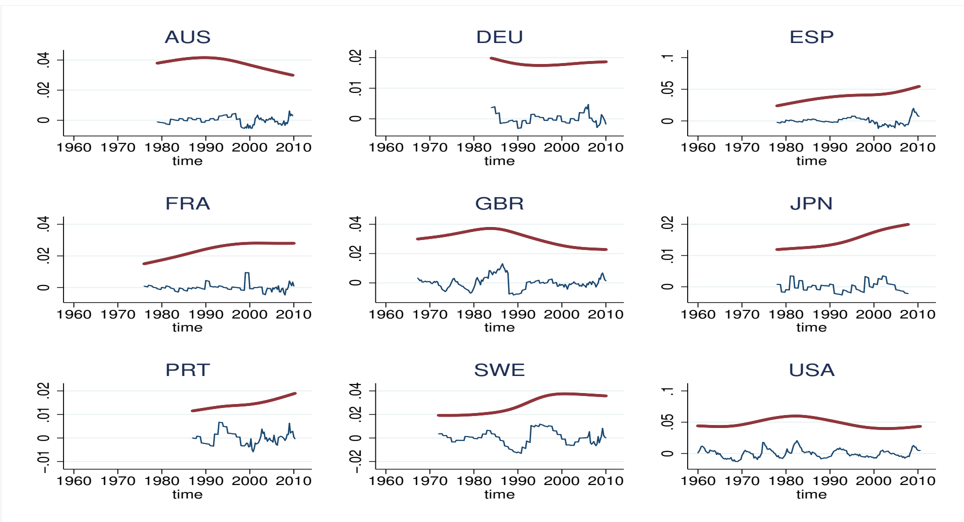
Interesting patterns emerge from trends (Figure 1). Unemployment culminates in the 1980s in the UK and the US, and in the 1990s in Australia, France, Spain and Sweden.



(a) Unemployment



(b) Job Finding Rate



(c) Job Destruction Rate

Figure 1: Unemployment Rate and Turnover - Trends and Cycles

Japan displays a monotonic, increasing trend throughout the 1960-2010 period. Unemployment rebounds in the early 2000s in Portugal and the US. Long-term unemployment trends hide strikingly different trends in turnover rates. Job destruction rates tend to increase in France, Japan, Portugal, Spain and Sweden, and to decrease in Australia, the UK and the US since the mid-1980s. Job-finding rates tend to increase in Australia, France and Spain, and to decrease in Japan, Sweden, the UK and the US. These patterns are potentially associated with important labor market reforms that we now briefly discuss.

3.2 Labor market policies

The set of labor market policy variables used as potential determinants of unemployment stocks and flows in the empirical analysis are the following: i) the replacement rate used to calculate unemployment insurance (UI) benefits at first date of reception; ii) public expenditure on active labor market policies per unemployed worker (ALMPs) normalized by GDP per worker, and broken down into three sub-categories (placement and employment services, employment incentives[8] and training); iii) the OECD index of product market regulation; iv) the OECD index of employment protection for regular contracts; v) the tax wedge (personal income tax plus payroll taxes and social security contributions). We exclude from the analysis LMPs such as the legal minimum wage, union density and other wage bargaining institutions as they mostly affect wages, which are outside the scope of this paper.

Table 2 displays the means and the standard deviations of all policy variables and their year-on-year changes between 1985 and 2007 (the period over which we have gathered a balanced sample of institutional variables). France, Portugal, Spain and Sweden offer relatively high support to the unemployed and high employment protection at the same time, whereas the US, the UK, Australia and Canada are on the low side. Germany and Japan are somewhere in-between. Note that some institutions show no change in the period (such as employment protection in the US). The associated policy effects cannot be

[8]These expenditures include incentives to private employment, direct job creation, job sharing and start-up incentives.

Table 2: Labor Market Institutions - 1985-2007

	Initial Replacement Rate		ALMP: Placement (%)		ALMP: Training (%)		ALMP: Incentives (%)		Product Market Regulation		Employment Protection		Tax Wedge	
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Australia	24.418	1.855	2.471	0.890	0.637	0.461	2.370	0.487	2.790	1.002	1.257	0.248	28.140	2.318
Δ	*-0.026*	*0.294*	*0.030*	*0.016*	*-0.002*	*0.033*	*0.009*	*0.044*	*-0.029*	*0.080*	*0.005*	*0.053*	*-0.011*	*0.628*
Germany	37.968	1.361	3.033	0.370	5.576	1.688	5.738	1.441	3.347	1.506	2.701	0.145	35.449	2.279
Δ	*0.009*	*0.337*	*0.007*	*0.039*	*0.021*	*0.170*	*-0.006*	*0.118*	*-0.046*	*0.110*	*0.005*	*0.035*	*0.034*	*0.530*
Spain	66.639	3.495	0.787	0.295	1.259	0.347	3.146	1.200	3.625	1.254	3.095	0.639	30.048	0.979
Δ	*-0.189*	*0.873*	*0.012*	*0.018*	*0.018*	*0.033*	*0.035*	*0.077*	*-0.036*	*0.097*	*-0.016*	*0.118*	*-0.022*	*0.478*
France	59.509	1.223	1.950	0.435	3.975	0.411	4.798	1.545	4.044	1.048	2.388	0.063	41.692	0.952
Δ	*0.027*	*0.259*	*0.013*	*0.019*	*-0.005*	*0.027*	*0.029*	*0.083*	*-0.040*	*0.100*	*0.002*	*0.015*	*-0.007*	*0.253*
UK	20.781	2.557	3.415	1.802	1.908	1.367	0.882	0.708	2.102	1.153	1.009	0.081	28.951	1.318
Δ	*-0.093*	*0.546*	*0.041*	*0.099*	*-0.024*	*0.067*	*-0.026*	*0.044*	*-0.037*	*0.111*	*0.002*	*0.018*	*-0.036*	*0.462*
Japan	33.891	4.129	6.738	3.118	0.983	0.210	0.701	0.232	3.350	0.864	1.870	0.000	22.077	2.585
Δ	*0.122*	*0.488*	*-0.140*	*0.083*	*-0.010*	*0.009*	*0.004*	*0.032*	*-0.032*	*0.094*	*0.000*	*0.000*	*0.107*	*0.338*
Portugal	65.493	2.579	2.128	0.540	3.534	1.375	3.586	1.092	4.122	1.131	4.449	0.291	26.762	2.261
Δ	*0.081*	*0.566*	*0.010*	*0.042*	*0.038*	*0.137*	*0.012*	*0.104*	*-0.039*	*0.107*	*-0.011*	*0.062*	*0.119*	*0.699*
Sweden	81.288	6.019	5.073	2.560	12.169	7.455	20.248	11.231	3.236	1.067	2.875	0.019	52.406	3.126
Δ	*-0.141*	*0.735*	*-0.032*	*0.171*	*-0.191*	*0.405*	*-0.226*	*0.543*	*-0.032*	*0.085*	*0.000*	*0.004*	*0.044*	*0.776*
US	27.704	2.493	0.846	0.121	1.368	0.328	0.849	0.041	2.181	0.333	0.170	0.000	23.600	1.617
Δ	*-0.040*	*0.788*	*-0.003*	*0.009*	*-0.011*	*0.015*	*0.000*	*0.006*	*-0.011*	*0.045*	*0.000*	*0.000*	*0.040*	*0.383*

Table 3: Labor Market Institutions - Correlated Change in 1985-2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Initial Replacement Rate	1.000						
(2) ALMP: Placement	-0.042	1.000					
(3) ALMP: Training	0.568	0.488	1.000				
(4) ALMP: Incentives	0.557	0.572	0.944	1.000			
(5) Product Market Regulation	0.224	0.046	0.409	0.303	1.000		
(6) Employment Protection	0.196	0.067	-0.077	-0.049	0.170	1.000	
(7) Tax Wedge	0.047	-0.451	-0.356	-0.391	-0.393	0.037	1.000

Note: Correlations of deviations of LMPs from country-specific means.

identified in this case. The sign of the average policy change and its standard deviation, identify the countries which intervened on this institutional front during the period. Only product market regulation shows a convergence toward deregulation in all countries, and only Portugal and Spain did reduce employment protection. All other policies show great diversity across country. Finally, Sweden stands alone in its effort to reduce ALMP spendings; but it true that it started from a very high point.

