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SHOCKS AND INSTITUTIONS IN A JOB MATCHING MODEL

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ABSTRACT.   This paper explains the divergent behavior of European and US unemployment rates using a job market matching model of the labor market with an interaction between shocks and institutions. It shows that a reduction in TFP growth rates, an increase in real interest rates, and an increase in tax rates leads to a permanent increase in unemployment rates when the replacement rates or initial tax rates are high, while no increase in unemployment occurs when institutions are "employment friendly." The paper also shows that an increase in turbulence, modelled as an increased probability of skill loss, is not a robust explanation for the European unemployment puzzle in the context of a matching model with both endogenous job creation and job destruction.

Key Words: Job Matching Model, Unemployment, Unemployment Benefits, Turbulence, TFP Slowdown.

JEL Classification: E24, J64.

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1. INTRODUCTION

In the 1950's and 1960's, the unemployment rate in both Europe and the U.S. was below five percent. During the 1970's European and U.S. unemployment rates increased sharply in response to the steep increase in oil prices. In the last two decades, however, unemployment rates diverged sharply: average European rates have remained high while American rates have returned once again to prior levels. There are a variety of institutional factors distinguishing Europe from the U.S., including strong unions, minimum wages, generous unemployment benefits, and high employment protection, that might explain differences in levels of unemployment. These institutional distinctions have been present throughout the postwar era, however, and thus they cannot by themselves explain the differences in how unemployment rates have changed. This unexplained divergence between unemployment rates has been termed the "European unemployment puzzle."

Recent research has focussed on explaining the puzzle by considering the interaction between institutions and long-term changes in the economic environment, thought of as "shocks" to the environment. Ljungqvist and Sargent (1998), for example, have argued that a long-term rise in economic turbulence, manifested in greater skill loss for displaced workers, raises unemployment by a greater amount when unemployment benefits are higher. Increased turbulence could thus explain why Europe, with its more generous unemployment benefits, would experience greater increases in unemployment. Blanchard and Wolfers (2000) present empirical evidence relating the behavior of the unemployment rate in several European countries and the U.S. to the slowdown in TFP growth and higher interest rates. They show that these factors lead to larger increases in unemployment where institutions are less "employment-friendly," as they are in Europe relative to the U.S.. Blanchard and Wolfers find statistically significant influence of the following institutions: the level of the

replacement rate (the share of income replaced by unemployment benefits), the duration of unemployment benefits, the amount of employment protection, the tax wedge (the difference between the real labor cost of a worker to an employer and the real consumption wage of the worker), the percentage of workers who belong to a union, and the extent to which unions and employer organizations coordinate wage setting.

Doubt has been expressed in the literature about the importance of some of these institutions. Nickell and Layard (1999, p. 3030), for example, argue that *"time spent worrying about strict labor market regulations, employment protection, and minimum wages is probably time largely wasted"*. Similarly, Garibaldi (1998) shows that the level of firing restrictions leaves steady state unemployment rates unaffected even though it has important (offsetting) effects on job creation and job destruction. This paper starts, therefore, by considering the interaction between the slowdown in TFP growth and increase in real interest rates (the shocks) and the level of unemployment benefits. Furthermore, we analyze the interaction between changes in labor taxation (as a shock) and the initial tax rate (as an institution).[1]

In this paper we assess the interactions between shocks and institutions using a job matching model of equilibrium unemployment. Following Mortensen and Pissarides (1994), job creation and destruction are both determined endogenously, with wages set via bilateral bargaining within employment relationships.

Comparing steady state equilibria, unemployment is shown to increase when either the growth rate falls, the interest rate increases, or the tax rate on labor income increases. Moreover, each of these factors leads to a larger rise in unemployment when the replacement rate is greater or the initial tax rate is higher. Thus, the model exhibits the interaction

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[1]Daveri and Tabellini (2000) also consider the effect of tax rates on unemployment but, as discussed in section 4.5, the focus of their explanation is quite different from ours.

effect found by Blanchard and Wolfers. Slower growth and higher interest rates lead to *permanent* effects on unemployment, since steady state equilibria are affected: as long as growth remains slow or interest rates remain high, job creation and destruction decisions are impacted in a manner that raises the equilibrium unemployment rate. This is contrary to the view of Blanchard and Wolfers and several other economists that productivity growth and interest rates should have only a transitory impact on unemployment and should not affect the natural rate of unemployment.[2]

Whether the interactions between the institutions and the shocks to the growth, interest, and tax rates are sufficient to quantitatively explain both the European and American unemployment experiences depends crucially on the cross-sectional distribution of productivity levels. The key view expressed in this paper is that high replacement rates and high tax rates increase the mass of jobs that are vulnerable to the type of shocks considered here. Indeed, it is easy to construct numerical examples where this is the case. The numerical examples suggest that the variability of outcomes at the relationship level, which may be tied to factors such as government protection and geographic distance, may play a role in accounting for the European unemployment puzzle. More broadly, our model has the feature that small changes in the cross-sectional distribution can have important quantitative effects on equilibrium outcomes. This stands in stark contrast to the recent body of work (e.g., Krusell and Smith (1998)) that has argued against the quantitative relevance of details of cross sectional wealth and income distributions in stochastic growth models with partially uninsurable idiosyncratic risk.

In an extension of our model, we incorporate turbulence. Following Ljungqvist and

[2]Phelps (1968), Gordon (1997), and Blanchard (2000, p. 257) also claim that the natural rate is not affected by productivity growth.

Sargent (1998), turbulence is modelled as a positive probability that a high-skilled worker looses his skills when he is displaced. In our model, a rise in turbulence typically *reduces* the level of equilibrium unemployment, contrary to the result of Ljungqvist and Sargent. As in Ljungqvist and Sargent, turbulence reduces the value of employment relationships for displaced high-skilled workers, and thus lowers the rate at which new relationships are formed. The destruction rate is also affected in our model, however: greater turbulence makes high-skilled workers more reluctant to leave their jobs, and job destruction falls. On balance, the latter effect tends to dominate and unemployment declines. Although an increase in turbulence cannot explain the increase in European unemployment rates in the present setting, allowing for some degree of turbulence does serve to greatly improve the model's ability to match the unemployment evidence quantitatively.

Section 2 documents the European unemployment puzzle, Section 3 lays out the model and Section 4 reports results for parameterized versions of the model. Section 5 concludes.

2.   EUROPEAN UNEMPLOYMENT PUZZLE

In this section we document the time series behavior of variables related to the European unemployment puzzle for five European countries (France, Germany, Spain, Italy and the United Kingdom) and the United States. Standardized unemployment rates are plotted in Figure 1. As documented by the figure, the unemployment rates in Europe and the U.S. were low and fairly similar in the beginning of the postwar period. During the 1970's, unemployment rates rose both in Europe and the U.S.. After this, however, the unemployment rate in the U.S. declined, while European unemployment remained high. Accounting for this difference, and, in particular, for the persistently high unemployment rates in Europe, constitutes a puzzle.

