Labor Market Reforms and Unemployment Dynamics[1]

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Abstract

We quantify the contribution of labor market reforms to unemployment dynamics in nine OECD countries (Australia, France, Germany, Japan, Portugal, Spain, Sweden, UK, US). We estimate a dynamic stochastic search-matching model with heterogeneous workers and aggregate productivity shocks. The heterogeneous-worker mechanism proposed by Robin (2011) explains unemployment volatility by productivity shocks well in all countries. Placement and employment services, UI benefit reduction and product market deregulation are found to be the most prominent policy levers for unemployment reduction. Business cycle shocks and LMPs explain about the same share of unemployment volatility (except for Japan, Portugal and the US).

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 looked for 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 induce different responses of unemployment to world-wide shocks (like an oil shock) and country-specific productivity shocks; and 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) 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 is potentially large, yet the number of parameters through which they impact the economy should be kept small for the model to be identified. Identification is indeed likely to fail if the number of intervention channels is greater 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, 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. This model is estimated for nine different countries (Australia, France, Germany, Japan, Portugal, Spain, Sweden, the United Kingdom and the United States), over the period 1985-2007, in two ways. First, a version without policy interventions is estimated on detrended series by the Simulated Method of Moments. 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 AER 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 new vacancies, is large compared to the volatility of ongoing wages. Finally, Hagedorn and Manovskii's (2008) solution to the puzzle does not require wage rigidity but assumes a very large value of non market time (some 95% of productivity).

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 positive surplus and are thus laid off or stay unemployed longer. With a thick left tail

[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).

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 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.

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 simulations. We find that placement services, unemployment benefits and product market regulation are the main policy tools significantly influencing unemployment over the 1985-2007 period. These by all means classical policies are accountable for close to one, or more than one percentage point change in unemployment. The other policies yielded, on average, only between 20% and a third of a percentage point. Specifically, Australia and France reduced (or prevented a rise of) unemployment by increasing expenditure on placement services and deregulating product markets. Germany deregulated. Spain massively reduced unemployment benefits, deregulated and reduced employment protection. The UK reduced unemployment benefit, improved placement services and deregulated. The only countries implementing unemployment-augmenting policies are countries with low unemployment rates and hit by a deep and long-lasting recession at the end of the eighties or the beginning of the nineties. Thus, Japan and Sweden massively reduced ALMP expenditure. Lastly, Portugal and the US made no noticeable classical policy intervention. We do not find evidence of policy complementarity, as the sum of individual effects is similar in value to the Difference-in-

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

Difference effect of the policy mix. Finally, we measure the relative contribution of LMPs and business cycle shocks to the long term variance of unemployment. In general, both contribute to about half of the total variance, with some exceptions: in Japan, business cycle shocks do not explain much unemployment volatility, and in Portugal and the US labor market policies seem to have little impact.

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.

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 $u_{t+1}(m) = 1$ if $S_t(m) < 0$, and

$$u_{t+1}(m) = u_t(m) + \delta(1 - u_t(m)) - \lambda_t u_t(m),$$

if $S_t(m) \geq 0$. 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.

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 marginal gain.[5]

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 (see Lise and Robin, 2013, for an extension of this model with two-sided heterogeneity).

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. However, only the meetings with unemployed workers generate a profit to the

[5]We state the model with on-the-job search. However, in this paper, contrary to Robin (2011), we shall not use wages in the empirical part. What really matters to solve the volatility puzzle is worker heterogenous productivities, which acts a amplification mechanism for aggregate shocks. We could as well use a standard Mortensen-Pissarides setup and rule out on-the-job search without changing much of the results.

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 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 can be 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 is un-

[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.

successful, 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 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 (Murtin and de Serres, 2014).

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 discretize 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 discretize 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 beta distribution is assumed for the ability distribution, namely

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

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.

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

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 $X_{nt}^1, ..., X_{nt}^K$:

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

In these equations, the LMP semi-elasticities ($\phi_\bullet^k, \delta_\bullet^k, c_{1\bullet}^k$) 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*.

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.

Table 1: Unemployment and Turnover Cycle - Descriptive Statistics

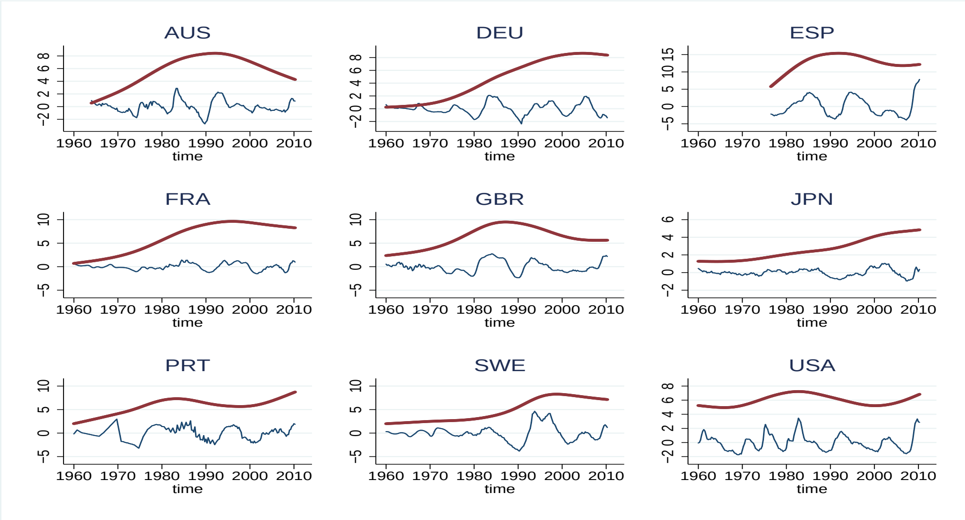
	Period	Unemployment				Job Destruction Rate			Job Finding Rate		
		mean	std	std		mean	std		mean	std	
				trend	cycle		trend	cycle		trend	cycle
Australia	1979Q1-2009Q4	5.69	2.62	1.19	1.10	3.78	0.36	0.23	47.74	6.62	5.69
Germany	1984Q1-2010Q1	6.09	2.72	1.27	1.06	1.81	0.06	0.52	18.71	0.88	2.71
Spain	1978Q1-2010Q2	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.