Table 3 displays the correlations between the LMP variables centered around their country-specific means. The three ALMP components are strongly correlated, in particular training and firm incentives. Interestingly, any increase in product market regulation or unemployment insurance is often accompanied by another policy aiming at reducing the social cost of unemployment (more is spent on training or employment incentives or in a reduction of the tax wedge). This is much less the case for employment protection.

As already emphasized, it is important for identification to restrict the channels of policy interventions. Heuristically, in absence of a more formal model of the mechanisms of policy interventions, we ended up restricting the mapping between LMPs and structural parameters in the following way.

A first set of policies affect the search-matching technology. More generous unemployment benefits should reduce unemployed workers' search intensity. More placement and employment services should increase the rate at which unemployed workers find jobs, and they should help improving match quality. Matches of higher quality should in turn be more resilient to exogenous destruction shocks. More training provided to unemployed workers should also raise match quality and reduce job destruction. The impact of training on job finding rates is yet ambiguous and possibly negative, as the participation to training programs may also increase the duration of unemployment. Therefore, we allow the replacement rate, the indices for placement and employment services, and training to determine parameters ϕ and δ (matching efficiency and exogenous job destruction).

Employment incentives (like payroll tax discounts), product market regulation, and employment protection to some extent, are another group of policies that operate through similar mechanisms: they primarily affect job creation and job destruction. Employment incentives encourage vacancy creation, but they also make employers less picky and thus permit the creation of matches of lower quality, which therefore terminate sooner than later. Less product market regulation fosters competition between firms, and less monopsony power benefits to employment in a way that can be captured in our model by a reduction in vacancy cost. At the same time, more competition between firms reduces profit margins and increases the probability of failure, and thus generates more job destruction. Employment protection renders separation more costly and delays job destruction. However, employment protection has no direct effect on the cost of vacancies. It only conditions job creation indirectly, as a lower job destruction rate mechanically implies that less job creation is needed to maintain the employment stock in equilibrium. These policies have no obvious impact on the matching function.[9] Hence, we allow employment incentives and product market regulation to determine parameters c and δ (cost of vacancy and exogenous job destruction). Employment protection only conditions δ.

These preconceptions are largely confirmed by the reduced-form regressions on unemployment rate, layoff rates, job finding rates and vacancies reported in Table 4. These regressions are similar to the ones estimated by Blanchard and Wolfers (2000). They found the same impact of ALMPs and product market regulation. However, they reported a positive correlation between employment protection and unemployment, which we could never obtain, whatever the estimation period. Note that Cahuc and Postel-Vinay (2002) estimated, like us, a negative correlation between EPL and unemployment.

[9] Murrain and de Serres (2013) provide empirical evidence that product market regulation hardly affects the matching efficiency parameter ϕ. So this channel is excluded from the analysis.

Table 4: Reduced-form Regressions of Unemployment, Turnover and Tightness on LMPs

	Log UNR	Log LDR	Log JFR	Log V	Log Tightness
Initial Replacement Rate	0.064	0.030	-0.037	-0.065	-0.133
	(0.008)	(0.008)	(0.008)	(0.020)	(0.021)
ALMP: Placement	-0.095	-0.069	0.020	*-0.012*	0.080
	(0.006)	(0.006)	(0.006)	(0.015)	(0.016)
ALMP: Training	-0.126	-0.091	-0.014	-0.198	-0.099
	(0.016)	(0.015)	(0.016)	(0.042)	(0.044)
ALMP: Incentives	0.013	0.034	*0.063*	0.326	0.341
	(0.016)	(0.016)	(0.017)	(0.044)	(0.046)
Product Market Regulation	0.045	-0.016	-0.076	-0.167	-0.199
	(0.011)	(0.011)	(0.011)	(0.028)	(0.030)
Employment Protection	-0.047	-0.078	-0.042	-0.006	0.046
	(0.006)	(0.006)	(0.006)	(0.015)	(0.016)
Tax Wedge	0.082	0.037	-0.051	0.015	-0.064
	(0.007)	(0.007)	(0.007)	(0.018)	(0.019)

Notes: 1) All regressions contain country fixed effects and country-specific controls for business cycle (ie the HP-filtered log GDP). 2) Italicized estimates are not significant at the 5% level. 3) UNR: Unemployment Rate; LDR: Layoff rate; JFR: Job Finding Rate; V: Vacancies; Tightness = vacancies/unemployment.

The set of labor market policies is complemented by a handful of socio-demographic variables, namely the shares of workers aged 15-24 and 55-64 in the 15-64 population, and mean years of higher education among the 15-64 population. Indeed there is empirical evidence (e.g. Murrain et al., 2013) that both unemployment entry and exit rates decline with age. These socio-demographic variables are assumed to have an impact on turnover parameters ϕ and δ.

4 Estimation procedure

The estimation is conducted in two steps. In the first step, we estimate a stationary version of the model that fits the cyclical components of the series of GDP, unemployment, job finding and job destruction rates, and vacancies separately for the nine OECD countries. Then, we use the estimated model to filter out the series of aggregate shocks y_t driving the business cycle. In the second step, we introduce LMPs into the empirical framework and we estimate their impact on the structural parameters ϕ, δ and c by fitting the raw series (non detrended) of unemployment, turnover and vacancies jointly for all nine countries. This estimation procedure is considerably easier to implement than any other method, Bayesian or frequentist, for nonlinear state-space models.

4.1 Assessing business-cycle dynamics

The estimation of the parameters controlling for the short-term response of the economy to business cycle shocks closely follows the method in Robin (2011). We assume that HP-filtered series follow the model of this paper as in a stationary environment exempt from any institutional change. Hence, we impose $\phi^k = \delta^k = c^k = 0$ to each policy variable ($k \geq 1$) and each country. Ten parameters remain to be estimated: the country-specific vacancy creation cost c^0, the exogenous layoff rate δ^0, the two parameters of the matching function (ϕ^0, η), the leisure cost parameter z, the three parameters of the distribution of worker heterogeneity (C, ν, μ), and the two parameters of the latent productivity process (ρ, σ). The number of aggregate states is set to $N = 150$, the number of different ability types is taken equal to $M = 500$.

