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Unemployment vs. Mismatch of Talents: Reconsidering Unemployment Benefits

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Unemployment vs. mismatch of talents:

Reconsidering unemployment benefits.*

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Abstract

We develop an equilibrium search-matching model with risk-neutral agents and two-sided *ex-ante* heterogeneity. Unemployment insurance has the standard effect of reducing employment, but also helps workers to get a *suitable* job. We show, through calibrations, how the mere difference on unemployment coverage, when countries experience a common *skilled-biased* technological shock, may result in differences in unemployment, productivity growth and wage inequality. These results are consistent with the contrasting performance of the labour market in Europe and the United States in the last twenty five years. The model is used to address some political economy issues.

Keywords: Unemployment, Productivity, Mismatch, Ex-ante heterogeneity, Search, Unemployment benefits, Efficiency, Inequality.
JEL Classification: J64, J65, D33.

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1 Introduction

In this paper we present a simple equilibrium search-matching model of the labour market with two-sided ex-ante heterogeneity. The predictions of this model are shown to be consistent with some salient features of the contrasting evolution of labour markets in *Continental* Western Europe and the United States. In particular, we focus on three observations. First, unemployment has risen dramatically in Europe, whereas it exhibits no such trend in the United States. Second, the productivity per worker has increased much faster in Europe than in the United States. Third, wage inequality has increased to a much larger extent in the United States than in Europe.

European unemployment increased, from an average of 4% in the early 70's to more than 11% in the mid 80's and, then, persistently remained very high. In the United States the unemployment rate was around 5% in 1975, and around 6% in 1994. The rising level of unemployment in Europe has been associated with decreasing rates of exit from unemployment (and fairly stationary rates of entry), longer duration of unemployment, and growing incidence of long-term unemployment (see, for example, Alogoskoufis *et al.* 1995). In the United States, instead, both the inflows and outflows are stationary and unemployment spells tend to be short. The unemployment gap notwithstanding, the total GDP growth in Europe has been similar to that in the United States over the last 25 years. In the period 1975-93, the GDP growth rate of the United States was 2.6% per year, that is about the same as that of Germany (2.5%), France (2.4%), Italy (2.8%) and Spain (2.5%). Different employment growth rates and similar GDP growth rates imply large differences in productivity growth; in the period 1975-94 the average gap between the growth rate of output per worker in the European Union and the United States was above one per cent per year.

While unemployment has been the main social concern in Europe, wage inequality, and the raise of the so-called "class of working-poor" which has been associated with it, has been the "big issue" in the United States. Although part of this inequality originates from the increasing gap between the earnings of qualified groups (college graduates, experienced workers) *vs.* non-qualified groups, it is now well-documented that, in the United States, wage differences have grown not only *across groups*, i.e. between workers with different qualifications, but also *within groups*, i.e. among observationally identical workers (Gottschalk, 1998; Levy and Murnane, 1992). Within group wage inequality accounts for at least 50% of the total increase in inequality for men and is, therefore, a very substantial part of the change that needs to be explained by economic theory. Moreover, historically, it was within group inequality which led, in the 70's, the upwards trend of earning inequality. An additional important observation is that a significant component of the increase in the variance of wages is due to the increase in the transitory movements in the earnings of individual workers. Quantitatively, Gottschalk and Moffitt (1994) document that one third of the widening of the earnings distribution originates from an increase in the instability of earnings. This evidence suggests that, in the 90's more than in the 70's, workers in the United States are frequently employed in technologies where they do not fully benefit from their specific skills. In other words, this suggests that the extent of *mismatch* has increased substantially in the United States.

Wage inequality has increased less dramatically, and, in some cases, not at all, in other OECD countries. In particular, within group wage inequality has remained, overall, stationary in Continental Europe. Although the results vary across studies, to some extent, this type of inequality seems to have remained practically unchanged throughout the 80's in Finland, France, Germany and Italy, and to have only marginally increased in The Netherlands (see Bertola and Ichino, 1995; Gottschalk and Smeeding, 1998). The only major exception is Sweden (Edin and Holmlund, 1995), a country which started from a very low level of inequality, however.[1]

The focus of our analysis is on unemployment benefits. For this purpose, we abstract from other important factors (labour market regulations, nominal rigidities, etc.) which are likely to have played an important role in determining the contrasting evolution of the labour market experiences on the two sides of the Ocean (see, among others, Bean, 1994). Our paper adopts a "minimalist strategy" (i.e., abstract from other institutional differences) with the aim of enlightening *one* of the possible factors which can contribute to explain the evidence. Previous papers have stressed a variety of channels through which high replacement ratios can cause high and persistent unemployment. Here we stress an observation which has been to a large extent neglected by the recent literature. Unemployment benefits provide a "search subsidy" (Burdett, 1979) for giving the unemployed time to find, not just *a job*, but *the right job.* In a labour market with search frictions, the existence of unemployment benefits tends to reduce job mismatches. In particular, unemployed workers without a

[1]In the case of Germany, we are not aware of any direct evidence, but we infer the claim in the text from the fact that neither overall nor across groups inequality has increased. Within-group inequality has instead increased substantially in Australia, Canada and the UK.

"safety net" might accept unsuitable jobs and form what can be identified with a class of "working poor." When this safety net is too high, however, workers become too selective, and reject matches which would have been socially efficient to accept.

Our basic idea is that economies which are in all identical except for the replacement ratio may react very differently to the occurrence of a common technological shock, which enhances the importance of mismatch. We argue that this *mismatch-biased* shock is related to what other papers have referred to as *skill-biased* technical change. To see the source of the similarity, we refer to the observation of Greenwood, Hercowitz and Krusell (1997), for the United States, who show that, starting in the mid-70's, there is an acceleration of *investment-specific* technological change, associated with a fall in the price of capital relative to that of labour. Such technological change has been called *skilled-biased technological change*, and is consistent with postulating a relation of complementarity between capital and skilled labour (see Krusell et al., 1995). In this paper, motivated by the evidence discussed above about the increase of earning instability and within group wage inequality, we postulate that there also exists a relation of complementarity between capital and capital-specific-skills (see Violante, 1997, for a similar notion of technical change in a model where workers' skills are technology-specific). In this case, technical change would appear to be *capital-specific-skilled-biased*. In the presence of search frictions, technological change of this nature enhances the relative value of the "right match", or, equivalently, increases the cost for agents to accept "unsuitable" jobs.

After characterising the trade-off between unemployment and mismatch, we construct two fictitious economies, equal in all except that one grants and the other does not grant unemployment benefits, and choose parameters such that the two economies have fairly similar (steady-state) unemployment rates, and could be identified with the United States and Europe in the mid 70's. Then, we simulate the response of these fictitious economies as they are hit by a common, unexpected permanent shock. Both fictitious economies reach steady states with features resembling those of the United States and European economies in the 90's. That is, the unemployment rate, and the average duration of unemployment spells, increase sharply in the economy with the more generous unemployment insurance, where both indicators remain approximately constant in the other. Furthermore, the growth of productivity per worker is much higher with than without unemployment benefits, and wage inequality increases in the economy without benefits, whereas it only changes marginally in the one with benefits.

We also address some political economy issues. Unemployment insurance also has important distributional implications. Increasing insurance typically makes the unemployed better off, while employed workers might either gain or loose (see also Saint-Paul, 1993 and 1997; Wright 1986). However, even in a world with risk-neutral (or perfectly insured) agents which take the cost of financing the system into account, workers may support some degree of benefits provision, since it both enhances the allocation of talents and strengthen the bargaining power of all workers by increasing the value of their outside option. We explore this possibility and, with it, the potential political support for a reform of unemployment protection policies. In particular, we show that in a "welfare state" economy, even in the knife-edge case in which the search-matching equilibrium is efficient with no unemployment benefits (see Hosios, 1990), a majority of the workers would have opposed, in the 70's, to dismantling the unemployment benefits system, even if they could perfectly foresee that preserving the status quo would have caused high unemployment and high taxes.

Our paper builds on a long tradition of equilibrium models of the labour market, begun with the work of Diamond (1982) and Mortensen (1982). A specific feature of our model is the explicit account of heterogeneity across agents. Some previous papers dealt with heterogeneity in a different way (Acemoglu, 1997a; Jovanovic, 1979; Lockwood, 1986; Moscarini, 1995; Mortensen and Pissarides, 1994). In our paper, heterogeneity is *two-sided,* i.e. both workers and firms are heterogeneous and there are no informational problems. Nevertheless, due to search frictions, workers and firms form matches which yield less than the maximum productivity. Since we focus on symmetric steady-states (such that in the economy there is a uniform density of unemployed of all types), the equilibrium of our model resembles that of some existing "stochastic job matching" models (Pissarides, 1985 and 1990), although both the microfoundations of the theory and the scope of the analysis are substantially different.

Among the vast literature which has studied the empirical issues considered in this paper, the paper that is more closely related to our work is Mortensen and Pissarides (1999). They apply the model of *ex-post* heterogeneity in order to study the different performances of OECD labour markets. Their model is similar to ours in that the "driving force" is an episode of skill-biased technical change. In their model, this shock enhances productivity differences across skills and, therefore, wage inequality (and unemployment differences) increases across groups, rather than within groups, as in our model. Accordingly, their work and our work (which have been developed independently) complement each other, by showing that the basic equilibrium-search matching model can be extended to account for different performances of labour markets (say, the United States *vs.* continental Europe) and that this framework can be of use to analyse the effects of different labour policies.