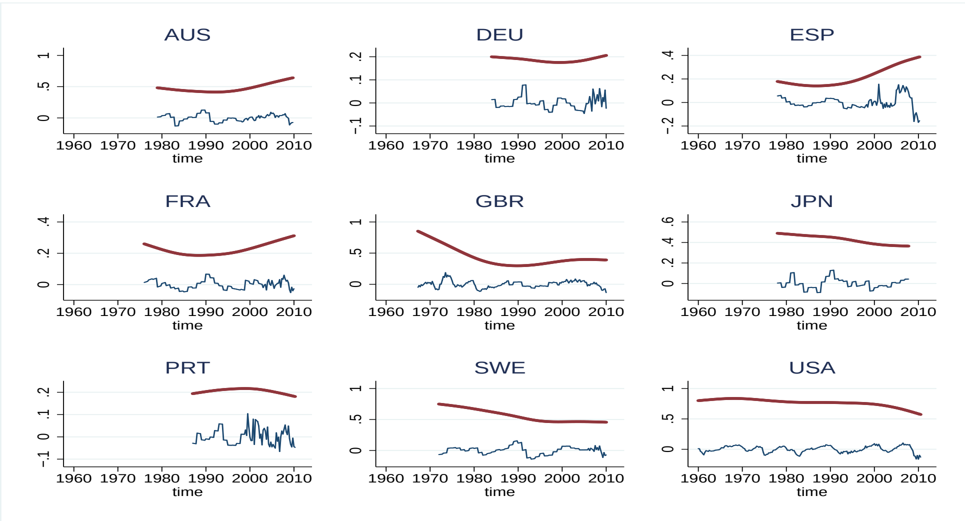
3.1 Unemployment and turnover cycle

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.

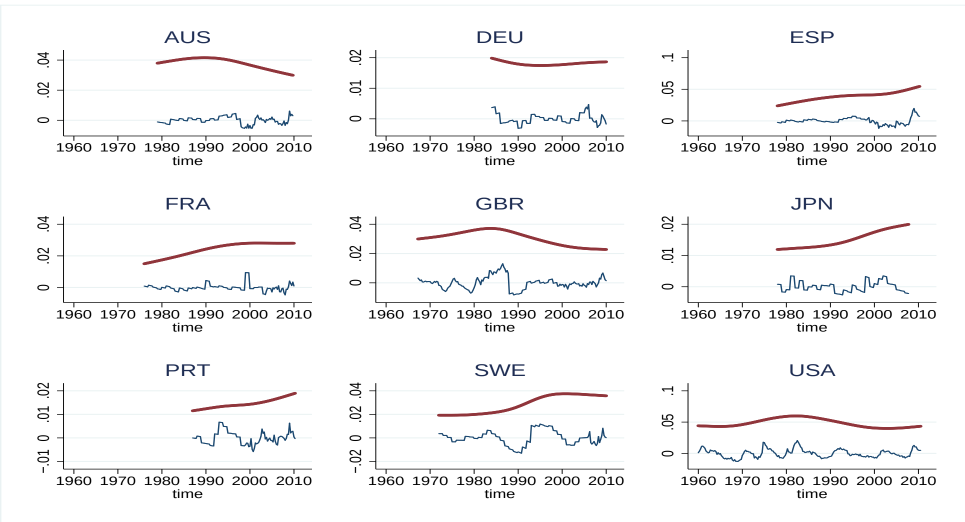
Interesting patterns emerge from trends (Figure 1). Unemployment culminates in the 1980s in the UK and the US, and in the 1990s in Australia, France, Spain and Sweden. Japan displays a monotonic, increasing trend throughout the 1960-2010 period. Unemployment rebounds in the early 2000s in Portugal and 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 pat-



(a) Unemployment



(b) Job Finding Rate



(c) Job Destruction Rate

Figure 1: Unemployment Rate and Turnover - Trends and Cycles

Table 2: 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.

terns 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.

Figure 2 plots the LMP series for all countries between 1985 and 2007 (the period over which we have gathered a balanced sample of labor market outcomes). Some institutions show no change in the period (such as employment protection in the US). The associated policy effects cannot be identified in this case. However, in general, LMPs do vary over

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

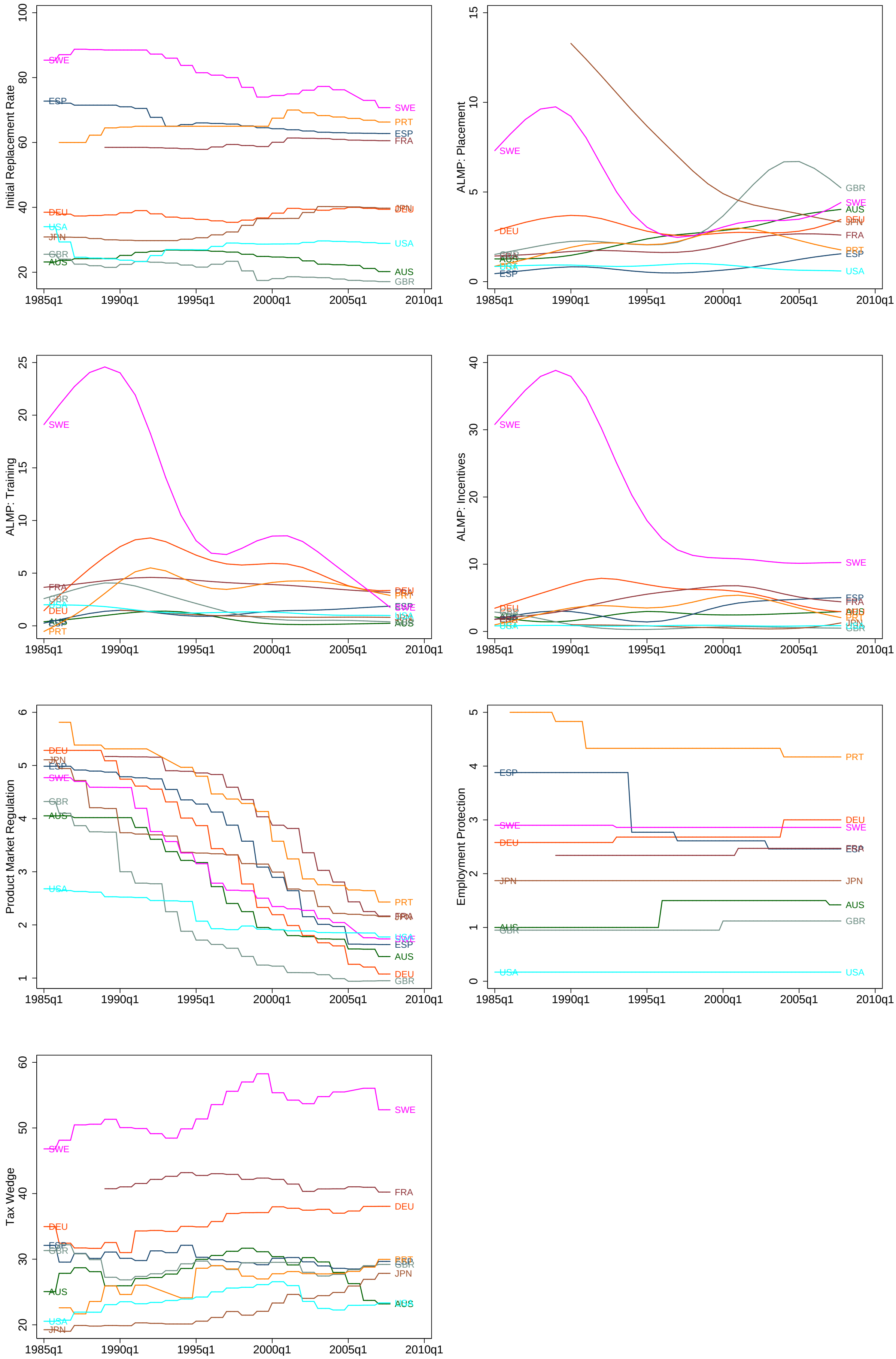


Figure 2: Labor Market Institutions - 1985-2007

time and across countries.