One possible explanation is that European institutions may have been less favorable for employment. More generous European unemployment benefits, for example, might lead workers to be more selective in accepting new jobs, thus raising European unemployment relative to that of the U.S.. Figure 2 plots OECD standardized replacement rates, indicating that U.S. replacement rates are much lower on average than those in Europe. Note however that European replacement rates were already high relative to U.S. levels at the beginning of the postwar period, when unemployment rates were similar. Thus, the rise in European unemployment cannot be explained by changes in European replacement rates.

The numbers in the graph may seem low. The reason is that the OECD standardized unemployment rate gives equal weight to the replacement rate in year 1 of an unemployment spell, to the average replacement rate in years 2 and 3, and to the average replacement rate for years 4 and 5. Using unequal weighting is unfortunate since the replacement rate during the first year is clearly more important than that during years 4 and 5. We, therefore, also report in Table 1 the benefit replacement rate and the corresponding benefit duration measure from Nickell and Layard (1999).

Figure 3 plots the effective tax rate on labor income from Daveri and Tabellini (2000). Just like replacement rates, labor tax rates cannot by themselves account for the dynamic differences between European and U.S. unemployment because tax rates were already substantially higher in Europe in the 1960's.[3]

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[3] Nickell and Layard (1999) point out that the labor market consequences of taxation depend on the sum of payroll taxes, income taxes, and consumption taxes. In this paper, differences in the taxation of labor income and unemployment benefits play a crucial role. This means that differences in payroll taxes and differences in the progressivity of income taxes across countries are important. Nickell and Layard (1999) show that average payroll taxes for the period from 1989 to 1994 were lower in the US than in all European

As Ljungqvist and Sargent (1998) and Blanchard and Wolfers (2000) have stressed, the differences between European and U.S. unemployment experiences might best be explained by the interaction between institutions and shocks to the economies. Consider, for example, the behavior of TFP growth and interest rates over the postwar period. Figure 4 documents a pronounced decline in TFP growth for all of the countries considered, coinciding roughly with the increase in unemployment. Real interest rates are considered in Figure 5, where increases over the postwar period may be observed for every country except Germany. Unemployment responses to the growth slowdown and rise in interest rates appear to vary based on institutional differences between countries. Blanchard and Wolfers, in particular, provide evidence that where institutions are less employment-friendly, e.g., where replacement rates are higher, unemployment rises by a greater amount in the face of slower growth and higher real interest rates. In the remainder of this paper we assess the extent to which an equilibrium job market matching model can rationalize these observed interactions between institutions and unemployment responses.

3. MODEL

In this section we present the model. Sections 3.1 through 3.4 describe the version of the model in which there is no growth and no turbulence. In Section 3.5 we show that adding disembodied growth is equivalent to an adjustment of the discount factor in the model with no growth. In Sections 3.6 we introduce turbulence.

3.1. Employment Relationships. Production takes place within employment relationships consisting of one worker and one firm, who interact through discrete time until the relationship is severed or the worker retires. A relationship produces output z per period.

countries considered in this paper except the UK.

When a relationship is first formed, the initial value of z is drawn from the distribution $\nu(z)$. For a continuing relationship, the value of z may vary as a consequence of relationship-specific productivity shocks that occur at the start of a period. We consider two kinds of productivity shocks.

(1) With probability γ^S there is a *switch* of the productivity level z. In this case, z is drawn again from the distribution $\nu(z)$. If no switch occurs, then the relationship maintains the previous period value of z.

(2) With probability ρ^x the relationship experiences an *exogenous breakup*, where severance occurs automatically. Exogenous breakups reflect events that permanently destroy the productivity of the relationship; e.g., market conditions may shift adversely. Alternatively, exogenous breakups can capture changes in workers' personal circumstances that lead them to change jobs. Assume that exogenous separations cannot occur in the period that a relationship is newly formed.

After the current-period productivity parameter is determined, the worker and firm decide whether to continue or sever their relationship, and, if the relationship is continued, they determine the worker's wage payment. Wages are set according to Nash bargaining, where π gives the worker's bargaining weight, and the disagreement point is severance of the relationship. In addition, workers are subject to shocks that induce retirement, occurring at the end of a period. Let ρ^r denote the probability of retirement. If the worker and firm agree to sever their relationship following a switch, or if exogenous separation occurs, then they each enter a matching market in which new employment relationships are formed. A retiring worker, in contrast, leaves the labor market and obtains a future value of zero.

3.2. Matching Market. New employment relationships are formed on a matching market. Each period, the number of newly formed relationships is $m(u, v)$, where u and v give the masses of unemployed workers and firms posting vacancies, respectively. We assume that $m(u, v)$ is a homogeneous function of degree 1 and that the total masses of workers and firms are fixed at unity. Because the mass of workers is equal to the mass of firms, the ratio of the mass of unemployed to the mass of vacancies and, thus, the matching probability are fixed. Each period, a proportion ρ^r of the workers leaves the market through retirement, replaced by an identical number of new entrant workers that flow into the unemployment pool. Further, established workers enter the unemployment pool when their employment relationships are severed.

While they are unemployed, workers receive unemployment benefits equal to b. To simplify the analysis, we assume that benefits are linked to average wages of all workers. Unemployed workers thus obtain a per period benefit of $b = \phi \overline{p}$ while unemployed, where $\overline{p}$ denotes the mean wage payment of all workers. New entrant workers do not receive unemployment benefits.

3.3. Zero Surplus Level. Newly-matched workers and firms choose to accept their match and begin an employment relationship if their initial productivity draw z is sufficiently high. Correspondingly, a worker and firm in an ongoing relationship choose to continue their relationship following a switch if the new draw of z is sufficiently high. We assume that the worker and firm bargain efficiently over the terms of their relationship, and thus they make acceptance and continuation decisions that maximize their *joint surplus.* Joint surplus is defined as follows. Let z denote the current value productivity parameter following any productivity draw, and suppose the worker obtains unemployment benefit b each period he

is in the worker matching pool. Then joint surplus is given by

$$s(z, b) = (1 - \tau_e(z)) z + g(z) - (1 - \tau_u(b)) b - w^w(b) - w^f, \tag{1}$$

where $g(z)$ denotes the future joint value from continuing the relationship, $w^w(b)$ denotes the worker's future value from entering the unemployment pool in the current period when he receives an unemployment benefit of b, w^f indicates the firm's future value from entering the vacancy pool in the current period, $\tau_e(x)$ is the tax rate on income earned in the relationship when income is equal to x and $\tau_u(x)$ is the tax rate on unemployment benefits equal to x.