Ljungqvist and Sargent (1998) is also similar in scope and to some extent complementary to our work. They stress the distortion on the incentives to search due to unemployment benefits in a model where job creation as exogenous. A calibration of the model shows that although unemployment benefits have moderate effects on the aggregate unemployment rate in a situation of "low economic turbulence" (the 60's) it can have larger effects as this turbulence increases (the 80's). A third paper closely related to our work is Acemoglu (1997b), which constructs a model with one-sided heterogeneity, where firms open jobs of different "qualities". The size of unemployment benefits and minimum wages affects the equilibrium composition of jobs in term of good *vs.* bad jobs. This paper, like ours and in contrast with Ljungqvist and Sargent (1998), stresses the existence of channels through which to give workers some social insurance can be welfare-improving (see also Acemoglu, 1997c).

The paper is organised as follows. Section 2 presents the model. Section 3 characterises the equilibrium. Section 4 discusses political economy issues. Section 5 presents the results of a calibration of the model, intended to reproduce the recent experience of Europe and the United States. Section 6 concludes. An appendix contains the technical details.

2 The model

2.1 *Ex-ante heterogeneity and search frictions*

We consider an economy populated by a continuum of firms, workers and rentiers, where both firms and workers are heterogeneous. In particular, each worker has a different productivity depending on in which firm he his employed. Workers are uniformly distributed along a circle of unit length and the total measure of workers is one. At each moment in time a worker can be either employed in a certain firm or unemployed. All unemployed workers search for a job, and search effort is costless. Employed workers cannot change job without going through unemployment (no *on-the-job search*). Firms are also uniformly distributed along the same circle of unit length, and the total measure of firms is $M > 1$. At each moment of time a firm can have a either filled position, or an open vacancy, or be idle. An active firm with a filled position employs one worker, and obtains a revenue from selling the output it produces. An active firm with an open vacancy pays a cost to keep the vacancy posted, and is not productive. Idle firms pay no cost and earn no revenue. We assume that M to be sufficiently large so that a positive measure of firms remain idle in any of the equilibria analysed here. The rentiers do not work, and each of them holds a balanced portfolio of shares of all M firms. The income of a rentier consists of dividends (possibly negative, in which case he is liable for the losses) plus an endowment flow. This endowment is assumed to be sufficiently large to avoid limited liability issues.[2] There is no physical capital, nor other financial assets, and agents consume entirely their income each period.

The productivity of an employed worker depends on the location of the firm where he becomes employed, and decreases with the distance between the worker and the firm. Let $\widehat{i,j} \in (0, \frac{1}{2})$ denote the length of the arc between the location of the firm ($i \in [0, 2\pi]$) and the location of the worker ($j \in [0, 2\pi]$). Next, let $\eta : \left[0, \frac{1}{2}\right] \to [\eta_l, \eta_u] \subset R^+$ be the function mapping distances between worker-firm pairs into productivities, where $0 < \eta_l < \eta_u < \infty$, and assume that $\eta\left(\frac{1}{2}\right) = \eta_l$, $\eta(0) = \eta_u$, and $\eta\left(\widehat{i,j}\right)$ is continuous and non-increasing with $\widehat{i,j}$. Thus, we interpret $\widehat{i,j}$ as a measure of mismatch between workers and firms, and label $\eta\left(\widehat{i,j}\right)$ the *mismatch function*. A particular mismatch function which will be used in section 5 is:

$$\eta\left(\widehat{i,j}\right) = \max\left\{\eta_l,\ \eta_l + a \cdot (1 - \gamma \cdot \widehat{i,j})\right\}, \tag{1}$$

where $a > 0$ and $\gamma \geq 2$. In this case, a worker's productivity is linearly decreasing with distance, for all jobs located in an arc of length $\frac{2}{\gamma}$ centered around his location. If he accepts any work outside that arc, the worker's productivity is given by the lower bound, η_l.[3]

[2] Alternatively, one could assume that the workers own the firms. Most of the analysis carried out in this paper would be unchanged under this alternative interpretation. However, our "political economy" analysis in section 4 relies on the existence of a potential conflict of interests between workers and firms, which we regard as a realistic feature, and which would be drastically reduced if workers owned the firms.

[3] An alternative way of modelling mismatch, which would give almost identical results, is to assume that all workers are equally productive upon hiring, and that there is a stochastic learning process which, at each moment, turns some employed worker into high productivity 'qualified' workers. The learning event is modelled as a Poisson process, whose arrival rate is a decreasing function of the distance between each worker-firm pair. Note that an increase in relative productivity of 'qualified' vs. 'unqualified' workers in that version of the model (i.e., a *capital-specific-technological-change)* is isomorphic to an increase in the parameter a

Next, we describe the matching technology. Firms do not sort workers ex-ante by specifying personal requirements when posting vacancies. This implies that any unemployed worker can meet and interview with any firm located at any point along the circle, with the same probability. The density of interviews between firms located at i and workers located at j is an increasing function of the density of vacancies posted at location i and the density of unemployment at location j. More formally, let $v : [0, 2\pi] \to \Re^+$ denote the density of vacancies at location i and let $u : [0, 2\pi] \to [0, 1]$ denote the density of unemployment at location j. The matching function, $m : \Re^+ \times [0, 1] \to \Re^+$, specifies the flow of "interviews" between firms located at i and workers located at j and depends positively on $v(i)$ and $u(j)$. As is standard, $m(v(i), u(j))$ is assumed to be constant returns to scale. Let $q(v(i), u(j)) = \frac{m(v(i),u(j))}{v(i)} \equiv q(i, j)$ and $\theta(v(i), u(j)) = \frac{v(i)}{u(j)} \equiv \theta(i, j)$. We make the following standard assumptions:

$$q(i,j) = q\left[\theta(i,j)\right], \quad q'\left[\theta(i,j)\right] < 0, \quad \epsilon_{\theta(i,j)} \equiv \left| \frac{dq(i,j)}{d\theta(i,j)} \frac{\theta(i,j)}{q(i,j} \right| < 1,$$
$$lim_{\theta(i,j)\to 0}\ q'\left[\theta(i,j)\right] = \infty, \quad lim_{\theta(i,j)\to\infty}\ q'\left[\theta(i,j)\right] = 0.$$

$q(i, j)$ represents the Poisson probability for a firm posting a vacancy at i to interview an unemployed worker located at j, and $\theta(i, j)q(i, j)$ represents the Poisson probability for an unemployed worker located at j to have an interview with a firm posting a vacancy at i. Note that neither of these probabilities depend on $\widehat{i,j}$. Due to ex-ante heterogeneity, only a fraction of the interviews which take place at each moment will be regarded as acceptable by workers and firms. The determination of this fraction will constitute part of the characterisation of the equilibrium.

Finally, we introduce the following standard notation:

d is the exogenous arrival rate of job separation, which is assumed to be the same for all matches. Once a job is terminated, the worker returns to the pool of unemployed (at his original location), and his productivity in the previous job is irrelevant to the effects of his future employment. The firm, in turn, becomes idle, and can decide whether or not to open a new vacancy;

r is the interest rate;

c is the hiring expenditure flow paid by firms while holding an open vacancy;

b is the unemployment benefit plus the value of leisure.

in equation (1).

2.2 *Asset price equations*

We will assume that there are no informational imperfections, i.e., both workers' and firms' locations are perfectly observed by both parties when interviewing.

First, we write the equations describing the value of a firm holding an open vacancy at $i \in [0, 2\pi]$:[4]

$$rV(i) = \dot{V}(i) - c + \frac{1}{2\pi}\int_{i}^{i+2\pi} q\left[\theta(i,\tau)\right]\left\{Max\left[J(i,\tau), V(i)\right]\right\}\ d\tau, \tag{2}$$

where $V(i)$ is the value of a vacancy posted at i,

$$rJ(i,j) = \dot{J}(i,j) + \eta\left(\widehat{i,j}\right) - w(i,j) - d\left[J(i,j) - V(i)\right] \tag{3}$$

is the annuity value of a firm located at i, which has filled its position with a worker located at j, and $w(i,j)$ is the wage paid to the worker. Observe that whenever filling a job is less profitable than keeping the vacancy, the job match is not formed, thus (except for cases to be specified later) the value of a firm holding a filled position can never fall short of the value of a firm holding an open vacancy at the same location. We assume that entry in vacancy creation is free. Since the value of idle firms is zero, entry will drive down the value of all vacancies to zero. Thus, in equilibrium:

$$V(i) = 0, \qquad \forall i \in [0, 2\pi]. \tag{4}$$

Next, consider the workers' decisions. Let $W(i,j)$ be the asset value for a worker located at j to be employed in a firm located at i. Then:

$$rW(i,j) = \dot{W}(i,j) + w(i,j) - d\left[W(i,j) - U(j)\right], \tag{5}$$

where U denotes the value of being unemployed, and is given by:

$$rU(j) = \dot{U}(j) + b + \frac{1}{2\pi}\int_{j}^{j+2\pi} \theta(\tau,j) q\left[\theta(\tau,j)\right]\left\{Max\left[W(\tau,j), U(j)\right] - U(j)\right\}\ d\tau \tag{6}$$

An acceptable job match generates a rent. We assume that if this rent is positive, it is shared between the firm and the worker, according to the Nash bargaining solution. The total surplus is given by $S(i,j) = [J(i,j) - V(i) + W(i,j) - U(j)]$,

[4]We do not specify time indices, for convenience, when this causes no confusion.

and the Nash solution implies that:

$$W(i,j) - U(j) = \frac{\beta}{1-\beta}\left[J(i,j) - V(i)\right] \tag{7}$$

where β is a parameter representing the bargaining power of the workers, and we recall that $V(i) = 0$ due to free entry. Note that (7) ensures that if a worker finds a particular match to be acceptable, so will the firm, and viceversa (i.e., $J(i,j) \geq V(i) \Leftrightarrow W(i,j) \geq U(j)$).