France, Portugal, Spain and Sweden offer 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, and Germany and Japan somewhere in-between. Sweden stands alone in its effort to reduce ALMP spendings. It started the period from a very high point, considerably more interventionist than any other country, and converged to a more comparable norm. Japan and Sweden used to spend a lot more than the other countries on placement and labor services. They tend to be overtaken by Great Britain and Australia, and France to a lesser extent; the UK spending more (per unit of labor productivity) in 2007 than Sweden. Product market regulation shows a remarkable convergence toward deregulation in all countries, with Great Britain, Germany, Australia, Spain and Sweden progressively becoming more deregulated than the US. There is some tendency to converge toward a more common model of employment protection among European states, with Portugal and Spain (particularly) reducing EPL and the UK and Australia increasing EPL (a bit). There are some variations in labor taxes over time and across countries, but they consistently remain higher in Sweden, France and Germany.

Table 2 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, product market deregulation or unemployment insurance reductions are often accompanied by another policy, such as increased expenditure on training or employment incentives or wage subsidies, aiming at reducing social or economic collateral costs. This is much less the case for employment protection which appears much less correlated with other LMPs.

3.3 Intervention mechanisms

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 help unemployed workers find jobs more easily and improve match quality. Higher quality matches 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 facilitate the creation of matches of lower quality, which therefore terminate sooner than later. Less product market regulation fosters competition between firms, which is favorable to employment in a way that can be captured in our model by a reduction in the 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; it delays job destruction but firms are also more reluctant to post vacancies. These policies have no obvious impact on matching efficiency. Hence, we allow employment incentives, employment protection, product market regulation and the tax wedge to determine parameters c and δ (cost of vacancy and exogenous job destruction). [9]

[9] The mapping between policies and the structural parameters through which policy interventions are channelled is consistent with several empirical results. In particular, Murtin and de Serres (2014) apply an IV procedure to panel data from 11 OECD countries observed since 1985 to disentangle the effects of policies on matching efficiency (i.e. our parameter ϕ) and job vacancy creation (i.e. our parameter c). Consistent with our set of assumptions, they find that: i) more generous unemployment benefits decrease matching efficiency but have no effect on vacancy creation (Table 4 Columns 3 and 4); ii) conversely, tighter employment protection decreases vacancy creation but has no effect on matching efficiency (Table 4 Columns 7 and 8); iii) the tax wedge has a strong negative impact on vacancy creation (Tables 4 and 7). In some cases, the empirical results are more mixed. For instance, Card et al. (2010) conclude in their meta-analysis of active labour market programmes that "training programmes are associated with

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. Murtin and de Serres, 2014) 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. This will allow us to test the ability of the heterogeneous-worker search-matching model to fit unemployment volatility well in all countries. 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.

4.1 Assessing business-cycle dynamics

The estimation of the parameters controlling 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 $\phi^k_\bullet = \delta^k_\bullet = c^k_\bullet = 0$ 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

positive medium-term impacts, although in the short run they often appear ineffective." This suggests a negative impact of training on the job destruction rate that materializes only in the mid-term once the unemployed has found another job, with little or no short-term effect due to improved matching efficiency.

(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 are estimated, we filter out the series of aggregate shocks y_t so as to minimize the sum of squared residuals of log GDP. The parameters and the series of aggregate shocks are then used to simulate the series of unemployment rates.

4.2 Assessing policy effects

In a second step, we introduce LMPs and we estimate all parameters, including the response to LMP shocks, by iterating the following procedure:

1. Given parameters, filter aggregate shocks out by fitting aggregate output series (detrended) by least squares, separately, country by country;

2. Given aggregate shocks, estimate parameters by fitting unemployment, turnover and vacancy series (actual, not detrended) by simulated least squares, weighing residual squares by the inverse variance of each series. Contrary to the first estimation, the estimation of policy parameters is done jointly for all countries.

This estimation procedure is considerably easier to implement than any other method, Bayesian or frequentist, for nonlinear state-space models.

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

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,[11] 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 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

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

We then compute standard errors for the parameters $\phi_\bullet^k$ 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 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 3. 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. It follows that the opportunity cost of employment z is also 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)

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

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.[12] 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, Murtin et al., 2014).

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 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 4 shows how the model fits the 18 moments used in estimation, Table 5 reports the correlations between actual and simulated HP-filtered series, and Figure 3 plots the actual an d 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

[12]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 3: 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