In equilibrium, $s(z, b)$ is an increasing function of z (as long as $\tau_e(x)$ does not increase too sharply with x), and there exists a *zero surplus level* $\underline{z}(b)$ indicating the smallest value of z at which accepting or continuing the relationship yields nonzero surplus to the worker and firm. For values of z below $\underline{z}(b)$, the worker and firm will either reject a new match, or they will destroy an existing match. The zero surplus level is defined by the following condition:

$$s(\underline{z}(b), b) = 0. \tag{2}$$

3.4. Equilibrium. The equilibrium conditions, involving equilibrium values of $g(z)$ and $w(b)$, equilibrium wage payments, and steady state conditions for the matching market, are given as follows. The future joint value from continuing a relationship is equal to [4]

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[4]This formula holds for values of $z \geq \underline{z}(\phi\overline{p})$. A match with a worker that is not entitled to unemployment benefits would be willing to produce for values of z lower than $\underline{z}(\phi\overline{p})$ but higher than $\underline{z}(0)$ to become entitled to unemployment benefits. For the values of z for which such an "entitlement effect" occurs, the relationship exists for only one period and $g(z)$ is equal to $(1 - \tau_u(b)) b + w^w(b) + w^f)$.

$$g(z) = \beta \left[(1 - \rho^x)\{(1 - \gamma^S)s(z,b) + \gamma^S \int_{\underline{z}(b)}^{\infty} s(y,b)d\nu(y)\} + (1 - \tau_u(b))b + w^w(b) + w^f \right].$$

(3)

The Nash bargaining solution implies that the wage payment to a worker having current unemployment benefit b, written $p(z,b)$, satisfies the following condition:

$$p(z,b) + g^w(z) = \pi s(z,b) + (1 - \tau_u(b))b + w^w(b),$$

(4)

where $g^w(z)$ indicates the worker's future value from continuing the relationship:

$$g^w(z) = \beta \left[(1 - \rho^x)\{(1 - \gamma^S)\pi s(z,b) + \gamma^S \int_{\underline{z}(b)}^{\infty} \pi s(y,b)d\nu(y)\} + (1 - \tau_u(b))b + w^w(b) \right].$$

(5)

For a worker having unemployment benefit b, the future value from entering the unemployment pool satisfies

$$w^w(b) = \beta \left[\lambda^w \int_{\underline{z}(b)}^{\infty} \pi s(y,b)d\nu(y) + (1 - \tau_u(b))b + w^w(b) \right],$$

(6)

where $\lambda^w = m(u,v)/u$ denotes the worker matching probability.

Let $u(b)$ denote the mass of workers in the unemployment pool at the end of a period, having unemployment benefit b. The probability that a firm in the vacancy pool matches with such a worker is given by

$$\lambda^f(b) = \frac{m(u,v)}{v}\frac{u(b)}{u}.$$

It follows that the future value obtained by a firm in the vacancy pool is

$$w^f = \sum_b \lambda^f(b)\beta \int_{\underline{z}(b)}^{\infty} (1 - \pi)s(y,b)d\nu(y) + \beta w^f.$$

(7)

Let e denote the total mass of employed workers in continuing employment relationships at the start of a period prior to realization of productivity shocks. Steady state conditions

for worker stocks and flows are given as follows. The stocks $u(0)$ and $u(\phi\overline{p})$ of new entrants and workers previously employed, respectively, must satisfy

$$\rho^r = \rho^r u(0) + (1 - \rho^r)\lambda^w(1 - \nu(\underline{z}(0)))u(0), \tag{8}$$

$$(1 - \rho^r)\left[\rho^x + (1 - \rho^x)\gamma^S \nu(\underline{z}(\phi\overline{p}))\right]e$$

$$= \rho^r u(\phi\overline{p}) + (1 - \rho^r)\lambda^w(1 - \nu(\underline{z}(\phi\overline{p})))u(\phi\overline{p}), \tag{9}$$

where gross inflows are given on the left-hand sides of the equations, and gross outflows on the right-hand sides. Observe in (9) that workers never flow directly from the $u(0)$ pool to the $u(\phi\overline{p})$ pool, since they must spend at least one period in the e pool to quality for benefits $\phi\overline{p}$. The stock e is determined by

$$(1 - \rho^r)\lambda^w\left[(1 - \nu(\underline{z}(0)))u(0) + (1 - \nu(\underline{z}(\phi\overline{p})))u(\phi\overline{p})\right]$$

$$= \rho^r e + (1 - \rho^r)\left[\rho^x + (1 - \rho^x)\gamma^S \nu(\underline{z}(\phi\overline{p}))\right]e. \tag{10}$$

We assume that the government uses tax revenues to finance unemployment benefits and the purchases of commodities. Below we let ζ denote the per capita value of these government purchases. We introduce this term to study tax rates that are not related to financing requirements of unemployment benefits. Let $e(b)$ denote the mass of employed workers that would be entitled to unemployment benefits b after displacement. The budget constraint for the government is equal to

$$e(0)\int_{\underline{z}(0)}^{\infty}\tau_e(y)yd\nu(y) + e(\phi\overline{p})\int_{\underline{z}(\phi\overline{p})}^{\infty}\tau_e(y)yd\nu(y) =$$

$$u(\phi\overline{p})(1 - \tau_u(\phi\overline{p}))\phi\overline{p} + \zeta. \tag{11}$$

3.5. Growth and Interest Rates. We assume that output within a relationship is equal to $(1 + \xi)^t z$ per period, where ξ is the growth rate. Output, thus, displays disembodied deterministic technological growth. We also assume that households are risk neutral and discount future earnings using the interest rate r. The model outlined above is consistent with the presence of growth, since the parameter β can be reinterpreted to capture the growth effect when $\xi \neq 0$. In particular, $\beta = (1 + \xi)/(1 + r)$.

This discount factor would also be appropriate under more general assumptions about preferences. Suppose that households pool their labor and profit incomes at the end of each period and choose aggregate consumption to maximize the discounted utility of a representative household using the composite discount factor $\delta = (1 - \rho^r)/(1 + \rho)$, which combines the retirement parameter, ρ^r, with the conventional discount factor, $1/(1 + \rho)$. Interest rates are determined by the following equation:

$$(1 + r)\delta M_{t+1} = 1, \tag{12}$$

where M_{t+1} is the marginal rate of substitution between consumption this period and next period.