Using the set of equations from (2) to (7), we can obtain the following expression for the wage rate paid to a worker in the accepted match i, j.

$$w(i,j) = \beta\left[\eta\left(\widehat{i,j}\right) + \Phi(j)\right] + (1-\beta)b, \tag{8}$$

where $\Phi(j) \equiv \frac{1}{2\pi}\int_j^{j+2\pi} \theta(\tau,j)q\left[\theta(\tau,j)\right]J(\tau,j)\,d\tau$.

3 Equilibrium

In this section, we will characterise the equilibrium. We restrict attention to initial distributions such that the same proportion of workers are unemployed at all locations $j \in [0, 2\pi]$. We will start by showing that if a stationary equilibrium, it must have a uniform distribution of vacancies at all locations. We then proceed to characterise the equilibrium, its dynamics and effects of parameter changes; in particular, employment benefits.

Lemma 1 *Assume $u(j) = u$ for all $j \in [0, 2\pi]$. Then, a stationary equilibrium must have $v(i) = v$ for all $i \in [0, 2\pi]$.*

Proof: (see Appendix)

This Lemma implies that, $\forall (i,j) \in [0, 2\pi]^2$, we have $\theta(i,j) = \theta$, and that the Poisson arrival rate of interviews is the same for all unemployed workers (as well as for all firms posting a vacancy), irrespective of their location.

3.1 *Allocation of talents and vacancy creation*

A preliminary important observation which descends from Lemma 1 is that, in a stationary equilibrium (whereby $\dot{V}(i)=\dot{J}(i,j)=\dot{W}(i,j)=\dot{U}(j)= 0$), for all $(i,j) \in [0, 2\pi]^2$, we have:

$$\Phi(j) = c\theta;\; J(i,j) = J(x);\; W(i,j) = W(x);\; U(j) = U, \text{ and} w(i,j) = w(x), \tag{9}$$

where $x \equiv \widehat{i,j}$. In words, the value of a firm with a filled position, $J(i,j)$, only depends on the distance between i and j (since this determines the productivity of the match, $\eta(x)$), but not the specific location of i and j along the circle. The same applies to the value of a job for an employed worker, $W(i,j)$. Furthermore, the value of unemployment is independent of j, as all workers face the same expected gain from getting a job in the future.

Recall, next, that Nash bargaining implies that a firm and a worker always agree, at the interview, on whether the match is profitable. Formally, a job is formed whenever $J(x) \geq 0$, which implies, by (7), that $W(x) \geq U$. There are two possible alternative cases. In the former case, $J(x) > 0$ for all $x \in [0, \frac{1}{2}]$, and all matches are considered as acceptable. In the latter case, there exists a *threshold distance*, $\bar{x}$, such that $J(\bar{x}) = 0$ (hence, $W(\bar{x}) = U$). Define $\bar{\eta}(\bar{x}) \equiv \frac{\int_0^{\bar{x}} \eta(x)dx}{\bar{x}}$, i.e. $\bar{\eta}$ is the average productivity of acceptable matches. Then, the threshold distance satisfies the following condition:

$$[\eta(\bar{x}) - b] - \frac{2\beta\, \bar{x}\, \theta q(\theta)}{r + d + 2\beta\, \bar{x}\, \theta q(\theta)} \left[\bar{\eta}\,(\bar{x}) - b\right] \geq 0 \tag{10}$$

or, equivalently:

$$(1-\beta)\,[\eta(\bar{x}) - b] - \beta c\theta \geq 0 \tag{11}$$

Both (10) and (11) hold with equality if $\bar{x} < \frac{1}{2}$.

The algebraic derivation of these conditions is in the Appendix. Equation (10) has the intuitive economic interpretation of a *comparative advantage* condition. The reservation distance is such that the value for a worker to accept a *type $\bar{x}$ job* is equal to the value of waiting, i.e. the present discounted expected value of a future match (when $\bar{x} = \frac{1}{2}$ waiting is always a dominated option). Equation (11) states the equivalent condition that the marginal match makes non-negative profits.

Next, we characterise the set of pairs $(\theta, \bar{x})$ which are consistent with the free entry condition in vacancy creation ($V = 0$). In particular, we have:

$$-c + \frac{(1-\beta)2\,\bar{x}\, q(\theta)}{r + d + \beta 2\,\bar{x}\, \theta q(\theta)} \left[\bar{\eta}\,(\bar{x}) - b\right] = 0, \tag{12}$$

which states that the cost for a firm of holding an open vacancy must be equal to the expected profit from filling the position.

Fig. 1 geometrically represents the equilibrium conditions implied by equations (11)-(12), when they both hold with equality –. In particular, equation (11) corresponds to the *skill allocation*, (SA), while equation (12) corresponds to the *vacancy creation,* (VC), schedule.

First, consider the *skill allocation* schedule. The more frequently matches occur (high θ), the more easily unemployed workers expect to get good job opportunities in the future, and the less eager they are to accept low-productivity jobs with low wages (small $\bar{x}$). Thus, in tight labour markets, people seeking employment tend to be very choosy, and to only accept highly suitable jobs. Since $\eta(x)$ is continuous and bounded, the range of values of θ which satisfy (11) is also bounded. Provided that $\eta_l > b$, there exists $\theta^* > 0$ such that $(1-\beta)(\eta_l - b) = \beta c \theta^*$, namely, there exists a sufficiently low matching rate, such that all jobs, even those implying the largest mismatch, are considered as acceptable. The particular *skill allocation* schedule in Fig. 1 corresponds to the piece-wise linear productivity function of equation (1). In this case, the schedule becomes vertical at θ^*, corresponding to values of $\bar{x}$ exceeding $\frac{1}{\gamma}$, since all "bad" jobs located at a distance longer than $\frac{1}{\gamma}$ have the same low productivity. Thus, workers accept jobs along the whole circle (i.e. they set $\bar{x}=\frac{1}{2}$) if $\theta < \theta^*$, and set the cut-off distance below $\frac{1}{\gamma}$, if $\theta > \theta^*$.

Consider, next, the *vacancy creation*, schedule, (12). Determining the slope of this schedule is less straightforward, as the partial derivative of the left hand side of (12) with respect to $\bar{x}$ has an ambiguous sign. We will prove below (see the proof of Proposition 1) that this schedule is either backward bending, as in Fig. 1, or monotonically increasing, as in Fig. 2. Parallel to the definition of θ^* provided above, we can define θ^{**} as the matching rate such that $c = \frac{(1-\beta)q(\theta^{**})}{r+d+\beta\theta q(\theta^{**})}\left[\bar{\eta}\left(\frac{1}{2}\right) - b\right]$, namely θ^{**} is the labour market tightness which is consistent with free entry in vacancy creation, when all interviews lead to employment.

`[Figs. 1&2 around here]`

The following proposition establishes the properties of the steady-state equilibrium of the model.

Proposition 1 *Assume $\eta_u > b$. Then:*

a) *There exists, for generic economies, a unique stationary equilibrium pair* (x^e, θ^e)*. Multiple equilibria can only exist for non-generic economies, whose parameters are such that* $\theta^* = \theta^{**}$*.*

b) *(i) If* $\theta^* < \theta^{**}$*, then* $0 < \bar{x}^e < \frac{1}{2}$*, and the equilibrium pair* (x^e, θ^e) *is as determined by (11) and (12); (ii) if* $\theta^* > \theta^{**}$*, then* $\bar{x}^e = \frac{1}{2}$ *and* $\theta^e = \theta^{**}$*.*

Proof. (see Appendix)

Proposition 1 rules out the possibility of multiple equilibria (except for non-generic cases). If the two schedules cross, then we have the unique interior equilibrium described by Fig. 1. If they do not cross, then the *vacancy creation* schedule is positively sloped everywhere, and we have a corner solution, like in Fig. 2.