Table 4: Fit of the Business Cycle Moments

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

Table 5: 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

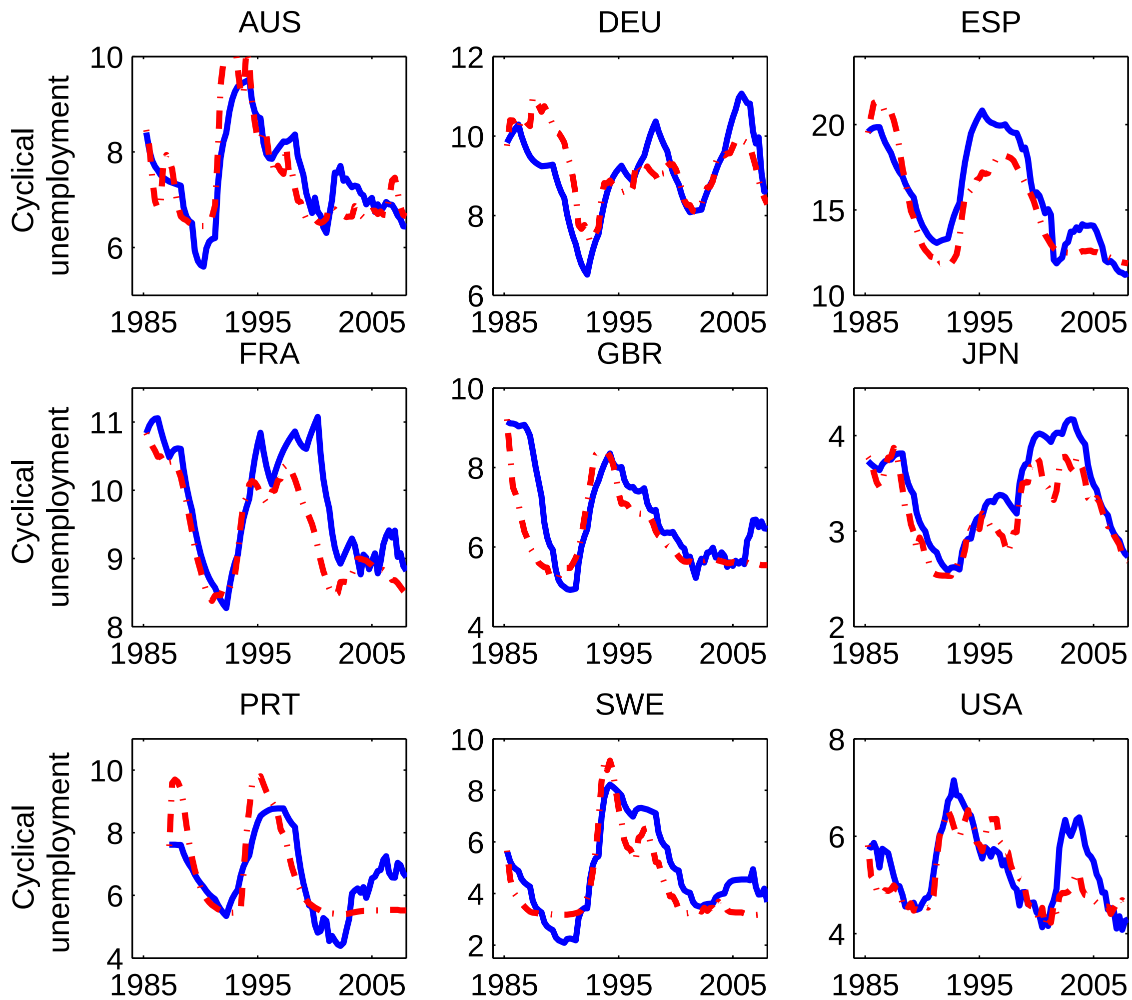


Figure 3: Unemployment Cycle - Actual (solid line) and Simulated (dotted)

and all separations follow from exogenous shocks. When aggregate productivity falls, low-skilled workers start losing their jobs because their match surplus becomes negative. 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, yet 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 uneven or jagged, 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 6. 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.

All the policy effects have the expected sign (when precisely estimated). Large effects are recorded for ALMP-placement services and training on job destruction rates, which we interpret as the result of improved matching technology. Employment incentives and product market deregulation also have a strong and positive effect on job creation. 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 6 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 5.0% reduction in the job destruction rate.[13] As expected, older (more experienced) workers tend to remain unemployed longer, but face a lower layoff risk.

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

Table 6: Estimates of Policy Effects

	ϕ	δ	c
Initial replacement rate	-0.028 (0.008)	0.029 (0.009)	
ALMP Placement and Employment Services	0.032 (0.006)	-0.101 (0.007)	
ALMP Training	-0.038 (0.016)	-0.097 (0.019)	
ALMP Incentives		0.057 (0.019)	-0.161 (0.059)
Product Market Regulation		-0.025 (0.017)	0.111 (0.062)
Employment Protection (regular contracts)		-0.043 (0.008)	0.037 (0.024)
Tax wedge		0.023 (0.008)	0.037 (0.023)
Mean Years of Higher Education	-0.014 (0.008)	-0.051 (0.009)	
Share 15-24 population	0.016 (0.010)	-0.011 (0.011)	
Share 55-64 population	-0.017 (0.006)	-0.036 (0.007)	

6.2 Fitting the trends

Figures 4-7 show how good the model is at predicting labor market outcomes given productivity shocks and institutional change. Table 7 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 0.82. The best fit is obtained for Australia, Japan, Sweden and the UK with correlations close to or above 0.90, while the model performs less well for the US with a correlation of about 0.56.

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 0.56 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 fails the fit test 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 finally ask whether the simulated series in Figures 4-7 reproduce the correlations with LMP variables that can be obtained by regressing unemployment rates, layoff rates, job finding rates and vacancies or tightness on LMPs. Table 8 shows the regression on actual data and on simulated series. In general the fit is good, showing that the three channels of policy interventions match reasonably well the observable impact of these policies on unemployment, layoff, job finding, vacancies and tightness.[14] We emphasize again that a unique structural effect of LMPs on parameters ϕ, δ and c is assumed for all nine countries.

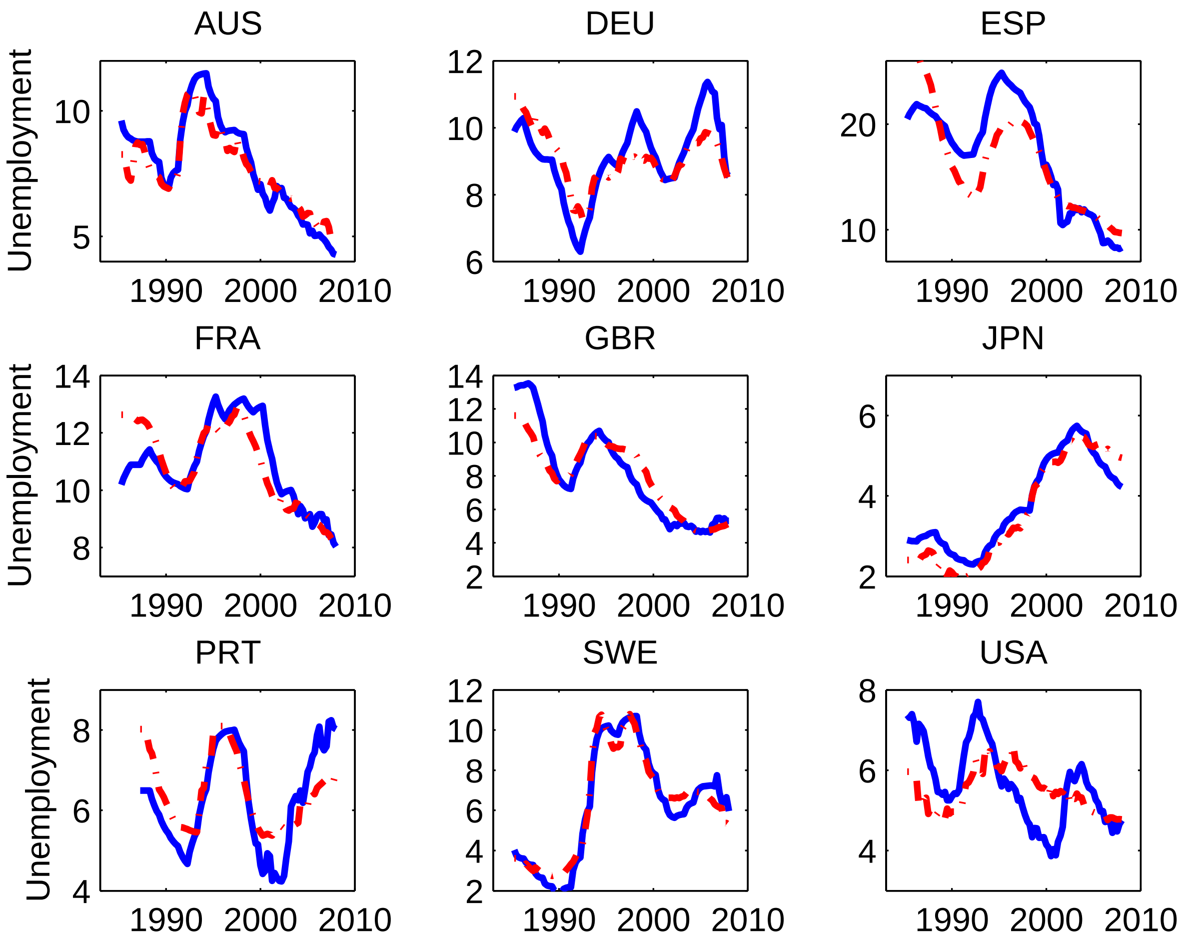
6.3 Assessing the Impact of Labor Market Policies