The business-cycle (BC) parameters $\theta_{BC} = (c^0, \delta^0, \phi^0, \eta, z, C, \nu, \mu, \rho, \sigma)$ are estimated using the Simulated Method of Moments, separately, country by country. In practice, we simulate very long series at quarterly frequency ($T = 5000$ observations) of aggregate output, unemployment rates, unemployment turnover and vacancies, and we search for the set of parameters θ_{BC} that best matches the following 18 country-specific moments: i) the mean, standard deviation and autocorrelation of log-GDP; ii) the mean, standard deviation and kurtosis of log-unemployment;[10] iii) the mean and the standard deviation of logged job finding and job destruction rates, and market tightness; iv) four output elasticities: unemployment, turnover rates and market tightness; v) the elasticities of the job finding rate with respect to market tightness and unemployment rate.

Once these structural parameters have been estimated, we filter out the series of aggregate shocks y_t so as to minimize the sum of squared residuals of log GDP.

[10]Matching the kurtosis of time-series observations forces the simulated series to be smooth.

4.2 Assessing policy effects

In a second step, we take the series of aggregate shocks y_t as given, and we estimate the policy parameters $\theta_P = (\phi^k, \delta^k, k = 1, ..., K)$ by Simulated Least Squares, that is we minimize the sum of squared residuals (i.e. the difference between simulated and observed series) for the *actual series* (i.e. not HP-filtered) of unemployment, turnover rates and market tightness, weighing observations by the inverse volatility (standard deviation) of each series. Contrary to the first step, the estimation of policy parameters is done jointly for all countries. Note that the constants in θ_{BC} are re-estimated together with θ_P. Fortunately, we obtained very similar first-stage and second-stage estimates for θ_{BC}.[11]

The economy is simulated assuming myopic expectations on policy interventions. Whenever a policy variable X^k is changed, which only happens infrequently, we recalculate the present values of unemployment and of match surplus for all aggregate states,[12] together with the values of job finding and job destruction rate, and keep them set to these levels until the next policy intervention.

We obtain standard errors for the estimates of LMP parameters θ_P as follows. Rather than estimating the Jacobian matrix and using the "sandwich" formula, which is numerically cumbersome and not very reliable given the amount of numerical simulations involved, we instead note that equation (1) implies that

$$\log f_t - \eta \log \theta_t - \log \left(\frac{\sum_m u_t(m) \ell_m \mathbf{1}\{S_t(m) \geq 0\}}{u_t} \right) - \log \phi^0 = \sum_k \phi^k X^k_{nt}.$$

We then compute standard errors for the parameters ϕ^k using the standard OLS formula for the regression of the left-hand side variable on LMP regressors. This calculation may severely overestimate the precision of the estimation by neglecting estimation errors induced by using parameter estimates instead of true values to predict the left hand side. But it nevertheless provides useful information on how much the simulated series are changed by a small perturbation of the policy parameters. We use a similar approach for

[11]See Appendix B.

[12]Note that the present values do not depend on parameters ϕ and c. The match surplus only changes with δ.

the other policy parameters based on equations (2) and (3).

5 The dynamics of cyclical unemployment

5.1 Parameter estimates

The results of the first-stage estimation are reported in Table 5. Productivity is more volatile in European countries than in Australia and the US. Worker ability is less heterogeneous in Portugal and more heterogeneous in Germany and Japan. In parallel, the opportunity cost of employment z is higher in Portugal and lower in Japan and Germany; otherwise, it does not differ much from 0.7, which is Hall and Milgrom's (2008) calibration for the US. It is difficult to compare the estimates of the vacancy cost across countries, as they use different ways of measuring vacancies. They are also not comparable with those estimated or calibrated in the other studies (e.g. 0.36 in Pissarides, 2009, 0.43 in Hall and Milgrom, 2008, 0.58 in Hagedorn and Manovskii, 2008), which all use a Mortensen-Pissarides model with a non-zero bargaining power for workers.[13] Matching efficiency (ϕ) is higher in Australia and Sweden and lower in France and Germany. The rate of exogenous job destruction (δ) is higher in the United States, Australia and Spain, and lower in Japan and Portugal. This inference is broadly in line with other micro and macroeconomic evidence on job turnover rates (see Jolivet et al., 2006, Elsby et al., 2012, Murrain et al., 2013).

Note that the elasticity of the matching function was arbitrarily fixed to 0.5 in all country-level estimations. Indeed, we could fit all moments well for any preset value of η. We explain this lack of identification as follows. The duration of unemployment is controlled by three components: matching efficiency (ϕ), the meeting elasticity with respect to market tightness (η) and worker employability (the sign of the match surplus). It seems that the latter two components are not separately identified. If one increases the meeting frequency as a function of the number of created vacancies (η), one can cancel

[13] If firms have less bargaining power, their ex-ante profits are smaller; the free entry condition then delivers the observed number of vacancies in equilibrium only if the unit cost of vacancy is also smaller. The bargaining power of unemployed workers is assumed equal to zero mainly for analytical simplicity.

Table 5: Estimates of Business Cycle Parameters

	AUS	FRA	DEU	JAP	PRT	ESP	SWE	GBR	USA
Productivity (y)									
ρ	0.970	0.938	0.933	0.942	0.842	0.972	0.961	0.970	0.959
σ	0.017	0.020	0.024	0.025	0.026	0.026	0.029	0.023	0.015
Worker Heterogeneity (x)									
Minimum (C)	0.701	0.679	0.527	0.514	0.826	0.705	0.700	0.695	0.663
μ	3.658	4.624	3.288	2.126	5.691	4.625	4.039	4.417	3.859
ν	1.511	2.090	2.727	1.870	1.187	1.723	1.606	1.821	1.898
Mean ($C + \frac{\nu}{\mu+\nu}$)	0.993	0.990	0.980	0.982	0.999	0.976	0.984	0.987	0.993
Mode ($C + \frac{\nu-1}{\mu+\nu-1}$)	0.824	0.870	0.871	0.804	0.858	0.840	0.830	0.852	0.852
Std ($\frac{\mu\nu}{(\mu+\nu)(\mu+\nu+1)}$)	0.416	0.432	0.461	0.446	0.353	0.413	0.416	0.422	0.434
Unemployment benefit									
z	0.716	0.716	0.683	0.565	0.834	0.745	0.728	0.721	0.693
Vacancy cost									
c^0	20.14	21.99	12.11	17.95	38.13	36.94	16.13	16.72	5.07
Matching function									
Efficiency (ϕ^0)	2.195	1.268	1.244	1.868	1.963	1.801	2.611	1.871	1.698
Elasticity (η)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Job destruction rate									
δ^0	0.038	0.023	0.017	0.014	0.013	0.036	0.024	0.029	0.043

that effect by recalibrating the fraction of workers at risk of unemployability (i.e. by putting more mass in the left tail of the ability distribution).

5.2 Fitting the cycle

Table 6 shows how the model fits the 18 moments used in estimation, Table 7 reports the correlations between actual and simulated HP-filtered series, and Figure 2 plots the actual and simulated unemployment cycles.

The fit is generally good (at least for such a simple model). In particular, the model has no problem fitting both the volatility of output and the volatility of unemployment. The mechanism is simple to understand. In good times, unemployment is low and stable and all separations follow from exogenous shocks. When aggregate productivity falls, low-skilled workers start losing their jobs because their match surplus becomes negative.