3.2 *The dynamics of unemployment, output and productivity*

Given, $\bar{x}$ and θ^e, unemployment has the following law of motion:

$$\dot{u}_t = d(1 - u_t) - 2\ \bar{x}^e\ \theta^e q(\theta^e) u_t. \tag{13}$$

The linear differential equation (13) has a standard interpretation. The flow into unemployment is given by the exogenous separations, $d(1 - u_t)$, while the flow out of unemployment is given by the probability that an unemployed worker finds an acceptable match, $2\ \bar{x}^e\ \theta^e q(\theta^e)$, times the mass of unemployed at time t. It immediately becomes evident that if the initial distribution of unemployment is uniform, it remains uniform over time. The solution to the differential equation (13) is $u_t = u^* + (u_0 - u^*)e^{-\left[2\bar{x}^e \theta^e q(\theta^e) + d\right]t}$, where $u^* = \frac{d}{d + 2\bar{x}^e \theta^e q(\theta^e)}$ is the steady-state unemployment rate to which unemployment monotonically converges.

Next, consider, the dynamics of output. Define gross production at time t as y_t.[5] Gross output has the following law of motion:

$$\dot{y}_t = \bar{\eta}\ (\bar{x}^e) 2\ \bar{x}^e\ \theta^e q(\theta^e) u_t - d y_t, \tag{14}$$

where y_0 is predetermined. To understand (14), observe that the average productivity of new jobs at t will in general differ from that of the jobs terminated

[5] We define as *net* production the production flow generated by firms holding a filled position minus the hiring expenditure flow suffered by firms holding a vacant position. *Gross* production is equal to net production plus hiring expenditure.

at t. In particular, the average productivity of the employed workers at t (thus, the productivity of jobs which are terminated) is a predetermined variable which depends on past hiring decisions, while the average productivity of new matches is not predetermined. The latter is equal to $\bar{\eta}\ (\bar{x}^e)$, and the output flow from newly created jobs is, therefore, equal to this average productivity times the flow of successful matches, $2\ \bar{x}^e\ \theta^e q(\theta^e) u_t$. The solution to (14) is given by:

$$y_t = y^* + \Big[(y_0 - y^*) + \bar{\eta}\ (\bar{x}^e)(u_0 - u^*)\Big]\, e^{-dt} - \bar{\eta}\ (\bar{x}^e)(u_0 - u^*) e^{-\left[2\bar{x}^e \theta^e q(\theta^e) + d\right] t}, \tag{15}$$

where $y^* = \bar{\eta}\ (\bar{x}^e) \frac{2\bar{x}^e \theta^e q(\theta^e)}{d + 2\bar{x}^e \theta^e q(\theta^e)}$ is the steady-state equilibrium gross production levels. The dynamic system is globally stable, thus the economy converges to y^*, u^* starting from any pair of initial conditions u_0, y_0. To determine *net production*, finally, observe that the aggregate hiring expenditure in the economy is given by $cv_t = c\theta u_t$. Thus, net production is equal to $z_t = y_t - c\theta^e u_t$.

We conclude with an important remark. Irrespective of the initial distribution of existing matches, the equilibrium converges over time to a stationary uniform distribution of jobs. More precisely, the steady-state will, at every location $i \in [0, 2\pi]$, have a density $1 - u^*$ of firms with a filled position and a uniform distribution of filled job (productivities) over the interval $x \in [0, \bar{x}]$. In other words, the extent of mismatch will be independent and identically distributed with respect to the location of workers and firms. This feature will be important in the following sections, when we study the effect of parameter changes.

3.3 *An unexpected change of unemployment benefits*

We will now discuss an important result of comparative statics: the effect of an unanticipated increase in unemployment benefits. We assume that the shock occurs when the economy is in a steady-state as characterised by the previous subsection. When b increases, both curves in Figs. 1 and 2 will shift to the left, and the geometrical analysis followed so far is inconclusive. It can be shown, however, that *when b increases, both the threshold distance and the tightness of the labour market fall.* To see this, we first rearrange (10) as follows:

$$\Big[\bar{\eta}\ (\bar{x}) - b\Big] = \frac{[r + d + 2\beta\ \bar{x}\ \theta q(\theta)]\ \Big[\bar{\eta}\ (\bar{x}) - \eta(\bar{x})\Big]}{r + d}. \tag{16}$$

Next, replacing the left hand-side of (16) into (12), we obtain:

$$\frac{1}{q(\theta)} - \left\{ \frac{(1-\beta) 2\, \bar{x} \left[\bar{\eta}\ (\bar{x}) - \eta(\bar{x}) \right]}{(r+d)c} \right\} = 0 \tag{17}$$

Equations (11) and (17) provide an alternative characterisation of a(n interior) equilibrium. The advantage of this formulation is that only (11) is dependent on b, and this facilitates the geometrical analysis of the comparative statics. Equation (17) defines a positively sloped locus – labeled *VCbis* in Fig. 3 – in the plane $(\theta, \bar{x})$. This can be shown by observing that $\frac{1}{q(\theta)}$ is an increasing function of θ, while $\frac{d}{d\bar{x}} \left\{ \left[\bar{\eta}\ (\bar{x}) - \eta(\bar{x}) \right] \bar{x} \right\} = -\ \bar{x}\ \eta'(\bar{x}) > 0$ and using standard differentiation. When b grows, the skill allocation schedule shifts to the left, and the equilibrium has a lower threshold distance as well as a less tight labour market. The more generous insurance, the lower is the mismatch and the higher the productivity per worker in equilibrium. But, at the same time, unemployment insurance reduces job creation and employment.

`[Fig. 3 around here]`

3.4 *Transitional dynamics after a shock*

When the value of some parameter of the model changes unexpectedly (e.g., an increase in b), the rents generated by some of the existing matches, which were profitable before the shock, might turn negative. We must therefore clarify what happens to the matches which become unprofitable. One could assume that workers and firms split the losses associated with the continuation of unprofitable matches (equation (8) extends to cases in which surplus is negative). We find this option rather unplausible. In particular, it seems unrealistic that some employed workers have lower welfare than the unemployed. These workers would prefer to quit their job, and postulating that they are not allowed to quit is equivalent to introducing some "slavery-type" condition.

There are other possible solutions. For example, assuming that separation is partially endogenous, i.e., that a job can be destroyed at no cost whatsoever, as soon as it ceases to be profitable. In this case, unemployment would become a "quasi-state" variable, which jumps discontinuously in case of unexpected parameter changes. For instance, after an increase of b, the unemployment rate would instantaneously jump upwards, from u^* to $u^* + 2(\bar{x}_0^e - \bar{x}_1^e)(1-u^*)$, where $\bar{x}_0^e$, $\bar{x}_1^e$ denote the equilibrium threshold distances before and after the shock respectively (note that, on the contrary, a decrease of b does not cause any discontinuous jump in unemployment). Our formulation is consistent with this assumption, although the event of a sudden increase of unemployment due to massive job destruction seems, also, rather unrealistic.

Another alternative is to introduce dismissal costs.[6] To capture employment protection constraints in a reduced-form fashion, we introduce the alternative assumption that, while job termination remains exogenous, whenever the surplus generated by a job turns negative, the firm must bear the entire loss, and pay the worker a salary granting him the same utility which he would receive if unemployed. Formally, this implies modifying (8) as follows:

$$w(x) = \max\left[rU, \beta\left[\eta(x) + c\theta\right] + (1-\beta)b\right]. \tag{18}$$

In words, the worker receives the reservation wage whenever the match generate a non-positive surplus in an existing job. Under this assumption, unemployment remains strictly predetermined, and the model predicts more realistic transitional dynamics.[7] Although we will stress this last interpretation of the model when discussing transitional dynamics, most of our results, and in particular the steady-state analysis, which is the main focus of this paper, are identical in the two cases.

4 The political economy of unemployment benefits

The purpose of this section is to analyse how gains and losses from policy changes are distributed among different agents when the unemployment benefit system is changed. We start by stating a standard efficiency result. Consider a social planner who is only subject to the search frictions and can costlessly redistribute income among agents (or, alternatively, the planner has no egalitarian concern). The planner maximises the present discounted value of the output stream plus leisure, given initial conditions. The following result can be established.

[6] This is also the approach followed by Mortensen and Pissarides (1999), although their model has different features.

[7] A third alternative, following Shaked and Sutton (1983), is to assume that wages are determined according to $w(x) = \max\left[rU, \beta\eta(x)\right]$, derive the equation corresponding to (10) and show that in that corresponding equation b plays a similar role than under our Nash bargaining wage determination. With this formulation, wages obey the same contracting rule after a shock.

Proposition 2 *The competitive search-matching equilibrium with no unemployment benefits is efficient, both in terms of job creation and assignments, if and only if* $\alpha = \beta$.

The proof of this Proposition is provided in Marimon and Zilibotti (1997). Proposition 2 generalises the well-known result that the equilibrium rate of job creation is inefficient when there are search frictions in the labour market, except for the non-generic case when the elasticity of the matching function is equal to the bargaining power of workers (Hosios, 1990; Pissarides, 1990; Mortensen (1996a)). In particular, it establishes that mismatch is generically suboptimal in a decentralised equilibrium (being either too large or too small) with exogeneous bargaining powers, but when the Hosios-Pissarides condition is satisfied workers are efficiently assigned to jobs.

We now turn to the distributional effects of changing unemployment benefits. Consider an economy where the unemployed receive a provision equal to b_0. Unemployment and output are at the corresponding steady-state, $u_0(b_0), y_0(b_0)$. Given this steady state, filled positions are uniformly distributed over the interval $[0, \bar{x}_0^e (b_0)]$. Without much loss of generality, assume $\eta'(x) < 0$ for all x. The following lemma is a first step towards accounting for distributional effects.