For example, when the utility function of the agent is given by

$$\sum_{s=t}^{\infty} \delta^{s-t} \frac{C_s^{1-\gamma} - 1}{1 - \gamma},$$

where C_s is consumption in period s, then we have

$$M_{t+1} = \left(\frac{C_{s+1}}{C_s} \right)^{-\gamma}$$

and

$$(1 + r)\delta \left(\frac{C_{s+1}}{C_s} \right)^{-\gamma} = 1. \tag{13}$$

Note that using δM_{t+1} to discount $(1+\xi)z$ is equivalent to using $(1+\xi)\delta M_{t+1}$ to discount z. The relationship between ξ and M_{t+1} depends crucially on assumptions about the utility function. The asset-pricing literature has shown that standard assumptions about preferences cannot explain average real interest rates.[5] A related problem of standard preferences is that the predicted effect of ξ on r is inconsistent with the data.[6] Note, however, that irrespective of the particular specification for preferences, optimizing behavior pins down the "growth-adjusted" discount factor at

$$(1+\xi)\delta M_{t+1} = \frac{1+\xi}{1+r}. \tag{14}$$

Instead of trying to solve the difficult question of how ξ affects M_{t+1}, this equation suggest that one may simply use observed growth and interest rates to infer the appropriate effective discount factor. This is the approach followed in this paper.[7]

3.6. Turbulence. In this subsection we distinguish between low-skilled and high-skilled workers. This allows us to analyze the turbulence effect of Ljungqvist and Sargent (1998). They argue that the European unemployment puzzle can be explained by the interaction between high replacement rates, on one hand, and an increase in the probability that an

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[5]See, for example, Weil (1992).

[6]For example, the CRRA preferences used above imply that a decrease in the growth rate should lower real interest rates, while in Section 2 we documented that the observed decrease in TFP growth rates coincided with an increase in real interest rates.

[7]Taking the interest rate would be appropriate if one thinks of the matching model as a partial equilibrium model. For example, the model can be viewed as being relevant for those sectors for which growth can be characterized as disembodied. We are sympathetic to this view, since one could very well argue that growth in some sectors is better described as embodied growth. We discuss embodied growth in more detail in Section 4.5.

unemployed skilled worker cannot find a job in which he can use his acquired skills, on the other. Unemployed workers who had previously earned high wages, and are thus entitled to high unemployment benefits, thus, become more likely to receive low wage offers. The corresponding increase in the rejection rate of job offers would then lead to an increase in the unemployment rate. As in Ljungqvist and Sargent (1998) we capture an increase in turbulence by an increased probability that a high-skilled worker becomes a low-skilled worker.

It is interesting to analyze an increase in turbulence in our framework because it differs in two important aspects from the framework of Ljungqvist and Sargent (1998). First, we allow for endogenous wage setting between the worker and the employer, meaning that the worker can bargain for a higher wage instead of simply having a choice between rejecting or accepting the employer's wage offer. Second, in contrast to Ljungqvist and Sargent (1998), the breakup decision in our model is not exogenous, but is allowed to vary in response to changes in the economic environment. The view that employees are likely to change their behavior is clearly formulated by Alan Greenspan in the following quote: *"But the sense of increasing skill obsolescence has also led to an apparent willingness on the part of employees to forgo wage and benefit increases for increased job security. Thus, despite the incredible tightness of labor markets, increases in compensation per hour have continued to be relatively modest."* [8]

The current-period skill level of a particular worker is denoted by k, and the high and low skill levels are given by h and l, respectively. Unemployed workers obtain a per period benefit of $b_k = \phi \overline{p}_k$ where $\overline{p}_k$ denotes the mean wage payment of all skill k workers. When a

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[8] Alan Greenspan in "Is there a new economy?: The effect of human psychology on the market." Vital Speeches of the Day, Oct 1, 1998, 64(24): 741-745.

relationship is first formed with a worker having skill level k, the initial value of z is drawn from the distribution $\nu_k(z)$. Assume $\nu_h(z) > \nu_l(z)$; i.e., the high-skill distribution first-order stochastically dominates the low-skill distribution. In addition to the probability of a *switch* and an *exogenous breakup*, the relationship with a low-skilled worker can now also receive an *upgrade* at the beginning of the period, wherein he receives a draw from $\nu_h(z)$.[9]

High-skilled workers who become unemployed will become low skilled with probability γ^D. The key feature of the model with turbulence is, thus, that there are low-skilled unemployed workers with a high level of unemployment benefits b_h.

Adjusting the equations is reasonably straightforward. The surplus equation for a high-skilled worker is now given by:

$$s_h(z, b_h) = (1 - \tau_e(z))z + g_h(z) - (1 - \tau_u(b_h))b_h - (\gamma^D w_l(b_h) + (1 - \gamma^D)w_h(b_h) + w^f), \quad (15)$$

where the subscripts h and l denote the skill level of the worker. The zero surplus level is defined by the following condition:

$$s_k(\underline{z_k}(b), b) = 0. \quad (16)$$

In the model without turbulence ($\gamma^D = 0$) the value of $\underline{z_l}$ is the same for those workers who receive a switch and for the unemployed who enter a new relationship, because both are entitled to b_l.[10] In the model with turbulence, however, the zero surplus level for the

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[9] We assume that workers experiencing an upgrade must work for at least one period at the high skill level in order to qualify for the benefit b_h. To reduce the number of different worker classifications we assume that in case of an upgrade a worker receives a draw of z in the range of values where an existing relationship with a high-skilled worker who is entitled to b_h would not break up.

[10] Note that this is not true for the (small number of) new labor market entrants who are not yet entitled to unemployment benefits.

unemployed with high unemployment benefits, $\underline{z}_l(b_h)$ will be higher than the zero surplus level for the unemployed with low unemployment benefits, $\underline{z}_l(b_l)$. Note that the latter zero surplus level still equals that of the low-skilled workers who receive a switch.

The equilibrium conditions are modified as follows. The continuation values for the relationship with a low-skilled worker and a high-skilled worker are given by

$$
g_l(z) = (1 - \rho^x)\beta(1 - \gamma^U) \left[(1 - \gamma^S)s(z, b_l) + \gamma^S \int\limits_{\underline{z}_l(b_l)}^{\infty} s(z, b_l)d\nu_l(y) \right]
$$

$$
(1 - \rho^x)\beta\gamma^U \frac{\int\limits_{\underline{z}_h(b_h)}^{\infty} s_h(z, b_l)d\nu_h(y)}{1 - \int\limits_{\underline{z}_h(b_h)}^{\infty} d\nu_h(y)} + (b_l + w_l(b_l) + w^f), \tag{17}
$$

and

$$
g_h(z) = (1 - \rho^x)\beta \left[(1 - \gamma^S)s_h(z, b_h) + \gamma^S \int\limits_{\underline{z}_h(b_h)}^{\infty} s_h(y, b_h)d\nu_h(y) \right]
$$

$$
+ \beta(b_h + \gamma^D w_l(b_h) + (1 - \gamma^D)w_h(b_h) + w^f). \tag{18}
$$

Equations (4), (5) and (6) are changed in a similar way. For $\gamma^D > 0$, there is a nonnegligible stock $u_l(b_h)$ of workers who have low skills but obtain the high unemployment benefit on the basis of their previous job. To calculate average wages (and, thus, unemployment benefits) and taxes one needs a precise differentiation of the different groups, since not all workers with the same skill level earn the same wage and operate at the same range of values for z. In particular, in the model with turbulence there are four different types of unemployed and six different types of employed workers (see the appendix for details).[11]

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[11] This makes the complete set of transition equations somewhat tedious. Details of the transition equations are available on request.