In order to get a sense of the marginal effect of each policy on unemployment, we calculate a "difference-in-differences" (DiD) treatment effect for each LMP separately and all together as follows. First we simulate for the period 1985-2007 the benchmark series of labor market outcomes responding to the estimated series of aggregate productivity shocks and to the observed series of LMP variables, which vary over time. Then we run counterfactual simulations with one specific LMP variable, say Z, remaining fixed to its country-specific mean value, while other LMPs are the time-varying observed ones, and we re-calculate the average counterfactual unemployment change over the period. Finally, for each country, we calculate DiD policy effects as the benchmark mean unemployment change minus the counterfactual mean change. The latter quantity reflects the effect of the variation in Z over the period. In the last counterfactual simulation corresponding to the line at the bottom of Table 9, all LMPs are frozen, so that the calculated average unemployment change corresponds to the joint effect of all LMPs reforms.

[14]Note that the reduced forms conclude to a positive effect of employment protection on unemployment, the layoff rate being reduced by more than the job finding rate is increased. Cahuc and Postel-Vinay (2002) already made that conclusion.

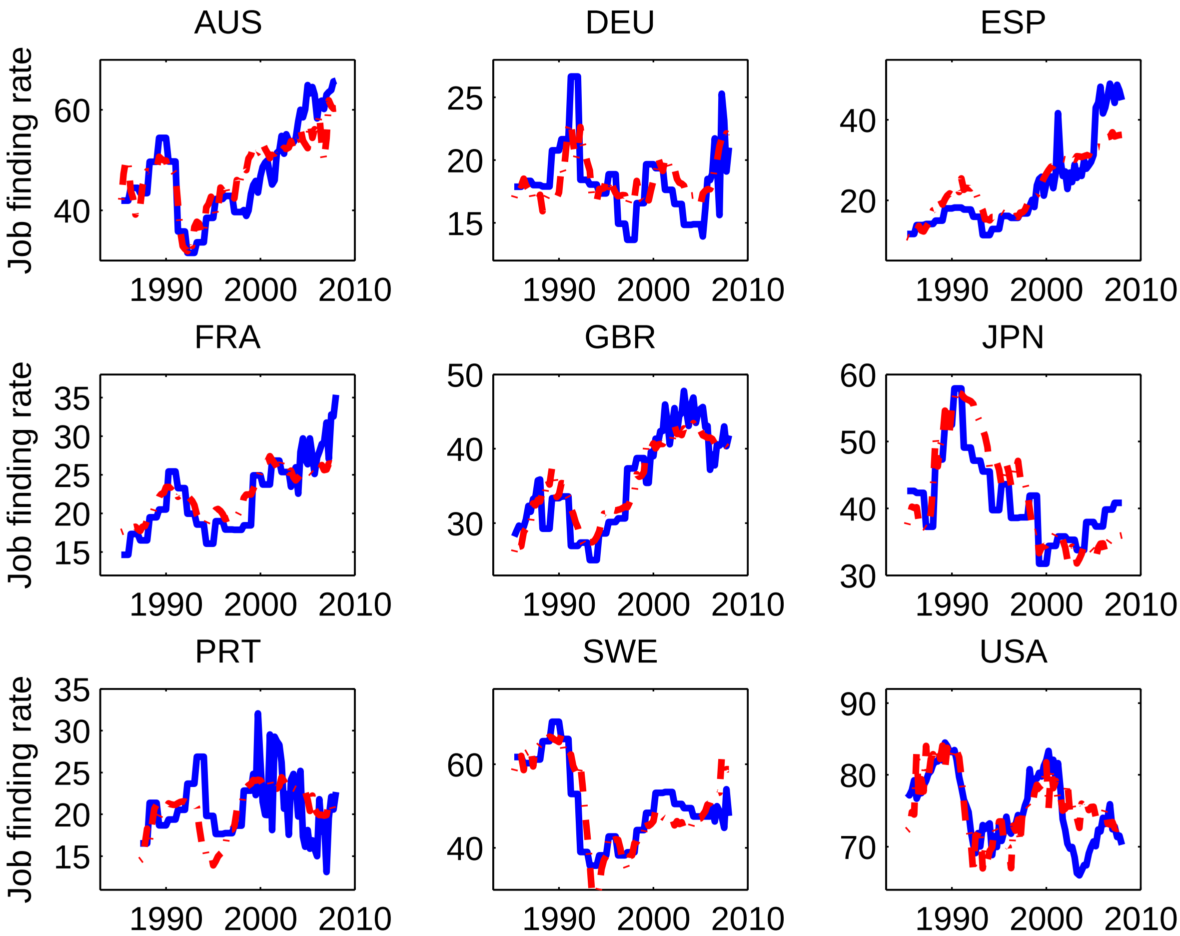
Table 7: Correlation Between Actual and Predicted Unfiltered Series