Lemma 2 *Let* $b > b_0$ *and* $0.5 \geq \bar{x}^e (b_0) > \bar{x}^e (b)$. *Then:*

1. *For all* $x \leq \bar{x}^e (b_0)$, *we have* $J(x, b) < J(x, b_0), W(x, b) > W(x, b_0)$, $U(b) > U(b_0)$.
2. *For all* $x \leq \bar{x}_0^e (b_0)$, $U(b) - U(b_0) \geq W(x, b) - W(x, b_0)$.
3. *Let* $x > x'$. *Then:* $W(x, b) - W(x, b_0) \geq W(x', b) - W(x', b_0)$. *In particular:*

   a) *If both* $x, x' \in [0, \bar{x}^e (b)]$, *then* $W(x, b) - W(x, b_0) = W(x', b) - W(x', b_0)$;

   b) *If* $x \in [\bar{x}^e (b), \bar{x}_0^e (b_0)]$ *and* $x' \in [0, \bar{x}_0^e (b_0)]$, *then* $W(x, b) - W(x, b_0) > W(x', b) - W(x', b_0)$.

That is, raising b (ignoring the costs of financing it) increases the reservation wage of workers and the value of the human assets of all workers (both employed and unemployed), whereas it decreases the value of firms (*part 1*). However, the effects are not symmetric. Unemployed workers makes the largest gains (*part 2*). Furthermore, some richer employed workers benefit less than some poorer co-workers (*part 3*). To understand why, observe that a group of relatively poor workers, namely those whose mismatch ranges in the interval $x \in [\bar{x}^e(b), \bar{x}_0^e(b_0)]$, are employed in jobs which turn non-profitable when the benefits go up to b. These workers benefit from the change.[8] These poor workers therefore receive an implicit or explicit premium over the wage increase which accrues to their richer, better-matched colleagues (*part 3b*). The welfare gains of all workers belonging to this richer group are instead equal, irrespective of x (*part 3a*).

Next, we consider the cost of financing the system. Assume that the system is financed through lump sum taxes, levied on all workers (both employed and unemployed), and that, at each t, all workers (both employed and unemployed) have to pay a tax equal to $\tau = bu_t$. Let T denote the asset value of 'being a tax-payer' of a country in which the unemployed receive the gross benefit b. Then:

$$T(b, u_0) = -b \int_0^\infty e^{-rt} u_t(b, u_0) dt. \tag{19}$$

$T(b, u_0)$ is a decreasing function of b, since the higher b the larger the fiscal burden to finance the provision. Since all workers are subject to the same tax burden, while the gains from raising unemployment benefits depend on their employment status (Lemma 2), we can state the following Proposition.

Proposition 3 *Let $b > b_0$. Assume that, at $t = 0$, $u_0 = u^*(b_0)$ and $y_0 = y^*(b_0)$ (where stars denote steady-states). Then (unless all workers unanimously prefer b to b_0 or b_0 to b), $\exists\ \hat{x} \in [\bar{x}^e(b), \bar{x}_0^e(b_0)]$ such that all the unemployed and all workers employed at a distance $x \geq \hat{x}$ prefer b to b_0, while all workers employed at a distance $x < \hat{x}$ prefer b_0 to b.*

Proposition 3 establishes that, unless workers have unanimous views, there is a conflict of interests between workers with the option of increasing benefits gathering the support of the unemployed and the "poorer" employed workers, and the opposition of the "richer" employed workers. This case is represented by Fig. 4 (where $NW(x, b) = W(x, b) + T(b)$ and $NU(b) = U(b) + T(b)$). In this case, although harmful to well-matched workers (the NW schedule shifts to the left), the increase of the unemployment benefits from b_0 to b increases

[8] If, on the one hand, firms can lay-off workers at no cost, these workers will become unemployed. However, the entitlements to receive benefits plus the perspective of getting a better job in future make these "poor" workers better off. If, on the other end, there are firing restrictions and workers are entitled to earn more than what the Nash rule would grant them (according to equation (18)), the improvement takes the form of a higher wage.

the welfare of the "poor" workers holding a job in the range $[\hat{x}, \bar{x}_0^e]$, as well as of all the unemployed.

`[Fig. 4 around here]`

Note, to conclude, that if benefits were financed, more realistically, by linear (or progressive) income taxation, or pay-roll taxes, this would reinforce the alignment of interests between the "working poor" and unemployed workers.

5 Calibration: the United States vs. Europe

5.1 *Unemployment, output growth and inequality: the 70's* vs. *the 90's*

In this section, we present the result of a numerical solution of the model with calibrated parameters, which illustrates how the model can successfully mimic some key features of the contrasting behaviour of the labour markets in Western Europe and the United States in the last two decades.

In order to obtain numbers comparable with the data, we introduce a trend of *neutral* technical change. More precisely, we assume that b, c, and $\eta(x)$ grow at the exogenous rate g. It is easily shown that the steady-state equilibrium in the presence of neutral technical change is given by a simple modification of (10) and (12), whereby the interest rate (r) is replaced by the difference between the interest rate and the rate of technical change ($r-g$). In particular, the solution characterised by Proposition 1 remains true up to replacing r by $r-g$, and neither the tightness of the labour market nor the reservation distance changes over time. Note that for technical progress to be neutral, the productivity of all matches must grow at the same rate, i.e. $\eta_{t+k}(x) = e^{gk}\eta_t(x)$ for all x. If technical progress is non-neutral, the importance of mismatch changes over time, and this affects the agents' equilibrium behaviour.

We will consider two hypothetical economies which only differ by the extent of unemployment insurance, b. One economy, denoted by U, will be assumed to have no unemployment insurance ($b=0$), and will be interpreted as a US-type laissez faire economy[9]. The other economy, denoted by E, provides

[9]Here we follow Mortensen (1996b) who argues that the limited extent of unemployment benefits in most states of the United States results in a non-positive effect of benefits on reservation wages.

the unemployed with benefits of unlimited duration ($b > 0$, financed by lump sum taxes charged from all workers, both employed and unemployed), and can be interpreted as a typical welfare state European country. The two economies will be identical in all other parameters.

We assume that the two countries are initially at their respective steady-states, which we interpret as the situation in the early 70's. Then, both economies are hit by a common, unanticipated shock increasing the importance of mismatch, by widening the productivity gap between the best ($x = 0$) and the worst ($x = \frac{1}{2}$) job that a worker can perform. The new steady state will be interpreted as the situation in the nineties.

We calibrate the parameters as follows. We interpret a time period of unit length to be one quarter, and set the interest rate equal to 0.01125, implying an annual interest rate of 4.5%. The rate of neutral technical change is assumed to be 1% per year (thus, $g = 0.0025$). The separation rate is set equal to $d = 0.04$, implying an average duration of a match of about six years. Although this duration might seem fairly long – especially for the United States – it should be noticed that we are here considering the duration of employment spells, not of jobs (i.e, we ignore job-to-job movements). Since in this experiment we do not want to introduce exogenous differences between Europe and the United States other than b, we find that this figure is reasonable. We parameterise the mismatch function according to the linear specification given by equation (1), and set the initial minimum productivity ($\eta_{l,0}$) equal to 2.25, a normalisation without any particular importance. Furthermore, we set $a_0 = 0.5$ implying that each agent is 22% more productive in his best than in his worst possible occupation, and let $\gamma = 4$, implying that each worker is, to some extent, skilled in 50% of the possible employments. The bargaining power of both parties is equal, so $\beta = 0.5$, corresponding to the symmetric Nash solution, and the elasticity of the matching function is constant with $\alpha = 0.5$. Recall that when $\alpha = \beta$ the equilibrium with no benefits is efficient. The hiring cost is assumed to be equal to foregoing the production flow of one low-productivity worker, i.e. $c_0 = 2.25$. Leisure is assumed to be worthless. In E, the welfare state economy, unemployed workers receive a subsidy equal to 50% of the wage paid to the worst paid workers (in both the initial and final period). Although this is less than the average subsidy granted to unemployed workers in many European countries, in reality benefits have usually a limited duration. Moreover, accepting a job has normally a positive influence on the level of future benefits, hence we regard this figure as a realistic approximation of the impact of the benefits on the reservation wages.