4. SHOCKS AND UNEMPLOYMENT RATES

The goal of this section is to document that the model outlined in Section 3 can explain the divergent behavior of European and U.S. unemployment rates when key aspects of the economic environment deteriorate. To accomplish this, we will show that a decrease in the growth rate, an increase in the interest rate, as well as an increase in the tax rate (the shocks considered) lead to a higher steady state unemployment rate. Further, the magnitude of the effect can be small at low initial tax rates and replacement rates (the institutions), but substantial at high initial tax rates and replacement rates. The idea is that the steady state values corresponding with the favorable economic environment capture the average values of the unemployment rate during the 1950's and 1960's, and the steady state values corresponding to the unfavorable economic environment reflect the average values of the unemployment rate during the 1980's and 1990's. The 1970's represent a transition period that we will not try to model.

In Section 4.1, we give the basic intuition behind our story and illustrate it using several numerical examples that document the interaction between the reduction in the discount factor and the level of unemployment benefits. In Section 4.2, we show that the same idea applies to changes in tax rates on labor income. In Section 4.3, we demonstrate that an increase in turbulence is not a good candidate to explain the European unemployment puzzle in this framework, when an increase in turbulence is modelled as an increased probability of skill loss after job separation. In Section 4.4, we emphasize the importance of the cross-sectional distribution of productivity shocks and in Section 4.5 we discuss related literature.

4.1. Implications of Shocks in the Benchmark Model. In this section we study the effect of changes in the growth rate and the interest rate on steady state unemployment

rates.

Intuition. In Section 3.5, it was established that the appropriate discount factor in a model with disembodied growth is equal to $(1 + \xi)/(1 + r)$. Figure 6 plots the scaled values of $(1 + \xi)/(1 + r)$ for five-year intervals. The graph clearly shows that combining the growth effect and the real interest rate effect, one observes for each country a decrease in the transformed discount factor. We will start by investigating the effect of changes in this discount factor on the steady state unemployment rate and the interaction with the level of the replacement rate.

Consider again the equation that determines the zero surplus level.

$$\underline{z} + g(\underline{z}) - b - w(b) = 0. \tag{19}$$

To simplify the notation we have set tax rates to zero. A decrease in the discount factor will decrease both $g(\underline{z})$ and $w(b)$. The question is which one will decrease more. If $g(\underline{z})$ is equal to $w(b)$, then it is not hard to show that there will be no effect on $\underline{z}$. If $g(\underline{z})$ is bigger than $w(b)$, then a decrease in the discount factor, not surprisingly, will have a bigger impact on $g(\underline{z})$ than on $w(b)$, thus increasing $\underline{z}$. The value of $g(\underline{z})$ will be bigger than $w(b)$, and $\underline{z}$ will be smaller than b, when the probability of receiving a switch, γ^S, is higher than the matching probability for an unemployed worker, λ. The intuition for this last result is relatively simple. The idea is that when $\gamma^S > \lambda$ relationships stay together at values of z that are somewhat less than b because by staying together they have a better chance of quickly increasing their earnings. We find it implausible that the best way to increase productivity is to end the relationship, and therefore, the natural case to consider is the one where $\gamma^S > \lambda$ and $g(\underline{z})$ is bigger than $w(b)$. Thus, a decrease in the discount factor increases $\underline{z}$ and, correspondingly, increases the rejection rate of unemployed workers along with the

breakup probability of workers within a relationship.

Graphically, this idea is captured in Figure 7, which show how the surplus changes in response to a decrease in the discount factor. A shift to a low growth (or high interest rate) economy lowers the joint surplus, raising both the rejection probability for new matches and the destruction probability for ongoing ones. Thus, the flow out of the unemployment pool is reduced, while the flow into the pool is increased, leading to the robust prediction of a higher steady-state unemployment rate. Further, an increase in the replacement rate, ϕ, also shifts joint surplus downward, raising the rejection and destruction probabilities. We will show below that the effects of lower β and higher ϕ are complementary, causing a decline in β to have a bigger effect when ϕ is large. It should be stressed that slower growth and higher interest rates lead to permanent changes in unemployment, based on the fact that unemployment is determined in steady state equilibrium. This contrasts with the conjecture of Blanchard and Wolfers (2000), who argue that the shocks affect unemployment in a transitory way. As long as β remains low, however, the zero surplus level continues to be high, and high levels of unemployment are maintained.

Benchmark Parameterization. This effect may be illustrated using some numerical examples. The distribution $\nu(z)$ is taken to be uniform with support $[\underline{\nu}, \overline{\nu}]$, while the matching probability is fixed. Periods are taken to be quarters. Table 2 reports numerical values of the parameters for our benchmark specification.

Results for the benchmark parameterization are given in part A of Table 3, which reports for a low- and a high-replacement-rate economy the equilibrium unemployment rates for various values of the discount factor β. Note that the low- and the high-replacement-rate economy are identical in everything except the replacement rate. As documented by the

table, a decline in growth or a rise in the interest rate, both reflected by a fall in the discount factor β, lead to higher unemployment rates for high levels of the replacement rate ϕ. At low values of ϕ, however, there is no rise in unemployment associated with a fall in β. The model, therefore, exhibits an interaction between shocks and institutions, whereby higher replacement rates exacerbate the unemployment effects of either a growth slowdown or a rise in interest rates. The key aspect of this parameterization is displayed in Figure 8, which plots the cross-sectional distribution of productivity values z, along with the zero surplus levels. The figure captures our basic believe that at high replacement rates, the mass of jobs sensitive to deteriorations in the economic environment is bigger.

Note that in the high-replacement-rate economy, only the lowest productivity jobs are destroyed. The average productivity of ongoing relationships will, therefore, increase in the high-replacement-rate economy relative to the low-replacement-rate economy.[12] This is consistent with Nickell and Layard (1999), who document that labor productivity has increased in Europe relative to the U.S..

Duration and Flows Into and Out of Unemployment. In several European countries, the fraction of long-term unemployed has increased in the last few decades.[13] Moreover, Machin and Manning (1999) argue that the rise in the incidence of long-term unemployment is mainly due to a decrease in the flows out of unemployment. To understand the relevance of these observations for our model, consider the following steady state expression for the

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[12] The increase in average productivity leads to an increase in average wages and, thus, an increase in unemployment benefits. This increase in unemployment benefits leads to a further increase in the unemployment rate. The effect is quantitatively, however, very small and the overall increase in the unemployment rate would be similar if the value of b is kept constant.