	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



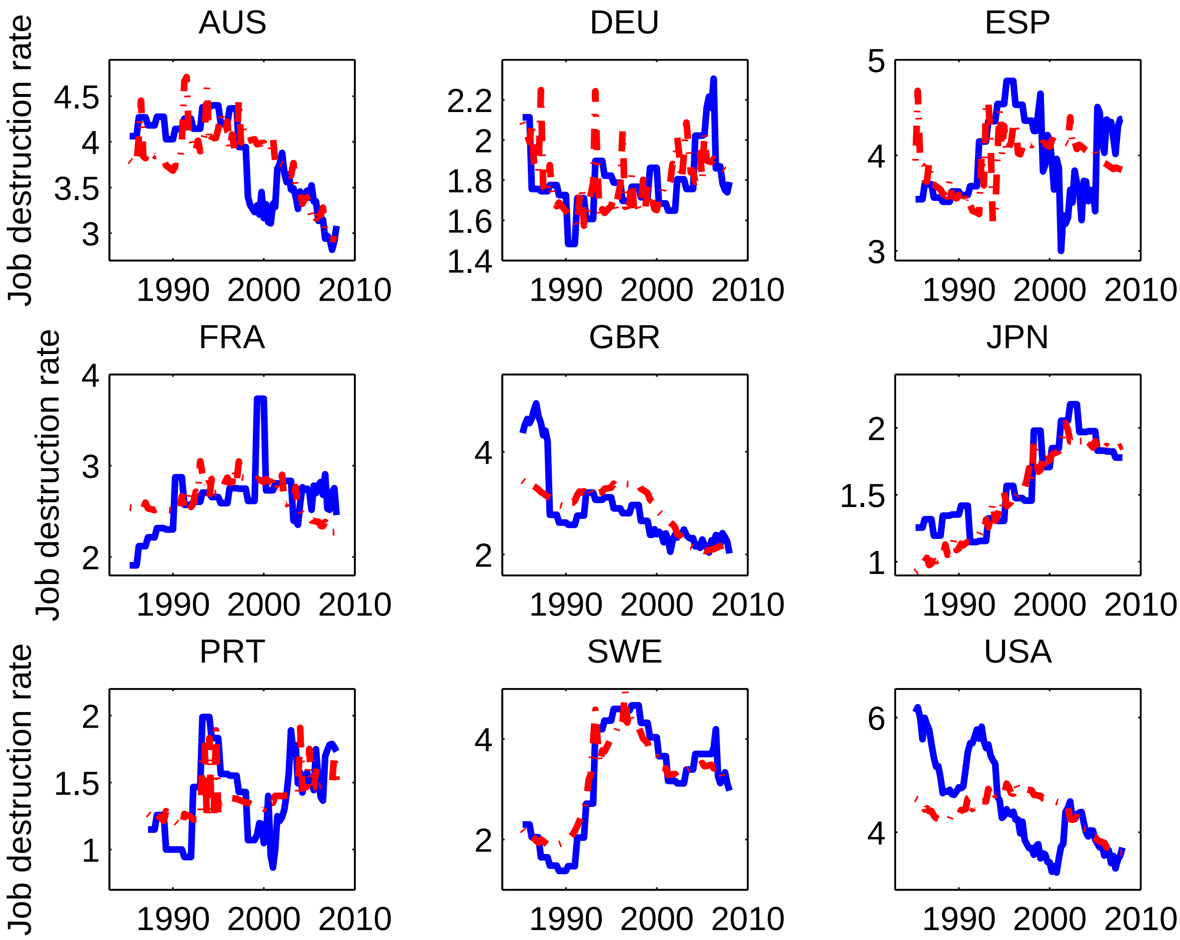
solid, dark line: actual series (non HP-filtered); dotted, light: prediction

Figure 4: Unemployment



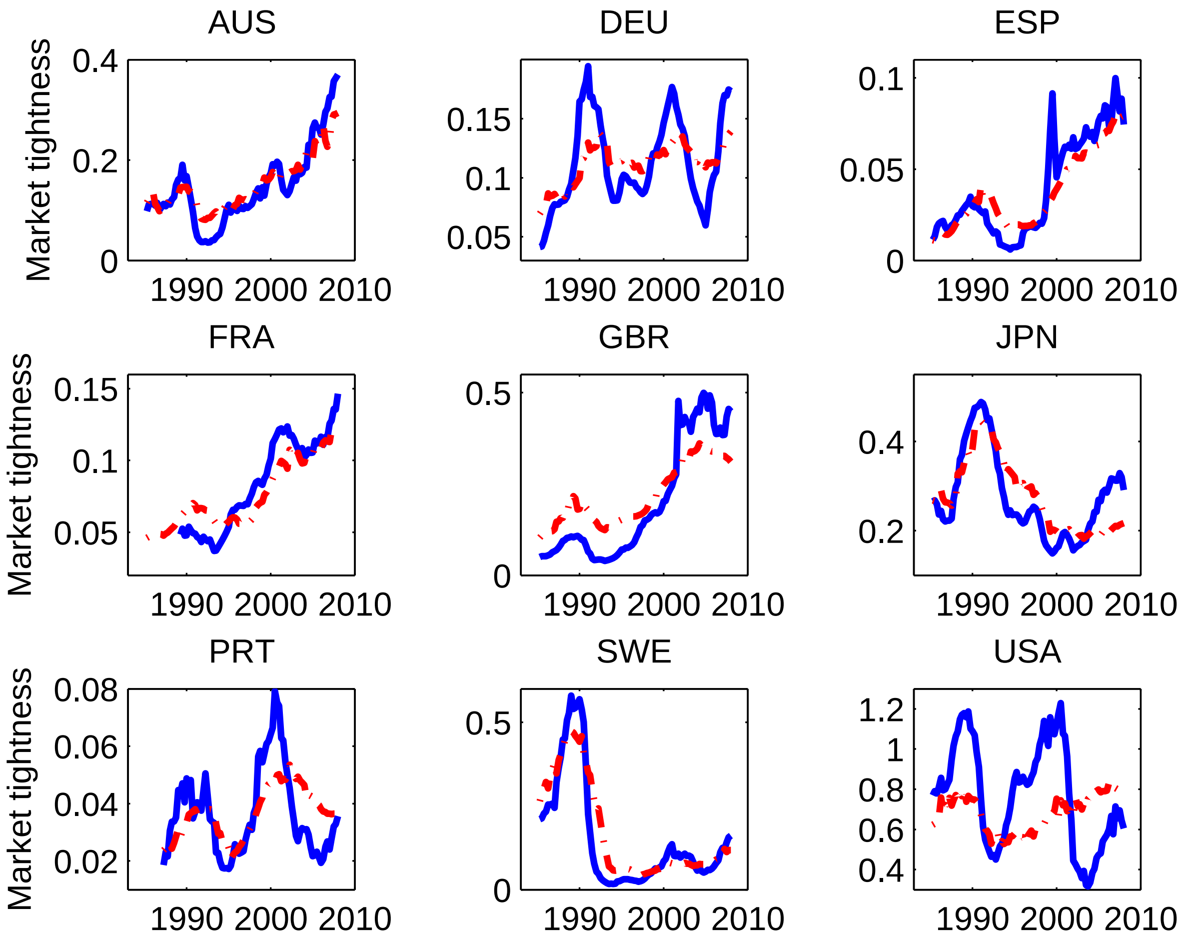
solid, dark line: actual series (non HP-filtered); dotted, light: prediction

Figure 5: Job Finding Rate



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

Figure 6: Unemployment



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

Figure 7: Unemployment

Table 8: Reduced-Form LMP Effects on Employment - Actual and Simulated

	Log UNR		Log LDR		Log JFR		Log V		Log Tightness	
	Observed	Simulated	Obs.	Simul.	Obs.	Simul.	Obs.	Simul.	Obs.	Simul.
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)

Table 9 reports the results. Placement services, UI initial replacement rate and product market regulation are the main intervention channels by which countries significantly influenced unemployment over the period, these by all means classical policies being accountable for close to one, or more than one percentage point reduction or augmentation of unemployment.[15] The other policies yielded, on average, only between 20% and a third of a percentage point.