The skill-biased technical change shock is captured by an increase in the parameter a above its trend in both countries. In particular, a is assumed to increase from $a_0 = 0.5$ to $a_1 = 0.85$. As a result, in the final steady-state the best matched worker's productivity exceeds the worst matched worker's productivity by about 38%. Table 1 summarises the results, by comparing the steady-states of the two economies before (*steady-state 1*) and after (*steady-state 2*) the shock. We will regard the time elapsed between the initial and final situation as approximately twenty years. In the initial period, all workers in both economies accept matches along the entire circle, i.e. $\bar{x}= \frac{1}{2}$. The resulting unemployment rates do not differ a great deal, although, not surprisingly, unemployment is higher in E (5.5%) than in U (3.9.%). The average duration of unemployment is about four months in U, and 5.7 months in E. The wage distribution is very similar in the two countries, and so are output and productivity. Note that total output is initially slightly larger in U than in E. In the final steady-state, the situation looks dramatically different. The unemployment rate remains almost the same in U (3.8%) but increases substantially in E (11%). The explanation of this diverging behaviour is that in E, where the cost of unemployment is lower due to insurance, the optimal search behaviour changes. In response to the shock which increases the gap between their productivity in suitable and unsuitable occupations, they become more selective and lower the cut-off distance to $\bar{x} = 0.219$. In U, instead, where unemployment is a more painful experience, agents continue to rush into *any* employment. As a result, although the vacancy-to-unemployment ratio does not change significantly in either country, the average duration of unemployment, stable in country 1, doubles in country 2, increasing to over one year. For the same reason, the share of long-term unemployment grows substantially in E, where, after the shock, it takes more than six months for more than half of the unemployed workers to exit unemployment, while, for almost 30%, it takes more than a year.[10]

[10]The predictions of the model as to the change in the share of long-term unemployment are consistent with the evidence that this share has increased substantially in Europe, whereas there has hardly been any change in the United States. On the other hand, the model is not entirely successful in some of its quantitative predictions. First, it predicts a lower share of long term unemployment in Europe than what we observe. Second, and more important, it fails to recognise that long-term unemployment was already high in Europe during the 70's. In 1989, about 70% of the unemployed in Europe had to wait more than six months before finding employment (vs. 53% in our model), and about 50% had to wait for more than one year.

Table 1. Comparison between steady-states.

		steady-state 1	steady-state 2	% change
Cut-off, $\bar{x}$	U	0.5	0.5	
	E	0.5	0.218	
Unemployment rate	U	3.9	3.8	
	E	5.5	11.1	
Average duration of unemployment (months)	U	4.1	4.0	
	E	5.8	12.5	
Average productivity per employed	U	2.29	2.89	23.6
	E	2.31	3.15	30.8
Total output	U	2.20	2.78	23.6
	E	2.19	2.80	24.6
Percentage of unemployed with duration $\geq$ 6 months	U	14.1	13.6	
	E	25.1	52.8	
Percentage of unemployed with duration $\geq$ 12 months	U	2.0	1.8	
	E	6.3	27.9	
Ratio between highest lowest wage	U	1.107	1.173	6.6
	E	1.133	1.146	1.2
Ratio between 90th-10th wage percentile	U	1.087	1.142	5.5
	E	1.086	1.116	3.1

Although workers experience longer unemployment spells in the welfare state economy, they are on average better assigned to jobs. As a result, productivity growth is higher in E (+31%) than in U (+24%). If we interpret the period length as twenty years, this translates into average yearly growth rates of 1.18% and 1.54%, respectively. The productivity gap is of the order of 0.4% per year. The observed differential of productivity growth between the United States and Europe is about 1.1% per year, so this specification of the model predicts more than one third of the observed difference. Furthermore, note that total output growth is larger in country 2 than in country 1. Remarkably, the model predicts that with standard parameters an economy with 11% unemployment rate can be more productive than an economy with 4% unemployment rate, since very high employment is obtained in U at the cost of larger mismatch.

The transitional dynamics of unemployment and output depends on whether unproductive matches can be costlessly destroyed. If we rule out the possibility of instantaneous distraction, we have the following patterns. In the economy without insurance, unemployment is almost constant, whereas in the economy with insurance the unemployment rate first grows rapidly and, then, settles down at the new steady-state level. As far as output is concerned, the two economies start from very similar levels, and the economy with welfare state reaches some higher output level at the new steady-state. However, the cost of this better performance in the long run is a sharp initial recession. The output in the economy with welfare state remains below that of the economy without insurance for about ten years. Twenty years after the shock, all variables in both economies are very close to their respective steady-state, and this justifies our interpretation of the steady-state figures of Table 1 as the situation prevailing in the 70's and the 90's. If firms could instead exit at no cost, unemployment in E would jump upwards upon the occurrence of the shock, overshooting the steady-state level. In particular, more than half of the existing jobs would suddenly be destroyed, causing a dramatic boom of unemployment. Unemployment would then gradually fall to its new steady-state level, which would be the same as *steady-state 2* in Table 1.

Table 1 also shows that the model correctly predicts the qualitative changes in wage inequality, although the quantitative effects are fairly small. As noticed earlier, the model has predictions about within group wage inequality, which, as shown in the Introduction, has grown in the United States more than in Europe. As shown in the two last rows of Table 1, our model predicts a significantly larger increase in wage inequality in the economy without unemployment insurance than in the one with insurance, and this is valid for both the ratio between the highest and the lowest wage and the ratio between the 90th and the 10th percentile. The explanation of this difference is that while many workers in U accept jobs which are highly unsuitable to their characteristics, and therefore receive a low wage, poor matches are not formed in E. This reduces the spread of the wage distribution. Thus, although both economies were hit by an intrinsically unequalising shock, this is partially offset, in the welfare state economy, by the change of attitudes of the unemployed. On the contrary, in E, the increase of the productivity differentials between good and bad matches is entirely passed through to increasing wage differentials between "lucky" well-matched workers and "unlucky" badly matched workers.

5.2 *The welfare state dilemma: winners and loosers*

The calibrated version of the model presented above can also be used for assessing some of the distributional effects discussed in section 3. Consider country E, and assume that, when the *mismatch biased* technological shock occurs, the agents living in E can choose whether to keep the status quo (unemployment insurance), or dismantling the system of benefit provision (like in country U) in order to avoid the increase of unemployment. As we will see, this choice will raise a conflict of interests between agents with different employment status.

Recall that, when the shock occurs, the economy is in a steady-state, where the unemployment rate is 5.5%. We assume, here, that firms cannot lay off workers when matches turn unprofitable, but, according to equation (18), existing jobs must be continued and workers paid no less than their reservation wage. First, consider the "rich", well-matched workers whose jobs remain profitable after the shock (i.e., $x \in [0, 0.219]$). If unemployment benefits were abolished, these workers would suffer a wage cut (compared with the status quo) due to the loss of bargaining power in the wage negotiation (outside option effect). In our calibrated economy, the loss, as measured by the asset value difference between being employed in a match x with and without benefits is equal to $W(x, b) - W(x, 0) = 12.0$ (recall that, by Lemma 2, the welfare change is identical for all well-matched workers, such that $x \in [0, 0.219]$). Consider, next, the unemployed. We expect that the unemployed would loose more than the employed workers from cutting benefits to zero. In fact, the measured loss is, in their case, equal to $U(b) - U(0) = 13.2$. The loss of the "poor" employed workers (such that $x \in [0.219, 0.5]$) is bounded between the loss of the rich workers and that of the unemployed. All agents, however, would gain from tax reduction. Since we assume uniform lump sum taxes, this gain is the same for all workers, both employed and unemployed. The present discounted cost of financing the existing benefit system with the perspective of growing unemployment (see equation (19)) is $T(b) = 13.0$.

As these numbers immediately show, the unemployed are better off with than without benefits (since $13.2 > 13.0$), while well-matched workers would prefer a no-insurance system ($12.0 < 13.0$). A large share of the working poor, however will also gain from the provision of benefits. In particular, it turns out that all employed workers with $x > 0.242$ will be better off with than without insurance, whereas all 'richer' workers with $x < 0.249$ are worse off without insurance. Since employed workers are initially homogeneously distributed in the interval $x \in [0, 0.5]$ this means that about 50% the employed workers, together with all the unemployed (5.5% of the working population), would prefer to preserve the welfare state, even though the effects on unemployment are perfectly predicted. Note that the results change if we assume that unproductive matches can be terminated. In this case, unemployment would have boomed upon the occurrence of the technological shock, and the cost of keeping the existing welfare state system would have become prohibitively high. In this case, all workers (including the unemployed) would support a laissez-faire oriented reform.

6 Conclusions

In this paper we have shown how a search equilibrium model, where agents have differently skills for performing different tasks, can capture the main facts regarding the contrasting performances of the United States and Continental European labour markets. In our simulated results, the contrast arises from the different responses to a mismatch-biased technological shock, which are the result of differences in unemployment insurance (or social norms regarding unemployment protection). Although the scope of our "calibration" is mainly illustrative, we believe that the results are insightful to assess the trade-off involved in unemployment protection policies (unemployment vs. mismatch). Our results complement other explanations of the "contrasting performance of the United States and European labour markets" that explore alternative mechanisms and that may also be at work.

We believe that the theoretical model which we have constructed is of independent theoretical interest, and is suitable to study a number of positive or normative issues which have been ignored in this paper. Among them, the impact of other labour policies; the transitional effects of sectorial reallocations; the relation between economic fluctuations and employment mismatches, etc. In the current development of the model, we have made restrictive simplifying assumptions that should be reassessed in the future. For instance, we have ruled out on-the-job search, while mismatched workers have substantial incentives to look for better matches while employed. Furthermore, the assumption of uniform initial distributions of unemployment needs to be addressed in more detail by future work, by focussing on the stability property of the uniform steady-state distribution considered here, and extending attention to non-stationary solutions when the entire distribution of unemployment is the state variable of the economy.