[13] See, for example, Ljungqvist and Sargent (1998).

unemployment rate:

$$\lambda^w(1 - \rho^R)u = \rho^D(1 - u), \tag{20}$$

where ρ^R is the rejection rate and ρ^D is the destruction rate (here we have abstracted from retirement and new entrants, which do not play an important role in the numerical exercises). In our model, ρ^R is equal to ρ^D (except for new entrants), so it may seem that our framework is not consistent with the observation made by Machin and Manning (1999). Moreover, it might seem difficult to generate realistic increases in the outflow rate $\lambda^w(1 - \rho^R)$ with a constant matching probability.

Because of composition effects, however, our mechanism is consistent with a substantial increase in the *average* duration of unemployment, a substantial decrease in the *average* outflow rate of unemployment, and a modest increase in the *average* outflow rate of employment. To clarify this statement, consider the following example of an economy with two types of workers: type A and type B. For simplicity we assume that workers never switch type;[14] this means that both types operate with complete independence. Suppose that jobs of type A workers are destroyed with probability equal to 0.1 and that jobs of type B workers are destroyed with probability equal to 0.02. According to our model, these are also the rejection rates of new job offers. Furthermore, assume that the mass of type A workers is equal to 0.1, the mass of type B workers is equal to 0.9, the matching probability for a type A worker is equal to 0.3 and the matching probability for a type B worker is equal to 0.8. Then it is straightforward to calculate that the steady state unemployment rate is equal to 4.94%, that the outflow rate of unemployment is equal to 50.3% and that the outflow rate

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[14]Recall that in the turbulence version of the model we allow workers to switch types, and in Section 4.3 we consider the importance of composition effects in the model with turbulence.

of employment is equal to 2.61%. Now suppose that in response to a deterioration of the economic environment the destruction rate of type A workers increases from 0.1 to 0.4, while the destruction rate of type B workers remains unchanged. This increases the unemployment rate from 4.94% to 9.14%. Note that for type A workers there is a substantial increase in the outflow rate of employment. The *average* outflow rate of employment, however, increases only from 2.61% to 3.3% because the number of employed type A workers decreases relative to the number of employed type B workers. In the unemployment pool, the fraction of type A workers, i.e. the workers with high unemployment duration, increases. This results in a substantial decrease in the outflow rate of unemployment and a substantial increase in the average unemployment duration. Specifically, the average unemployment duration increases from 2.6 to 4.5 periods.

Alternative Parameterizations. An important feature of the benchmark parameterization is that the value of $\underline{z}$ is not in the support of the distribution $\nu(z)$ for the high discount factor case for both the low- and the high-replacement-rate economy. Suppose instead that we increase the support of z such that there are endogenous breakups during the favorable, i.e. high β, period. If we keep the rate of exogenous breakups, ρ^x, the same then unemployment rates across the high-replacement-rate and the low-replacement-rate economy would not be equal during the favorable times. We consider two alternatives to deal with this. In the first, the rate of exogenous breakups, ρ^x, is higher in the low-replacement-rate economy, and in the second, the standard deviation of z is higher in the low-replacement-rate economy.

When one thinks of the low-replacement-rate economy as the U.S., then these specifications do not seem especially implausible. Since distances are bigger in the U.S., relocations

for personal reasons are more likely to lead to job termination in the U.S. than in Europe. The presence of government subsidies could also trim the low side of the distribution in Europe. There are some empirical observations consistent with these conjectures. Nickell and Layard (1999), for example, document that regional mobility has been substantially higher in the U.S. than in most European countries. For the period from 1980 to 1987, for example, an average of 2.9% of all workers changed region each year in the U.S., while for the five European countries considered in this paper the highest percentage was observed for France, at only 1.3%.[15] Also important in this respect are the observations from Nickell and Layard (1999) about minimum wages. They report that the minimum wage relative to the country's average wage over the period from 1991 to 1994 was substantially higher in Sweden than in the U.S., but in Sweden no workers were at or near the minimum wage while in the U.S. four percent of the workers were at or near the minimum wage. In Spain, however, more workers were at the minimum wage even though the minimum wage in Spain was lower.

Results for Alternative Parameterizations. In the first alternative considered, we set the rate of exogenous breakups, ρ^x, in the high-replacement-rate economy equal to zero and choose the support of the distribution such that the unemployment rate in the high-replacement-rate economy is again equal to (approximately) 5% when $\beta = 0.99$, i.e., the value corresponding to the favorable growth and interest rate regime. The results for this case are reported in the first two columns of part B of Table 3 for the high- and the low-replacement-rate economy, respectively. For the low-replacement-rate economy the zero surplus level is still outside the support of the distribution, and changes in the discount factor have no effect on the breakup and rejection margin. The key idea of this parameterization is graphically

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[15]Regions are of comparable geographical size.

presented in Figure 9.

In the second alternative, the support of z in the economy with a low replacement rate is set such that the unemployment rate is equal to 5% when $\beta = 0.99$ and the rate of exogenous destruction equal zero. Obviously the support for z will then be wider in the economy with a low replacement rate. The results for the low-replacement-rate economy are reported in the third column of part B of Table 3. When we compare the third column with the first column, then we see that unemployment rates actually increase more in the low-replacement-rate economy. This despite the fact that the mass of jobs just to the right of $\underline{z}$ is larger in the high-replacement-rate economy. There is a stronger response to the level of $\underline{z}$ in the high-replacement-rate economy, however, because $\underline{z} - b$ is lower in the low-replacement-rate economy, leading to a higher level of $g(\underline{z}) - w$. As pointed out before, the higher $g(\underline{z}) - w$, the higher the effect of changes in β on $\underline{z}$.

Note that the matching probabilities are assumed to be equal across economies. But duration of unemployment has been much lower in the U.S. then in Europe,[16] so it makes sense to use a higher matching probability in the low-replacement-rate economy. In particular, we increase the matching probability in the low-replacement-rate economy from 0.3 to 0.5 and repeat the last experiment. The results in the fourth column of part B of Table 3 show that the increase in the matching probability reduces the sensitivity of the unemployment rate to a change in the discount factor, by decreasing the value of $g(\underline{z}) - w$. In fact, when we compare the first and the fourth column we see that the unemployment rate is again more sensitive to changes in the discount factor in the high-replacement rate economy.

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[16]See Table 1 in Machin and Manning (1999).