Table 6: Fit of the Business Cycle Moments

	AUS		DEU		ESP		FRA		GBR		JPN		PRT		SWE		USA	
	true	sim.	true	sim.	true	sim.	true	sim.	true	sim.	true	sim.	true	sim.	true	sim.	true	sim.
Mean GDP	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.01	1.00	1.00	0.99	1.01	1.00	1.00	0.99	1.01	1.00
Std log GDP	0.017	0.018	0.021	0.024	0.028	0.029	0.019	0.022	0.023	0.026	0.027	0.029	0.029	0.027	0.029	0.031	0.017	0.018
Autocorr. log GDP	0.93	0.98	0.92	0.94	0.96	0.98	0.97	0.95	0.98	0.98	0.95	0.96	0.96	0.86	0.98	0.97	0.96	0.98
Mean UNR	0.074	0.075	0.091	0.092	0.159	0.156	0.098	0.095	0.067	0.067	0.034	0.034	0.066	0.066	0.048	0.047	0.054	0.053
Std log UNR	0.125	0.124	0.118	0.117	0.191	0.190	0.087	0.085	0.174	0.161	0.141	0.138	0.187	0.191	0.366	0.310	0.144	0.126
Kurtosis log UNR	2.62	2.55	3.28	3.18	1.66	2.10	1.56	2.25	2.08	2.36	1.92	2.38	2.39	2.74	2.41	2.23	1.94	2.25
GDP elasticity of UNR	-5.35	-6.15	-3.82	-4.46	-6.11	-6.26	-2.70	-3.61	-4.35	-5.78	-4.50	-4.55	-5.76	-4.68	-9.88	-9.14	-6.43	-6.67
GDP elasticity of JFR	5.42	6.44	3.47	5.73	4.97	7.41	5.55	4.28	3.14	6.01	3.10	4.80	3.58	4.95	4.33	9.12	3.13	6.96
GDP elasticity of JDR	-1.81	-0.53	-1.02	-0.51	-2.69	-0.58	0.29	-0.45	-2.90	-0.51	-2.04	-0.30	-4.99	-3.37	-7.25	-1.02	-3.68	-0.29
GDP elasticity of tightness	17.56	9.15	11.73	6.00	8.32	10.40	4.59	5.61	12.89	8.64	8.92	5.57	11.58	6.40	23.32	11.63	12.22	9.21
Mean JFR	0.48	0.48	0.18	0.18	0.21	0.21	0.22	0.23	0.42	0.42	0.43	0.43	0.21	0.20	0.56	0.56	0.79	0.79
Std log JFR	0.12	0.13	0.14	0.14	0.19	0.22	0.13	0.09	0.11	0.16	0.11	0.14	0.16	0.17	0.15	0.31	0.07	0.13
Mean JDR	0.038	0.038	0.018	0.018	0.037	0.037	0.024	0.024	0.030	0.030	0.015	0.015	0.014	0.014	0.027	0.025	0.044	0.044
Std log JDR	0.066	0.027	0.078	0.075	0.110	0.054	0.085	0.035	0.135	0.037	0.098	0.039	0.201	0.200	0.264	0.081	0.098	0.018
Mean tightness	0.14	0.14	0.15	0.15	0.03	0.03	0.08	0.08	0.17	0.17	0.37	0.37	0.03	0.03	0.25	0.25	0.86	0.86
Std log tightness	0.37	0.17	0.36	0.15	0.48	0.30	0.15	0.12	0.35	0.23	0.28	0.17	0.40	0.22	0.77	0.38	0.33	0.17
Tightness elasticity of JFR	0.26	0.72	0.27	0.89	0.24	0.72	0.33	0.75	0.25	0.71	0.31	0.84	0.16	0.68	0.18	0.79	0.16	0.76
UNR elasticity of JFR	-0.76	-1.01	-0.61	-1.07	-0.69	-1.12	-0.99	-1.04	-0.34	-1.00	-0.54	-0.98	-0.42	-0.72	-0.32	-0.95	-0.42	-1.01

Table 7: Correlation Between Actual and Predicted Detrended Series

	AUS	FRA	DEU	JAP	PRT	ESP	SWE	GBR	USA	Average
Productivity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unemployment	0.83	0.68	0.88	0.87	0.73	0.92	0.77	0.87	0.75	0.81
Job Finding Rate	0.70	0.64	0.70	0.79	0.74	0.77	0.31	0.85	0.82	0.70
Job Destruction Rate	0.16	0.03	0.32	0.02	-0.06	0.20	0.36	0.23	0.34	0.18
Market Tightness	0.71	0.63	0.38	0.51	0.83	0.84	0.43	0.67	0.65	0.63

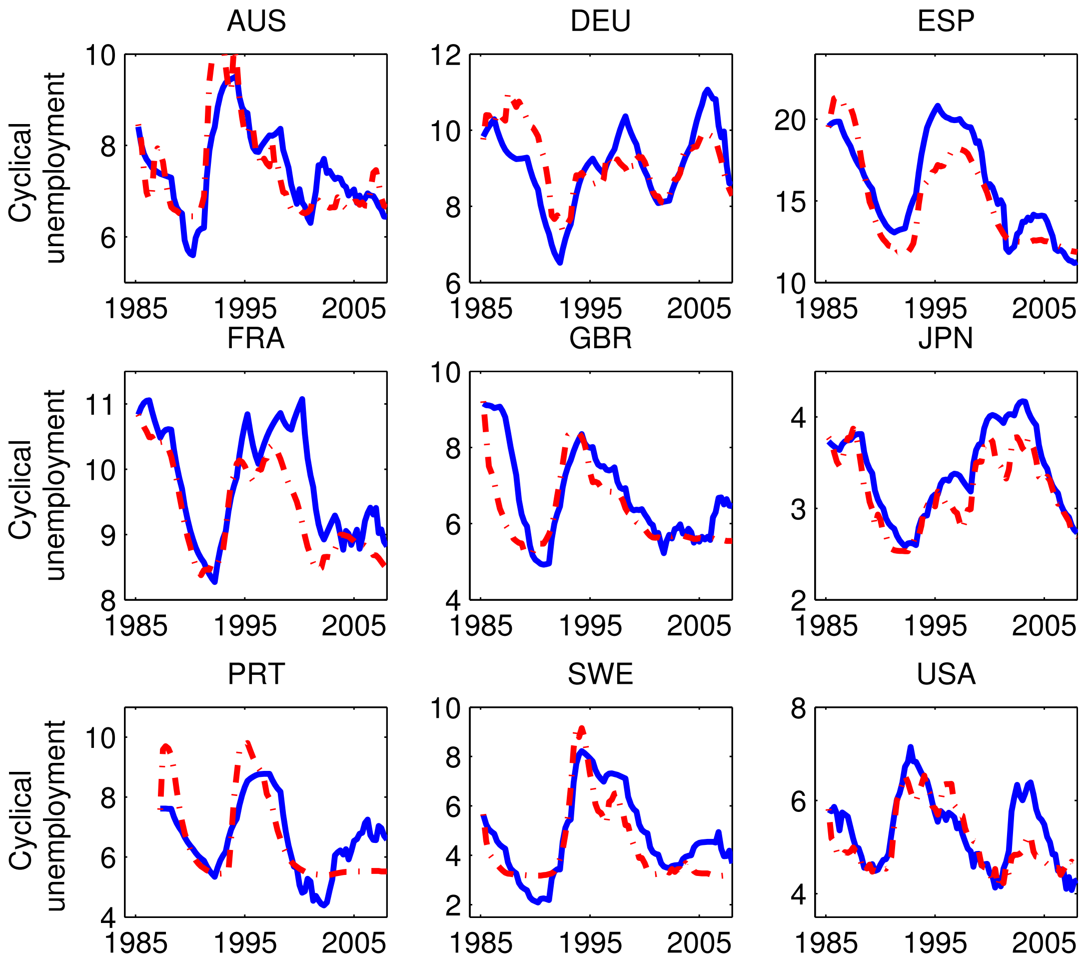


Figure 2: Unemployment Cycle - Actual (solid line) and Simulated (dotted)

A thick left tail of the distribution of worker heterogeneity amplifies the recessive effect of negative productivity shocks. If the recession lasts, unemployment increases because low-ability workers remain unemployed longer. When the economy recovers, previously unproductive workers become productive again, and they progressively start to get back to work. The process of layoff and reemployment is dissymmetric: all unproductive workers are immediately laid off, while all unemployed, but productive, workers are not instantaneously reemployed.