These average effects hide a variety of interventions across countries, which we summarize as follows. Australia and France increased expenditure on placement services and deregulated product markets. Germany deregulated. Spain massively reduced unemployment benefits, deregulated and reduced employment protection. The UK reduced unemployment benefit, improved placement services and deregulated. The only countries implementing unemployment-augmenting policies are countries with low unemployment rates and hit by a deep and long-lasting recession at the end of the eighties or the beginning of the nineties. Thus Japan and Sweden massively reduced ALMP expenditure. Lastly, Portugal and the US made no noticeable classical policy intervention.

For each individual LMP, it is interesting to look at the cross-country correlation between the average unemployment change and the LMP change. If this correlation were equal to one, this would suggest that the model is linear and that the elasticity of LMPs is identical across countries. As a result, we find that the correlation between unemployment changes and LMP changes is large but not always close to one, which indicates that the model captures some nonlinearities and/or heterogeneities that reduced forms tend to miss. We also do not find evidence of much policy complementarity, as the sum of individual effects is similar in value to the DiD effect of the policy mix. This finding contradicts Bassanini and Duval (2009) and other authors.

Note that the correlation with LMP changes is large but not always close to one, which indicates that the model capture some nonlinearities that reduced forms tend to miss. We also do not find evidence of much policy complementarity, as the sum of individual effects is similar in value to the DiD effect of the policy mix. This finding contradicts

[15] Yet the effect of product market regulation on employment has not received much attention. See Felbermayr, G. and J. Prat (2011) for a recent exception.

Bassanini and Duval (2009), who report positive interaction effects on the basis of reduced-form regressions. Finally, identical labor market reforms trigger unemployment responses proportional (in magnitude) to the baseline unemployment value — high-unemployment countries such as Spain or France witnessing larger unemployment reductions than the other countries; and more intensive interventions yield proportionally bigger effects (see the correlations in the last column of Table 9).

Next we measure the relative contribution of LMPs and business cycle shocks to the long term variance of unemployment. In general, both contribute to about half of the total variance, with some exceptions: in Japan, business cycle shocks do not explain much unemployment volatility, and in Portugal and the US labor market policies seem to have little impact. The lower panel of Table 10 analyzes the contributions of each LMP separately. These results confirm those reported in Table 9. For Australia, Japan and the UK, the main and most effective policies were placement services and product market deregulation; in Germany and Sweden, it is a mix of all three ALMPs; in France product market deregulation; and Spain reduced employment protection.

Table 9: Assessing the Impact of Labor Market Reforms on Unemployment

	AUS	FRA	DEU	JAP	PRT	ESP	SWE	GBR	USA	Mean	Mean absolute DiD	Correlation with mean LMP change
Unemployment Rate, Average Change (percentage point)												
Actual	-5.35	-2.15	-1.33	1.32	1.52	-12.16	1.94	-7.96	-2.62	-2.97		
Simulated	-3.55	-4.27	-2.46	2.75	-0.88	-15.90	1.86	-6.17	-1.19	-3.31		
(Correlation between actual and simulated = 0.93)												
"Diff-in-Diff" Policy Effects (percentage point)												
Initial replacement rate	-0.21	0.52	0.10	0.57	0.67	-3.19	-1.47	-1.30	-0.58	-0.54	0.96	0.94
ALMP: Placement	-1.60	-1.05	-0.31	3.50	-0.27	-1.70	1.19	-2.86	0.11	-0.33	1.40	-0.94
ALMP: Training	0.00	0.04	-0.36	0.04	-0.16	-0.85	1.42	0.29	0.12	0.06	0.36	-0.91
ALMP: Incentives	-0.04	-0.14	0.03	-0.01	-0.01	-0.41	0.94	0.23	0.00	0.06	0.20	-0.96
Product Market Regulation	-0.61	-0.90	-1.23	-0.33	-0.65	-1.69	-0.51	-1.07	-0.18	-0.80	0.80	0.65
Employment Protection	-0.23	-0.09	-0.20	0.00	0.31	1.85	0.01	-0.10	0.00	0.17	0.31	-0.89
Tax wedge	0.00	0.15	0.31	0.45	0.67	-0.64	0.32	-0.37	0.27	0.13	0.35	0.86
Sum of individual policy effects	-2.68	-1.48	-1.65	4.21	0.56	-6.62	1.91	-5.17	-0.26	-1.24	2.73	
Policy mix (all reforms)	-2.99	-1.95	-1.50	4.10	0.45	-5.65	2.30	-4.88	-0.30	-1.16	2.68	

Notes: For each country we first simulate unemployment over the 1985-2007 period responding to all observed LMP changes and estimated business cycle shocks. In a second step, we simulate the series of unemployment after shutting down one LMP at a time (i.e. the LMP is frozen to its average value for the whole period). The table shows the difference between the mean unemployment change across time estimated in the first step and the mean unemployment change, LMP by LMP, estimated in the second step.

Table 10: Share of Unemployment Variance Explained by Covariates

	AUS	FRA	DEU	JAP	PRT	ESP	SWE	GBR	USA	Mean	Correlation with std of LMP change
Pseudo-R2 of LMPs and business cycle (= 1 - MSE)	0.78	0.62	0.47	0.78	0.49	0.65	0.88	0.75	0.37	0.61	
Decomposition of Pseudo-R2											
Business cycle shocks	0.37	0.35	0.25	0.08	0.42	0.29	0.44	0.29	0.48	0.33	
LMPs	0.42	0.26	0.21	0.70	0.08	0.36	0.44	0.46	-0.10	0.31	
	Pseudo-R2 of specific LMPs										
Initial replacement rate	0.046	0.019	-0.002	-0.035	0.042	0.028	0.046	0.047	0.031	0.025	0.25
ALMP Placement	0.165	-0.024	0.088	0.432	0.022	0.019	0.152	0.195	0.028	0.119	0.48
ALMP Training	-0.014	0.014	0.115	-0.004	-0.002	0.008	0.359	0.000	-0.020	0.051	0.95
ALMP Incentives	0.004	0.057	0.072	0.001	0.023	0.007	0.549	0.006	0.004	0.080	0.99
Product Market Regulation	0.062	0.185	0.093	0.088	-0.042	0.086	0.057	0.104	-0.007	0.070	0.39
Employment Protection	0.079	-0.015	-0.028	0.000	0.032	0.205	0.001	-0.004	0.000	0.030	0.88
Tax wedge	0.045	0.033	0.080	-0.038	0.049	0.007	-0.002	0.019	-0.083	0.012	0.35

Notes: The simulations are the same as for Table 9. We calculate the mean squared error (MSE) of the benchmark model (i.e. the sum of squared errors for all the series used to estimate the parameters, unemployment, job finding and layoff rates, and tightness) with all LMPs and business cycle shocks. The pseudo-R2 is 1 - MSE. We calculate the contribution of business cycle shocks as 1 - MSE(LMP = 0), where MSE(LMP = 0) is the mean square error of the model with LMPs remaining fixed at their country-specific means. The contribution of LMPs is calculated as MSE(LMP = 0) - MSE.