Appendix

Proof of Lemma 1

Stationarity implies that, for all $(i, j) \in [0, 2\pi]^2$, $\dot{J}(i, j) = \dot{V}(i) = 0$. Imagine that, in contradiction with the Lemma, $v(i) < v(i')$ for some i, i'. Then, equation (2) implies that:

$$\begin{array}{c} V(i) = -c + \frac{1}{2\pi} q\left(\frac{v(i)}{u}\right) \int_i^{i+2\pi} \left(J(i, \tau)\right) d\tau \\ V(i') = -c + \frac{1}{2\pi} q\left(\frac{v(i')}{u}\right) \int_{i'}^{i'+2\pi} \left(J(i', \tau)\right) d\tau \end{array} \tag{20}$$

Equations (3)-(8), in turn, imply that:

$$J(i, j) = (r + d)^{-1} \left((1 - \beta) \left(\eta(\widehat{i, j}) - b\right)\right) - \beta \Phi(j)$$

Hence, for any $\kappa \in [0, 2\pi]$:

$$\int_\kappa^{\kappa+2\pi} \left(J(i, \tau)\right) d\tau = (r + d)^{-1} \left((1 - \beta) (\hat{\eta} - b)\right) - \beta \hat{\Phi} = \hat{J}$$

where $\hat{\eta} = \int_\kappa^{\kappa+2\pi} \eta(\widehat{\kappa, \tau}) d\tau$ and $\hat{\Phi} = \int_\kappa^{\kappa+2\pi} \Phi(\tau) d\tau$. Thus:

$$V(i) = -c + \frac{1}{2\pi} q\left(\frac{v(i)}{u}\right) \hat{J} > -c + \frac{1}{2\pi} q\left(\frac{v(i')}{u}\right) \hat{J} = V(i') \tag{21}$$

where the sign of the inequality follows from the properties of the matching function, $q(.)$. But (21) contradicts the assumption of free-entry, which implies that $V(i) = V(i') = 0$. Thus, $v(i)$ must be equal to $v(i')$. QED.

Proof of Proposition 1

We prove the Proposition through simple geometrical arguments.

To prove existence, we will first establish that either the Vacancy creation schedule (VC) lies entirely to the left of the Skill allocation schedule (SA), or the two schedules cross; we then establish that in both cases an equilibrium exists. To rule out that VC is entirely to the right of SA, observe that (a) from (11), the SA schedule intersects the horizontal axis in correspondence of $\theta = \frac{(1-\beta)}{\beta c}(\eta_u - b) > 0$; (b) for (12) to be satisfied, it must be the case that as $\bar{x} \to 0$, $\theta \to 0$ (which implies that $q(\theta) \to \infty$), therefore the VC schedule starts from the origin. Hence, at $\bar{x} = 0$, VC is always to the left of SA. Assume that VC is entirely to the left of SA. Then, it is easy to check that the solution $\left(\theta^e = \theta^{**}, \bar{x}^e = \frac{1}{2}\right)$ satisfies the conditions (10) (or, alternatively, (11)) and (12) – the former holding with strict inequality – and is, therefore, an equilibrium. Assume, instead, that VC and SA intersect. Then, it is immediate to show that any intersection point identifies an equilibrium.

To prove uniqueness, we show that the two schedules can cross at most once, except for non-generic parameter configurations. Define:

$$\ell^p(\theta, \bar{x}) \equiv (1-\beta)(\eta(\bar{x}) - b) - \beta c \theta,$$

$$\ell^v(\theta, \bar{x}) \equiv -c\left(r + d + \beta 2\, \bar{x}\, \theta q(\theta)\right) + (1-\beta) 2\, \bar{x}\, q(\theta) \left(\bar{\eta}\,(\bar{x}) - b\right),$$

where $\ell^p(\theta, \bar{x}) = 0$ and $\ell^v(\theta, \bar{x}) = 0$ implicitly define, respectively, the SA and VC schedules. First, observe that $\ell_1^v(\theta, \bar{x}) < 0$. Then, standard differentiation shows that VC is positively (negatively) sloped if and only if $\ell_2^v(\theta, \bar{x}) > (<)0$. Next, observe that $\ell_2^v(\theta, \bar{x}) = (1-\beta)(\eta(\bar{x}) - b) - \beta c \theta$ (to obtain this result, we use the fact that from the definition of $\bar{\eta}\,(\bar{x})$ it follows that $\bar{\eta}'\,(\bar{x})\;\bar{x} = \eta(\bar{x}) - \bar{\eta}\,(\bar{x})$). Hence, $sign\left[\ell_2^v(\theta, \bar{x})\right] = sign\left[(1-\beta)(\eta(\bar{x}) - b) - \beta c \theta\right] = sign\left[\ell^p(\theta, \bar{x})\right]$. This implies that VC is positively sloped when it lies to the left of SA (since in this region $\ell^p(\theta, \bar{x}) > 0$), negatively sloped when it lies to the right of SA (since in this region $\ell^p(\theta, \bar{x}) < 0$) and vertical when the two schedules intersect (since $\ell^p(\theta, \bar{x}) = 0$ along SA). Since SA is everywhere non-positively sloped, the two schedules can cross at most once. Multiple intersections between the schedules SA and VC (hence, multiple equilibria) are only possible if $\theta^* = \theta^{**}$ (that is, in a case like that of Fig. 1, but such that the SA and VC

schedules coincide at $\bar{x} = \frac{1}{2}$). Clearly, this can only occur for non-generic parameter configurations. Ruling out this non-generic case, it is straightforward to check that when the two schedule cross in an interior point, no corner solution is an equilibrium. Viceversa, if the two schedules do not cross, there is a unique corner solution equilibrium. Hence, the equilibrium is, generically, unique.

Finally, the inspection of Figs. 1 and 2 immediately reveals that the equilibrium is interior if and only if $\theta^* < \theta^{**}$ and is a corner solution if and only if $\theta^* \geq \theta^{**}$. Hence, part b of the Proposition. QED.

Derivation of equations (10), (11) and (12).

All equations are derived by setting time derivatives in the Bellman equations equal to zero, since we are searching for a stationary solution. Also, we will use throughout the following facts:

a) $J(i,j) = J(\widehat{i,j}) = J(x)$; $W(i,j) = W(\widehat{i,j}) = W(x)$; $U(j) = U$; $w(i,j) = w(\widehat{i,j}) = w(x)$; $\eta(\widehat{i,j}) = \eta(x)$ (see condition (9) in the text).

b) $\int_i^{i+2\pi} Max\left[J(i,\tau), V(i)\right]\, d\tau = \int_0^1 Max\left[J(\tau), 0\right]\, d\tau = 2\int_0^{\bar{x}} J(\tau)\, d\tau$ and $\int_j^{j+2\pi} Max\left[W(\tau,j) - U(j), 0\right]\, d\tau = \int_0^1 Max\left[W(\tau) - U, 0\right]\, d\tau = 2\int_0^{\bar{x}} \left(W(\tau) - U\right)\, d\tau$

We first derive equation (10). The strategy is to search for $\bar{x}$ such that $W(\bar{x}) \geq U$ and $W(\bar{x}) > U$ if $\bar{x} < \frac{1}{2}$. Using equations (5), (6), (7), we obtain:

$$(r+d)\frac{\beta}{1-\beta}J(x) = w(x) - b - \frac{\beta}{1-\beta}2\theta q(\theta)\int_0^{\bar{x}} J(\tau)d\tau, \tag{22}$$

Next, we use (3) to obtain the following expression for the . This gives the following expression for the wage schedules:

$$w(x) = (1-\beta)b + \beta\eta(x) + 2\beta\theta q(\theta)\int_0^{\bar{x}} J(\tau)d\tau\,. \tag{23}$$

From replacing (23) into (22), and simplifying terms, we obtain:

$$(r+d)J(x) = (1-\beta)\left(\eta(x) - b\right) - \beta 2\theta q(\theta)\int_0^{\bar{x}} J(\tau)d\tau. \tag{24}$$

Integrating on both sides of (24) gives:

$$\int_0^{\bar{x}} J(\tau)d\tau = \left(r + d + \beta 2\bar{x}\theta q(\theta)\right)^{-1}(1-\beta)\left(\int_0^{\bar{x}}\eta(\tau)d\tau - b\bar{x}\right) \tag{25}$$

Finally, we substitute (25) into (24) and obtain:

$$(r+d)J(x) = (1-\beta)\left(\eta(x) - b\right) - \frac{(1-\beta)\beta 2\theta q(\theta)\bar{x}}{r+d+\beta 2\bar{x}\theta q(\theta)}\left(\bar{\eta}\left(\bar{x}\right) - b\right) \tag{26}$$

where $\bar{\eta}$ is defined in the text. Recall that Nash bargaining implies that, if $\bar{x} < \frac{1}{2}$, $W(\bar{x}) - U \Leftrightarrow J(\bar{x}) = 0$. If, instead, we have a corner solution, however, $J(x) > 0$ for all x (and $\bar{x} = \frac{1}{2}$). Thus, the general condition is:

$$\left(\eta(x) - b\right) - \frac{\beta 2\theta q(\theta)\bar{x}}{r+d+\beta 2\bar{x}\theta q(\theta)}\left(\bar{\eta}\left(\bar{x}\right) - b\right) \geq 0$$

which is the same as equation (10) in the text.