The fit of job finding rates is also good, with accurate estimates of volatility. However, the elasticity of job finding rates with respect to tightness (respectively to unemployment) is greatly over-estimated (resp. under-estimated). Although the correlation between actual and predicted series of tightness is good (around 65%), we generally greatly under-estimate its volatility. These two findings (the excess sensitivity of the job finding rate to market tightness and the under-estimation of the volatility of tightness) are related. The response of vacancy creation to productivity shocks has to be attenuated, or job finding rates would not be well fitted. Additional friction (such as the negative dependence of job finding rates to unemployment duration) is therefore required to make the job finding process more sluggish in recovery times.

Finally, the job destruction rate that is predicted by the model is too unevenly dented, and its correlation to actual series is poor. This may happen again because the process of endogenous job destruction is too lumpy. Following a negative productivity shocks, a mass of workers is instantly laid off, and the job destruction rate is immediately after reverted to the frictional rate of exogenous job destruction unless aggregate productivity keeps going further down.

We will see in the next section that this apparent failure at fitting some aspects of turnover and vacancies could be an artifact of detrending (using the Hodrick-Prescott filter). If total output is clearly trended and easily detrended, long-term trends in labor market variables are much more difficult to filter out. This is the reason why Shimer (2005), and his followers, including us, used the HP filter with a smoothing parameter of 10^5, much greater than the standard value of 1024 recommended for quarterly series.

Using 1024 yields a trend of unemployment that undulates like a cycle. In the next section, we will argue that a better way of handling trends in labor market variables is to model them by way of intervention variables (policy or demographics).

6 The impact of labor market reforms

6.1 Parameter estimates

The estimated policy parameters are reported in Table 8.[14] LMP variables are centered at their country-specific mean and standardized by the cross-country and cross-time standard deviation of the LMP. Policy parameters are thus semi-elasticities that quantify the relative increase in parameters ϕ, δ, c when LMPs are increased by one standard deviation around the country-specific mean of the policy variable.

Overall, we estimate 11 LMP effects, among which 7 are significant at the 1% confidence level and 3 at the 5% confidence level. All of them have the expected sign. Large effects are recorded for ALMP employment incentives, as an additional one-standard deviation decreases the vacancy cost c by 16.7%. Similarly, an additional one-standard deviation of placement and employment services (respectively training) yields a 11.4% (resp. 9.5%) decrease in δ. Product market regulation is another LMP that has a strong impact, as an additional one-standard deviation yields a 11.2% increase in c. The replacement rate, employment protection and the tax wedge also have significant effects, although of smaller magnitude (on ϕ, δ and c respectively). The bottom part of Table 8 reports the estimated effects of education and demographic variables. Educational achievement moderately reduces the pace of job destruction, as an additional 0.4-year of higher education (one standard deviation) yields a 4.7% reduction in the job destruction rate.[15] As expected, older (more experienced) workers tend to remain unemployed longer, but face a lower layoff risk.

[14]We do not comment on re-estimated cyclical parameters as they differ only marginally from previous estimates as shown in Appendix B.

[15]For comparison, mean years of higher education have on average increased by 0.33 years over the period 1985-2007.

Table 8: Estimates of Policy Effects

	ϕ	δ	c
Initial replacement rate	-0.030 (0.008)	0.031 (0.009)	
ALMP Placement and Employment Services	0.028 (0.006)	-0.102 (0.007)	
ALMP Training	-0.044 (0.016)	-0.100 (0.019)	
ALMP Incentives		0.061 (0.020)	-0.165 (0.057)
Product Market Regulation		-0.025 (0.018)	0.115 (0.051)
Employment Protection (regular contracts)	-0.023 (0.007)	-0.038 (0.008)	
Tax wedge		0.023 (0.008)	0.045 (0.022)
Mean Years of Higher Education	-0.010 (0.008)	-0.050 (0.009)	
Share 15-24 population	0.016 (0.010)	-0.019 (0.012)	
Share 55-64 population	-0.027 (0.006)	-0.053 (0.007)	

6.2 Fitting the trends

Figures 3-6 show how good the model is at predicting labor market outcomes given productivity shocks and institutional change. Table 9 displays the correlations between actual and predicted series. Actual and simulated unemployment rates are highly correlated for all countries, with an average correlation equal to 0.81. The best fit is obtained for Australia, Japan, Sweden and the United Kingdom with correlations close to or above 0.90, while the model performs less well for the United States with a correlation of about 0.5.

The fit of job destruction rates is greatly improved by comparison to the cyclical estimation, as the correlation between predicted and observed series jumps from 0.18 in the BC-model to 0.57 in the LMP-model. The fit of job finding rates, which are well predicted except for Germany and Portugal, and the US to a lesser extent, has also improved. Market tightness is well fitted for all countries but the US and Portugal.

The only country for which the model does not seem to be doing such a good job is the US. It may be that by estimating LMP effects jointly we impose to the US labor market a European norm that does not apply to the US. It may also be that simulating the economy at the quarterly frequency does not work well for the US, as very few workers remain unemployed longer than a quarter. Yet, overall, these results suggest that LMPs help predict the permanent shifts in unemployment and its turnover components well.

We then ask whether the simulated series in Figures 3-6 reproduce the correlations with LMP variables that were estimated in the reduced-form regressions of Table 4. Table 10 shows comparisons. In general the fit is quite good. The model