4.2. Shocks to Tax Rates in the Benchmark Model. In this section we discuss the effects of differential tax rates for labor income and unemployment benefits on the unemployment rate. It is easy to show that when tax rates are proportional and equal for both forms of income, tax rates have no effect on unemployment in our framework. Because of the presence of payroll taxes and progressive income taxes, however, this is not an empirically relevant case. In general the tax rate on labor income will be higher than the tax rate on unemployment benefits. The effects of tax rates on unemployment are similar to the effects of the discount rate on unemployment. Just like a reduction in the discount factor, an increase in the tax rate differential increases the zero surplus level. This has important consequences for the unemployment rate only if many jobs are affected by the increase. When most jobs have surplus values that are considerably above zero the increase in $\underline{z}$ will be unimportant. A low initial tax level, just like a low replacement rate, can ensure that most jobs have surplus levels that are high enough to be safe from increases in tax rates.

Since only differences between the tax rate on labor income and the tax rate on unemployment benefits matter in our model, we will normalize tax rates by setting the tax rate on unemployment benefits, $\tau_u(b)$, equal to zero. Moreover, we assume that positive profits are taxed at a constant rate and no tax credits are given for negative profits, that is, $\tau_z(z) = \tau_z > 0$ for z > 0 and $\tau_z(z) = 0$ for z < 0.

Part A of Table 4 shows the steady state unemployment rates for different values of the discount factor and different values of ζ, the level of per capita government purchases relative to the mean value of z. We consider values of ζ equal to 0, 0.25, and 0.5. The empirical literature has mainly focused on tax rates. In our framework, the tax rate is an endogenous variable influenced by the level of unemployment benefits, the number of unemployed workers and the level of government expenditures. Since changes in ζ affects the economy in our

model only through changes in tax rates, changes in ζ are the cleanest way to evaluate the effect of changes in tax rates. Note that it makes no sense to consider larger values of government expenditures since we have used the normalization that $\tau_u = 0$. We set the value of ϕ equal to 0.5. The first column in part A of Table 4, corresponding to the case where per capita government expenditures are equal to zero, is identical to the second column in part A of Table 3. In this case taxes are only used to finance unemployment benefits. We see that an increase in tax rates (caused by an increase in government expenditures) increases the steady state unemployment rate. The results in Part B correspond to the same exercise when the initial level of government expenditures is higher. In particular, while for part A the support of the distribution was chosen in such a way that the unemployment rate equals 5% when $\beta = 0.99$ and $\zeta = 0$, for part B the support of the distribution was calibrated such that the unemployment rate equals 5% when $\beta = 0.99$ and $\zeta = 0.10$. We clearly see that an increase in the tax rate has a bigger impact when the initial tax rate is higher.[17] In particular, starting at $\zeta = 0$ a five percentage point increase in per capita expenditures increases the unemployment rate from 5% to 6.24%, while the same percentage point change starting at $\zeta = 0.10$ increases the unemployment rate from 5% to 7.32%. Also note that the combined change in the discount factor and the tax rate leads to substantial changes in steady state unemployment rates.

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[17]One could argue that it would be better to ensure that the percentage change in 1-ζ is the same for part A and B of Table 4. The value of 1-ζ drops 5% (from 1 to 0.95) in part A. An equal percentage decrease in the value of 1-ζ in part B requires a reduction in 1-ζ from 0.9 to 0.855 or an increase in ζ from 0.10 to 0.145, slightly less than the increase to 0.15 considered. The results for the increase in ζ to 0.145 are, however, very similar.

4.3. Shocks in the Presence of and to Turbulence. We now consider the extension of the model that includes two skill levels and turbulence. In a turbulent economy, high-skilled workers may face a loss of skills if they lose their jobs, because of skill obsolescence or difficulty of finding a new job in the sector for which their skills are specialized. Following Ljungqvist and Sargent (1998), we model turbulence by assuming that high-skilled workers who separate from an employment relationship suffer a *downgrade* to low skills with probability γ^D. The previous version of the model, in which $\gamma^D = 0$, may be viewed as a "tranquil" economy in which skills never become obsolete. Greater degrees of turbulence are reflected by higher values of γ^D. The parameters for the economies with turbulence are given in Table 5. In the economy with a high replacement rate, exogenous destruction is set equal to zero and the support of z is chosen in such a way that for $\beta = 0.99$ and $\gamma^D = 0.10$ (the favorable regime values) the unemployment rate is equal to 5%. In the low-replacement-rate economy, all parameters are identical except the replacement rate and the level of exogenous destruction, which is increased to obtain a 5% unemployment rate for $\beta = 0.99$ and $\gamma^D = 0.10$.

The steady state unemployment rates for different values of the discount factor and the turbulence parameter are reported in parts A and B of Table 6 for the high- and the low-replacement-rate economy, respectively. In part B we see that the low-replacement-rate economy is still far enough away from the zero surplus level of z and is not affected by changes in the discount factor or the turbulence parameter. Two important observations can be made concerning the results for the high-replacement-rate economy. The first is that in contrast to Ljungqvist and Sargent (1998), an increase in turbulence *decreases* the unemployment rate. The reason is related to the aspect of turbulence that Alan Greenspan referred to in the quote cited in Section 3.6. In particular, faced with increased turbulence

(that is, an increased probability of skill loss), high-skilled workers are less likely to quit their job. Ljungqvist and Sargent (1998) fix the rate of destruction and do not consider a response in the destruction rate to a change in the economic environment. In our model an increase in turbulence does increase the rejection rate of the unemployed, because a rise in turbulence increases the fraction of unemployed workers entitled to unemployment benefits that are high relative to wage offers received. This effect, however, is dominated by the increased willingness of high-skilled workers to hold on to their jobs.

A second observation is that in the presence of turbulence, the impact of a change in the discount factor on the unemployment rate is substantially higher, due to a composition effect. A decrease in the discount factor not only increases the destruction rate for each skill level, but it also increases the fraction of low-skilled workers. Since low-skilled workers have higher destruction rates, unemployment rates rise even further. This composition effect is stronger for lower values of the upgrade probability, γ^U. This can be seen in part C of Table 6, which corresponds to part A except that γ^U is now equal to 0.10 instead of 0.15.[18] We see that a decrease of the discount factor from 0.99 to 0.97 would increase the unemployment rate from 5% to 23% and even if we allow for an increase in turbulence (γ^D increases from 0.10 to 0.15) the unemployment rate would still increase from 5% to 18.5%.

When γ^U is equal to 0.1, the unemployment rates in the low-replacement-rate economy are affected by the decrease in the discount factor, although the effect is very small. This is documented in part D of Table 6. Starting at values of $\beta = 0.99$ and $\gamma^D = 0.10$, a decrease in β to 0.97 would increase the unemployment rate from 5% to 5.6%. Note that at this point, an increase in γ^D to 0.15 would increase the unemployment rate slightly, to

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[18]In addition, the standard deviation is recalibrated to obtain a five percent unemployment rate in the favorable regime.