7 Conclusion

We have proposed a dynamic stochastic 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 used in the analysis, the model displays an impressive fit of unemployment dynamics. The amount of resources injected into placement and employment services, the reduction of UI benefits and product market deregulation stand out as the most prominent policy levers for unemployment reduction. All other LMPs have a significant but lesser impact. We also find that business cycle shocks and LMPs explain about the same share of unemployment volatility (except for Japan, Portugal and the US).

Our model fits labor outcome series well with the exception of the US. This seems to indicate that European and US labor markets differ in a fundamental way. It would be interesting for future work to collect series at the state level and estimate a specific version of the model for the US. It is thus likely that different policies, or the same policies but with different elasticities, explain different unemployment dynamics across US states.

Our model is both simple and flexible. Yet, in its present form, it remains too simple, and not flexible enough to adequately capture all aspects of labor market institutions. For example, specific legal aspects of employment protection may make difficult for firms to lay-off workers even if their match surplus is negative. Another 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. Another possible extension relates to labor market non participation.

References

[1] Bassanini, A., and R. Duval (2009), “Unemployment, Institutions and Reform Complementarities: Re-Assessing the Aggregate Evidence for OECD Countries", Oxford Review of Economic Policy,Vol. 25(1), pp. 40-59.

[2] Bertola, G., Blau, F. and L. Kahn (2007), “Labor market institutions and demographic employment patterns," Journal of Population Economics, vol. 20(4), pp. 833-867.

[3] Blanchard, O. and J. Wolfers (2000), “The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence", Economic Journal, vol.110 (462), pp. C1-33.

[4] Bruno, M., and J. Sachs (1985), “Economics of Worldwide Stagflation", Harvard University Press, Cambridge, MA, pp. vii+315.

[5] Card, D., Kluve, J. and Weber, A. (2010), “Active Labour Market Policy Evaluations: A Meta-Analysis”, The Economic Journal, 120: F452–F477.

[6] Cahuc, P. and F. Postel-Vinay (2002), “Temporary Jobs, Employment Protection and Labor Market Performance", Labor Economics No. 9, pp. 63-91.

[7] Elsby, M., B. Hobijn and A. Sahin (2012), “Unemployment Dynamics in the OECD", (2013), *Review of Economics and Statistics*, vol. 95(2), pp. 530-548.

[8] Felbermayr, G. and J. Prat (2011), “Product Market Regulation, Firm Selection and Unemployment”, Journal of the European Economic Association, Vol. 9 (2), pp. 278-318.

[9] Gertler, M., and A. Trigari (2009), “Unemployment Fluctuations with Staggered Nash Wage Bargaining", Journal of Political Economy, University of Chicago Press, Vol. 117(1), pp. 38-86, 02.

[10] Hagedorn, M., and I. Manovskii (2008), "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited", American Economic Review, Vol. 98(4), pp. 1692-1706.

[11] Hall, R.E. (2005), "Employment Fluctuations with Equilibrium Wage Stickiness". American Economic Review, Vol. 95(1), pp. 50-65.

[12] Hall, R.E., and A.B. Krueger (2012), "Evidence on the Incidence of Wage Posting, Wage Bargaining, and on-the-Job Search", American Economic Journal: Macroeconomics, vol.4(4), pp. 56-67.

[13] Hall, R.E. and P.R. Milgrom (2008), "The Limited Influence of Unemployment on the Wage Bargain," American Economic Review, vol. 98(4), pp. 1653-74.

[14] Jolivet, G., Postel-Vinay, F. and J.M. Robin (2006), "The Empirical Content of the Job Search Model: Labor Mobility and Wage Distribution in Europe and the U.S.", European Economic Review, vol.50, 877-907.

[15] Lise and Robin (2013), "The Macro-dynamics of Sorting between Workers and Firms", mimeo.

[16] Ljungqvist, L. and T.J. Sargent (1998), The European Unemployment Dilemma," Journal of Political Economy, vol. 106(3), pp. 514-550.

[17] Mortensen, D., and C. Pissarides (1994),"Job Creation and Job Destruction in the Theory of Unemployment", The Review of Economic Studies, Vol.61(3), pp. 397-415.

[18] Murtin, F., and A. de Serres, (2014), "How Do Policies Affect the Exit Rate Out of Unemployment: Disentangling Job Creation from Labor Market Frictions", forthcoming *Labour: Review of Labour Economics and Industrial Relations.*

[19] Murtin, F., de Serres, A. and A. Hijzen, (2014), "Unemployment Turnover and the Automatic Extension of Collective Wage Agreements", forthcoming OECD working paper.

[20] Pissarides, C. (2009), "The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?", Econometrica, Vol. 77(5), pp. 1339-1369, 09.

[21] Postel-Vinay, F., and J.M. Robin (2002), "Equilibrium Wage Dispersion with Worker and Employer Heterogeneity", Econometrica, 70(6), pp. 2295-350.

[22] Prescott, E. C. (2004), "Why Do Americans Work So Much More Than Europeans?", Federal Reserve Bank of Minneapolis Quarterly Review, vol.28(1), pp.2-13.

[23] Nickell, S. and R. Layard (1999), "Labor market institutions and economic performance," Handbook of Labor Economics, in: O. Ashenfelter and D. Card (ed.), Handbook of Labor Economics, edition 1, volume 3, chapter 46, pp. 3029-3084, Elsevier.

[24] Robin, J.M. (2011), "On the Dynamics of Unemployment and Wage Distributions", Econometrica, Vol.79(5), pp.1327.

[25] Rogerson, R. (2008), "Structural Transformation and the Deterioration of European Labor Market Outcomes," Journal of Political Economy, vol.116(2), pp. 235-259, 04.

[26] Shimer, R. (2005), "The Cyclical Behavior of Equilibrium Unemployment and Vacancies", The American Economic Review, vol.95(1), pp. 25-49.