6.3 Assessing the Impact of Labor Market Policies

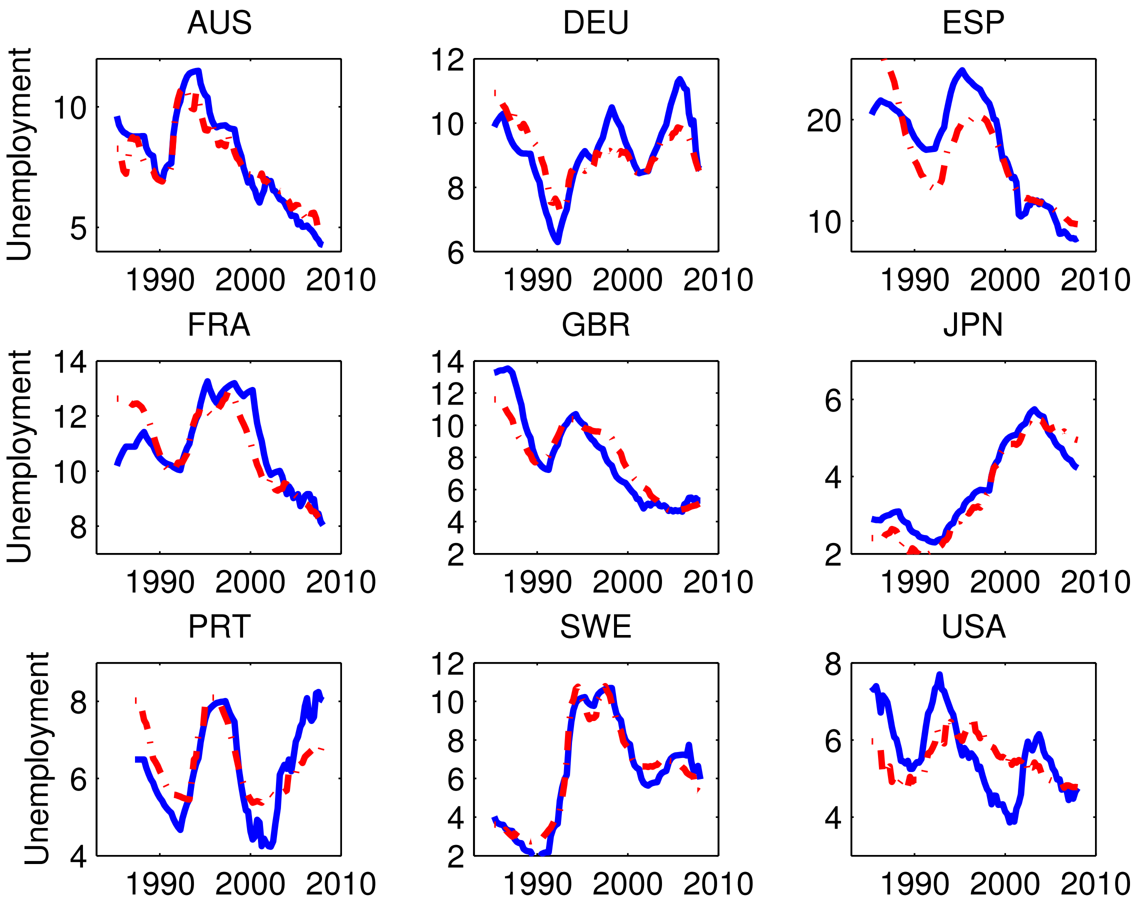
In order to get a sense of the marginal effect of each policy on unemployment, we proceeded to the following comparison. For each country, we calculate a benchmark unemployment value by setting LMPs at their country-specific mean values and simulating very long series of productivity shocks and implied labor market outcomes. We then calculate the resulting mean unemployment rate over time. In a second step, we calculate the counterfactual steady-state unemployment rates that result from a one-standard deviation (cross-time and cross-country) change in the LMPs. The choice of the direction is chosen in accordance to our prior on the effect of the policy on unemployment.

Table 11 reports the results. The top-panel displays the benchmark values of unemployment rates, job finding and job destruction rates, and vacancies. The bottom-panel shows counterfactual changes. In so far as the size of the assumed changes do represent commensurate and comparable policy reforms, the LMP the most conducive to unemployment reduction appears to be placement and employment services (-0.94 percentage points on average). All other LMPs have a similar influence, between a fifth and a third of a percentage point.

At the bottom of Table 11, we report the sum of individual LMP-effects, as well as the calculated effect on unemployment of a simultaneous change in all LMPs (labelled as the “policy mix"). We do not find evidence of policy complementarity, as the sum of individual effects is only (and always) slightly larger than the impact of the policy mix. This finding contradicts Bassanini and Duval (2009), who found positive interaction

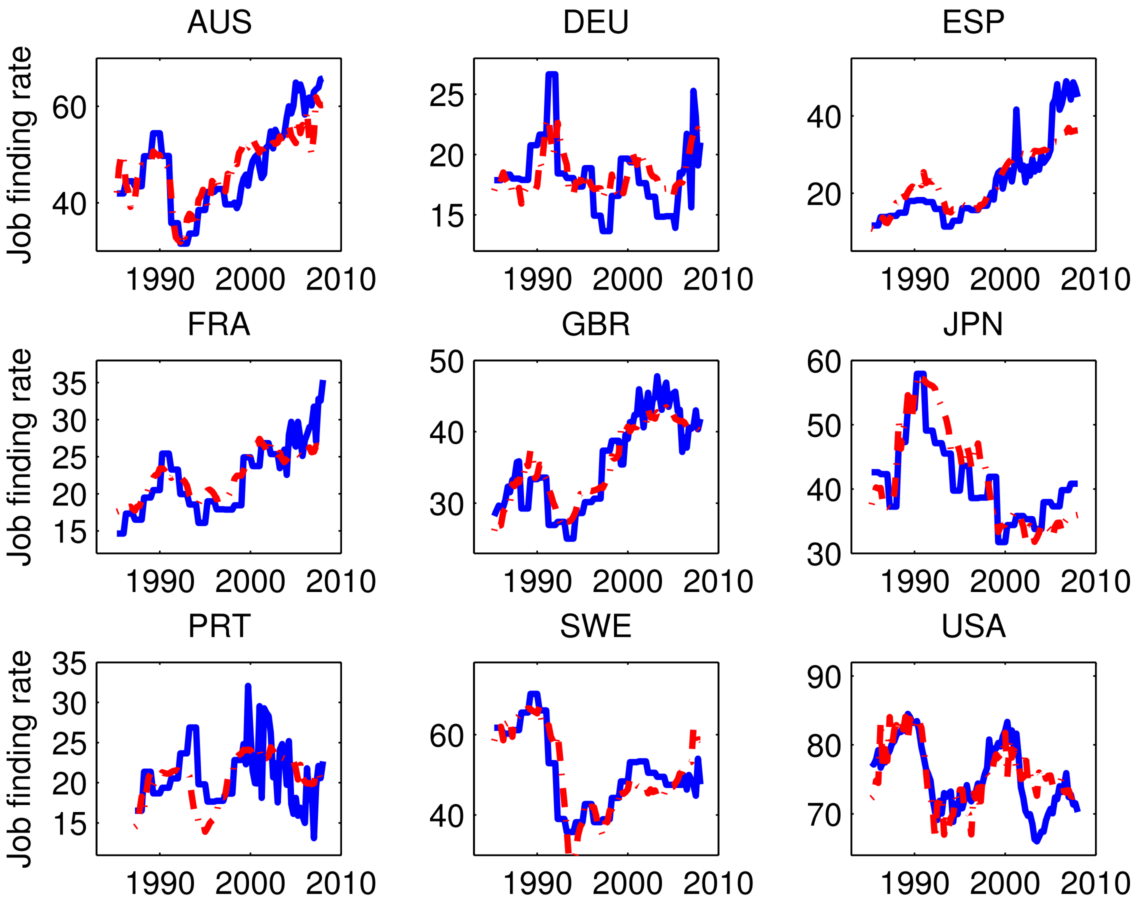
Table 9: Correlation Between Actual and Predicted Unfiltered Series