Next, we derive equation (11). Equations (3) and (8) imply (recalling that $\Phi(j) = c\theta$ for all j's) that $(r+d)J(\bar{x}) = (1-\beta)\eta(\bar{x}) - \beta c\theta \geq 0$, and this establishes the result. QED.

To obtain equation (12), finally, observe that equation (2) implies (given $\theta(i,\tau) = \theta$) that $c = 2\int_0^{\bar{x}} J(\tau)\ d\tau$. Substituting away $\int_0^{\bar{x}} J(\tau)\ d\tau$ using equation (25) yields equation (12). QED.

Proof of Lemma 3. Part 1. From (3) and (8) we have, for all $x \in [0, \bar{x}^e(b)]$, $J(x,b) - J(x,b_0) = w(x,b_0) - w(x,b) = (1-\beta)(b_0 - b) + \beta c(\theta(b_0) - \theta(b)) = (1-\beta)[\eta(\bar{x}$

$(b_0)) - \eta(\bar{x}\ (b))] < 0$. (Note that this expression is independent of x; this observation will be useful in the proof of part 3). This inequality holds true, *a fortiori*, for $x > \bar{x}^e\ (b)$. Also, from (2), (4), (6), (7) and (8) we have $U(b) - U(b_0) = (1-\beta)(b - b_0) - \frac{\beta}{1-\beta}\left[J(x,b) - J(x,b_0)\right] < 0$. Finally, from (5) we have that $W(x,b) - W(x,b_0) = w(x,b) - w(x,b_0) + d\left[U(b) - U(b_0)\right] > 0$.

Part 2. From (7), we have that, for all $x \in [0, \bar{x}^e\ (b)]$ $W(x,b) - W(x,b_0) = U(b) - U(b_0) + \frac{\beta}{1-\beta}\left[J(x,b) - J(x,b_0)\right]$. Since, from part 1, $J(x,b) - J(x,b_0) < 0$, then $W(x,b) - W(x,b_0) < U(b) - U(b_0)$. Next, consider the range $x \in \left[\bar{x}^e\ (b_0), \bar{x}^e\ (b)\right]$. In this range, (5) and (18), imply that $W(x,b) = U(b)$. But, since $W(x,b_0) > U(b_0)$, then $W(x,b) - W(x,b_0) < U(b) - U(b_0)$ also in this range of x's.

Part 3. The proof of part 1 shows that in the range $x \in [0, \bar{x}^e\ (b)]$, $J(x,b) - J(x,b_0)$ is independent of x. But, then, from (7), $W(x,b) - W(x,b_0)$ is also independent of x, and this proves part **(a)**. To prove part **(b)** we consider first the case in which $x' \in [0, \bar{x}^e\ (b)]$, and then the case in which $x' \in [\bar{x}^e\ (b), \bar{x}^e\ (b_0)]$. In the former case: $W(x,b) - W(x,b_0) = U(b) - W(x,b_0) > U(b) - U(b_0) + \frac{\beta}{1-\beta}\left[J(x,b) - J(x,b_0)\right] = U(b) - U(b_0) + \frac{\beta}{1-\beta}\left[J(x',b) - J(x',b_0)\right] = W(x',b) - W(x',b_0)$. In the latter case: $W(x,b) - W(x,b_0) = U(b) - W(x,b_0) > U(b) - W(x',b_0) = W(x',b) - W(x',b_0)$. **QED.**

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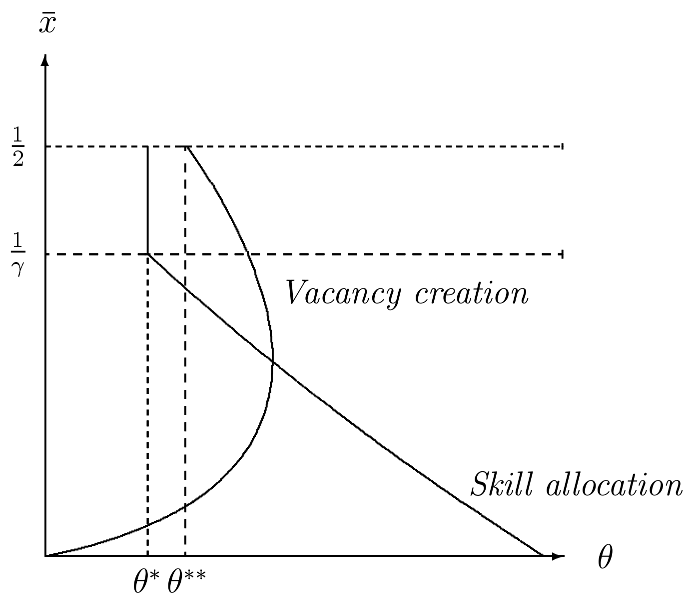

Fig. 1: Interior solution.

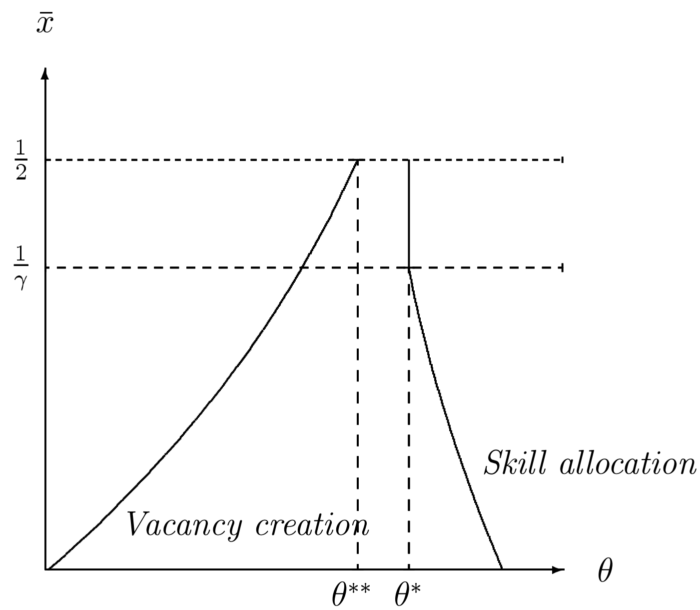

Fig. 2: Corner solution.

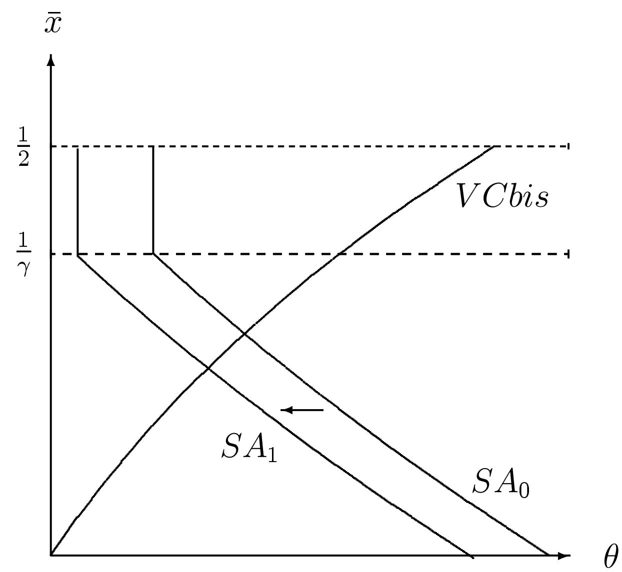

Fig. 3: Effect of an increase of b.

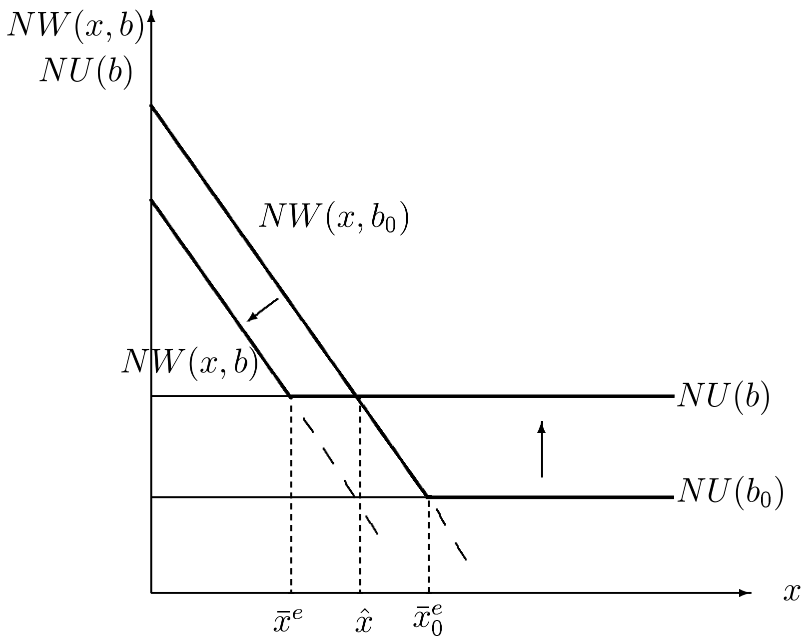

Fig. 4: Political Economy.