	AUS	FRA	DEU	JAP	PRT	ESP	SWE	GBR	USA	Average
Productivity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unemployment	0.96	0.79	0.67	0.97	0.75	0.81	0.98	0.89	0.56	0.82
Job Finding Rate	0.86	0.90	0.56	0.84	0.37	0.86	0.90	0.92	0.69	0.77
Job Destruction Rate	0.68	0.27	0.39	0.87	0.41	0.33	0.95	0.54	0.62	0.56
Market Tightness	0.94	0.90	0.71	0.81	0.58	0.90	0.92	0.97	0.14	0.76



solid line: actual series (non HP-filtered); dotted: prediction

Figure 3: Unemployment

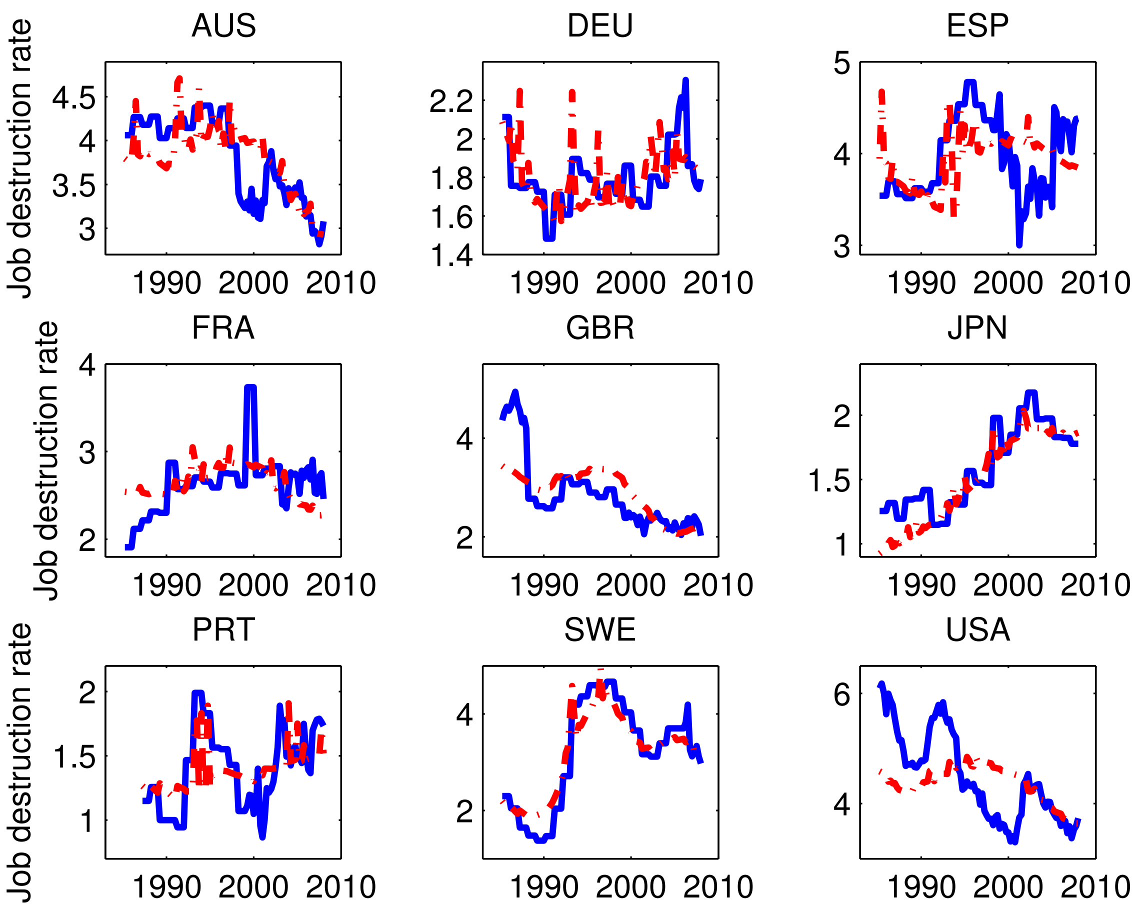


solid line: actual series (non HP-filtered); dotted: prediction

Figure 4: Job Finding Rate

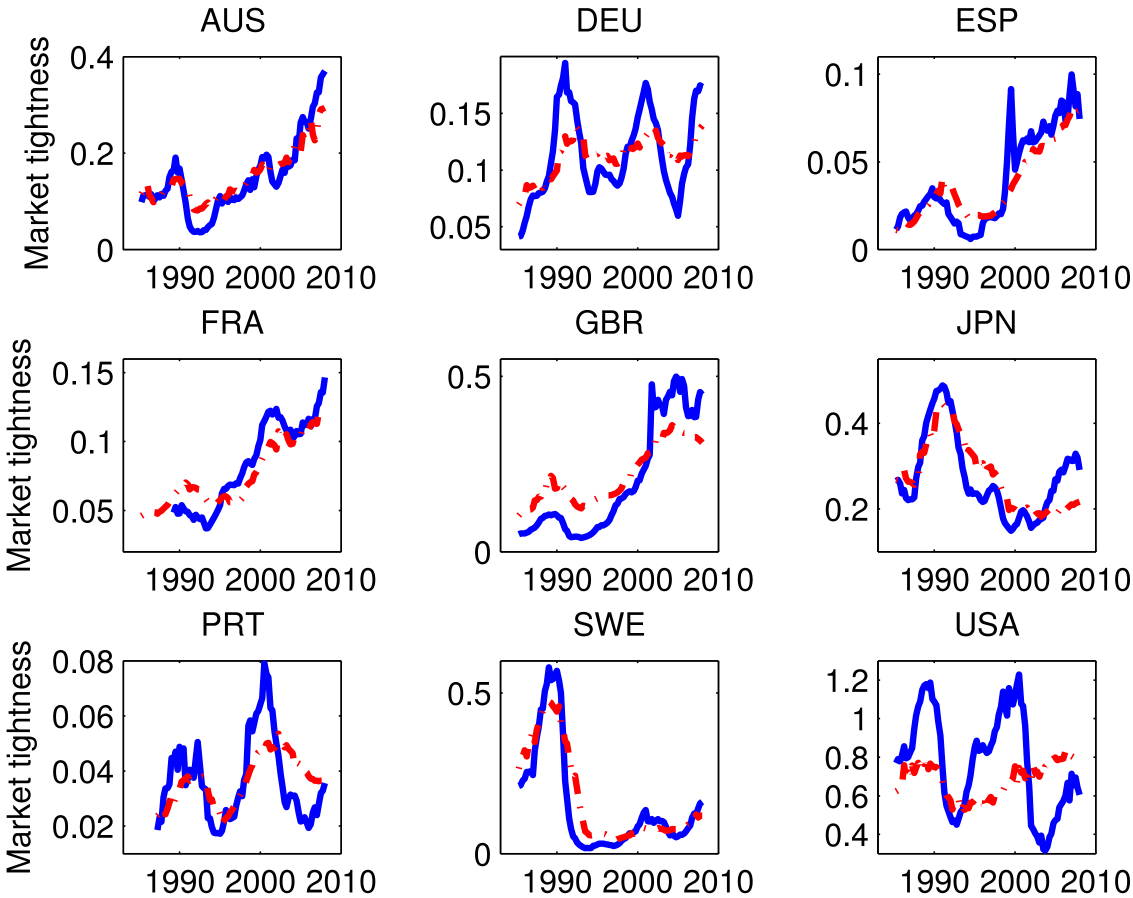
Table 10: Correlation Between Actual and Predicted Unfiltered Series

	Log UNR		Log LDR		Log JFR		Log V		Log Tightness	
	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated	Observed	Simulated
Initial Replacement Rate	0.064	0.054	0.030	-0.005	-0.037	-0.053	-0.065	-0.003	-0.133	-0.057
	(0.008)	(0.004)	(0.008)	(0.003)	(0.008)	(0.003)	(0.020)	(0.002)	(0.021)	(0.003)
ALMP: Placement	-0.095	-0.119	-0.069	-0.112	0.020	0.005	-0.012	-0.046	0.080	0.073
	(0.006)	(0.003)	(0.006)	(0.002)	(0.006)	(0.002)	(0.015)	(0.002)	(0.016)	(0.002)
ALMP: Training	-0.126	-0.104	-0.091	-0.077	-0.014	-0.029	-0.198	-0.049	-0.099	0.056
	(0.016)	(0.007)	(0.015)	(0.005)	(0.016)	(0.006)	(0.042)	(0.005)	(0.044)	(0.006)
ALMP: Incentives	0.013	-0.010	0.034	0.053	0.063	0.099	0.326	0.208	0.341	0.217
	(0.016)	(0.007)	(0.016)	(0.006)	(0.017)	(0.006)	(0.044)	(0.005)	(0.046)	(0.007)
Product Market Regulation	0.045	0.063	-0.016	-0.021	-0.076	-0.084	-0.167	-0.126	-0.199	-0.189
	(0.011)	(0.005)	(0.011)	(0.004)	(0.011)	(0.004)	(0.028)	(0.003)	(0.030)	(0.004)
Employment Protection	-0.047	-0.023	-0.078	-0.020	-0.042	0.008	-0.006	0.001	0.046	0.023
	(0.006)	(0.003)	(0.006)	(0.002)	(0.006)	(0.002)	(0.015)	(0.002)	(0.016)	(0.002)
Tax Wedge	0.082	0.027	0.037	-0.000	-0.051	-0.032	0.015	-0.056	-0.064	-0.083
	(0.007)	(0.003)	(0.007)	(0.002)	(0.007)	(0.003)	(0.018)	(0.002)	(0.019)	(0.003)
Average Years of Higher Education	-0.074	-0.036	-0.069	-0.044	0.003	-0.010	-0.030	-0.015	0.045	0.021
	(0.007)	(0.003)	(0.007)	(0.003)	(0.008)	(0.003)	(0.019)	(0.002)	(0.020)	(0.003)
Demographic share of 15-24 population	0.023	-0.028	0.013	-0.018	0.003	0.017	0.024	-0.004	-0.014	0.025
	(0.010)	(0.005)	(0.010)	(0.004)	(0.011)	(0.004)	(0.027)	(0.003)	(0.029)	(0.004)
Demographic share of 55-64 population	0.002	-0.028	0.010	-0.040	-0.011	-0.027	-0.011	-0.017	-0.022	0.011
	(0.006)	(0.003)	(0.006)	(0.002)	(0.006)	(0.002)	(0.016)	(0.002)	(0.017)	(0.003)



solid line: actual series (non HP-filtered); dotted: prediction

Figure 5: Job Destruction Rate



solid line: actual series (non HP-filtered); dotted: prediction

Figure 6: Market Tightness

Table 11: Assessing the Impact of Labor Market Reforms

	AUS	FRA	DEU	JAP	PRT	ESP	SWE	GBR	USA	Average
Steady-state labor market outcomes										
Unemployment rate – mean policy setting										
mean	7.59	10.72	9.07	4.47	6.52	18.18	6.09	8.09	5.64	8.49
std	0.87	0.85	0.74	0.33	0.68	3.10	1.15	0.78	0.30	0.98
Job finding rate – mean policy setting										
mean	46.40	22.14	18.05	39.45	21.02	18.28	48.84	32.54	74.17	35.65
std	5.12	2.07	1.97	3.19	2.09	3.87	7.67	3.19	3.95	3.68
Job destruction rate – mean policy setting										
mean	3.76	2.64	1.78	1.83	1.45	3.92	3.08	2.84	4.42	2.86
std	0.10	0.09	0.10	0.04	0.17	0.25	0.16	0.07	0.03	0.11
Change in steady-state unemployment after pro-employment policy reforms										
Initial replacement rate (-1 sd)	-0.29	-0.40	-0.25	-0.16	-0.24	-0.61	-0.22	-0.32	-0.22	**-0.30**
ALMP: Placement (+1 sd)	-0.93	-1.25	-0.74	-0.47	-0.69	-1.95	-0.70	-0.99	-0.72	**-0.94**
ALMP: Training (+1 sd)	-0.35	-0.45	-0.24	-0.16	-0.21	-0.72	-0.25	-0.36	-0.27	**-0.33**
ALMP: Incentives (+1 sd)	-0.22	-0.35	-0.24	-0.15	-0.24	-0.48	-0.18	-0.27	-0.17	**-0.26**
Product Market Regulation (-1 sd)	-0.26	-0.38	-0.25	-0.15	-0.24	-0.57	-0.20	-0.30	-0.20	**-0.28**
Employment Protection (-1 sd)	0.19	0.24	0.13	0.09	0.13	0.38	0.14	0.19	0.14	**0.18**
Tax wedge (+1 sd)	-0.20	-0.28	-0.17	-0.11	-0.17	-0.42	-0.15	-0.22	-0.15	**-0.21**
Sum of individual policy effects	-2.07	-2.87	-1.74	-1.10	-1.66	-4.37	-1.55	-2.26	-1.61	**-2.14**
Policy mix (all reforms)	-1.87	-2.57	-1.57	-0.99	-1.51	-3.95	-1.42	-2.02	-1.44	**-1.93**

Note: Each LMP is shifted by one standard deviation towards unemployment reduction. This corresponds to a decrease of 3.2 percentage points in the replacement rate, an increase of 0.011 (respectively 0.015 and 0.020) in the normalized volume of resources devoted to placement and employment services (resp. training and employment incentives), a decrease of 1.11 (respectively 0.16) points in the OECD index of product market regulation (resp. employment protection for regular contracts), and a 2.6 percentage points increase in the tax wedge. The measured change is with respect to a benchmark equal to the within-country average LMP.

effects on the basis of panel-data, reduced-form regressions.

Finally, identical labor market reforms seem to trigger very different unemployment responses (in magnitude) across countries, with high-unemployment countries such as Spain or France witnessing larger unemployment reductions than the other countries.

7 Conclusion

We have proposed a non-stationary dynamic search-matching model with worker heterogeneous abilities and labor market policy interventions. Worker heterogeneity makes the effect of negative productivity shocks on unemployment highly non linear, and provides an amplification mechanism solving the unemployment volatility puzzle. Policy interventions shift structural parameters such as matching efficiency, exogenous job destruction and vacancy cost, and have long term effects on unemployment. For all 9 OECD countries, the model displays an impressive fit of unemployment dynamics. The amount of resources injected into placement and employment services stands out as the most prominent policy lever in view of reducing unemployment. All other LMPs have a significant but lesser impact. We also find that the magnitude of the effect is larger for high-unemployment countries, and we find little complementarity between policies.

In its present form, the model remains too simple to adequately capture all aspects of labor market institutions. For example, an important operating mechanism is search intensity, which is not explicitly modeled here (only through an exogenous change in matching efficiency). Moreover, unemployment benefits are always paid for a fixed period of time, thus introducing state dependence in search intensity. These are just a few out of many possible ideas for future extensions.

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