5.7%. The main reason why an increase in turbulence increases the unemployment rate in the low-replacement-rate economy is not because of the effect proposed by Ljungqvist and Sargent (that there are more unemployed workers with benefits that are high relative to the wage offers their skills can generate). The quantitatively more important effect is that turbulence decreases the outside option for high-skilled workers and, thus, lowers the wages of high-skilled workers. This implies a reduction in future wages of low-skilled workers and thus a decrease in relationship benefits for low-skilled workers. This reduction implies an increases in their zero surplus level.[19]

Turbulence and the effect on unemployment rates?. The question arises whether in reality the effect of Ljungqvist and Sargent (1998) is always dominated by a reduction in the breakup probability of high-skilled workers. In our numerical examples we typically found numerically insignificant effects from increases in the rejection rates by the unemployed, because the mass of unemployed is relatively small. For example, suppose that the matching probability is equal to 50% and that both the destruction rate and the rejection rate of new job offers is equal to 2.56%. Then it is easy to calculate that the steady state unemployment rate would be equal to 5%. To get an increase of the unemployment rate to 10% one would have to increase the rejection rate to 53.8%, while one only has to increase the destruction rate to 0.054% to get the same increase in the unemployment rate.[20] Also, a problematic observation for the explanation given by Ljungqvist and Sargent (1998) is that most of the increase in European unemployment rates is due to an increase of the unemployment of

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[19]The quantitative importance of this effect is still small. For this effect to be quantitatively important, one needs a large mass of low-skilled workers, that is, a low value of γ^U. But when γ^U is low, changes in wages earned after an upgrade occurs are not very important.

[20]There is no retirement in this example.

workers with low skill levels.[21]

There actually is a more robust way to increase turbulence. Mortensen and Pissarides (1999) model an increase in turbulence as an increase in the cross-sectional variation of z. Table 7 reports steady state unemployment rates for different values of β and the cross-sectional variation of z in the high-replacement-rate economy and documents that an increase in turbulence now leads to a substantial increase in the steady state unemployment rate.

4.4. Empirical Relevance and the Importance of Cross-Sectional Data. We have generated numerical examples in which unemployment rates in the low-replacement-rate economy do not respond to a deterioration of the economy, but unemployment rates in the high-replacement-rate economy do. In the benchmark parameterization, in which there are no endogenous breakups in the favorable regime, this was accomplished using two economies that are identical except for the replacement rate. In the alternative parameterizations, the same effects are possible when there are endogenous breakups, but now the two economies have to differ in more than just the replacement rate. The key hypothesis in this paper is that the mass of jobs that were close to breaking up was substantially higher in Europe because of high tax rates and high outside benefits. In Section 2 we documented that tax rates and unemployment benefits are higher in Europe. But if Europe is more productive than the U.S., then European surplus values are not necessarily lower. To shed some light on this question, we plot in Figure 10 net profit rates in the manufacturing sector in the U.S. and Europe. The figure documents that in the early postwar period profit rates were

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[21]See Table 22 in Nickell and Layard (1999). This empirical observation is also inconsistent with the turbulence story told in Marimon and Zilibotti (1999), who model the increase in turbulence as an increase in the difference between the most and least productive job a worker could get. As in Ljungqvist and Sargent (1998) this would induce those workers with high unemployment benefits to remain unemployed longer.

higher in the U.S. than in Europe, but that in the second half of the sample period profit rates were slightly higher in Europe. The observed pattern for profit rates is consistent with the main hypothesis and a key prediction of this paper. The higher U.S. profit rates are consistent with higher surplus values which ensured that jobs in the U.S. were less sensitive to decreases in the growth rate and increases in the tax and interest rate.[22] Moreover, the increase of the profits rate in Europe relative to the U.S. is consistent with the property of our model that a deterioration of the economic environment destroys the less productive jobs in Europe but not in the U.S..

For a serious investigation about the quantitative importance of the mechanism proposed in this paper, however, one would need to know much more detailed information about the cross-sectional distribution of surplus levels than just observed averages. In particular, one would have to know detailed information about that part of the distribution of z close to the breakup level. Our hypothesis is that because of the higher replacement rate, there were more jobs close to breaking up during the sixties in Europe than in the U.S.. The model with turbulence makes it clear that even perfect knowledge of the cross-sectional distribution of *existing* jobs is not always enough to make model predictions. We saw, for example, that an increase in turbulence lowers the zero surplus level and one could not predict the additional mass of jobs created because these jobs never existed before.

Time-series information on several other variables, like job creation and job destruction, has only limited information to support or contradict the explanations proposed in this paper. In particular, our theory offers no prediction for steady state destruction rates. Our theory makes predictions for the destruction rate *conditional on the skill level*. That is, for each skill

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[22]In the model, higher profit rates can be due to higher values of z and to lower unemployment benefits which lowers workers' outside option and wages.

level, the destruction rate should go up more in economies with high replacement rates. But because of composition effects, aggregate destruction rates could either decrease or increase. For example, it is possible that in the seventies a large number of low-productivity, high-destruction-rate jobs were destroyed in Europe and never again created. This would increase the productivity of the remaining jobs and lower the average destruction rate. Moreover, although job protection seems to have offsetting effects on average unemployment rates, it can have important effects on average job destruction and job creation rates and could also be important to understand business cycle properties of unemployment rates.

4.5. Related Literature. There are several other papers that study the relationship between growth and steady-state unemployment rates. A key issue is whether technological progress is modelled as embodied or disembodied technological progress. We follow Pissarides (1990) and model growth as disembodied technological progress, while Aghion and Howitt (1994) model growth as embodied technological progress. In Aghion and Howitt (1994) a relationship can only benefit from new technology by severing the relationship, going to the matching market, and getting newly matched. We argue that embodied technological progress is a sensible approach for capital and investment but less so for labor market models. Note that in Aghion and Howitt (1994) a worker who was part of a relationship that was severed because of a low productivity level (relative to the newly available technology), will actually be capable of using the newest technology, but only after having been unemployed for some time. We argue that it makes more sense to let existing relationships incorporate new technologies. Mortensen and Pissarides (1998) generalize Aghion and Howitt (1994) by allowing existing relationship to upgrade to the newest available technology by paying an upgrade cost. It seems to us that such an upgrade cost to benefit from the newest technology

should be lower for an existing firm then for a new relationship.[23] This implies that firms would never break up to obtain the new technology but rather would continue the existing relationship and pay the upgrade cost.

This issue is important because with embodied technological progress (allowing vacancy costs to rise at the same rate as the productivity of new matches), an increase in growth actually increases unemployment.[24] The reason is that higher growth causes existing relationships to become obsolete faster and, thus, to break up faster. This idea is used by Hornstein, Krusell, and Violante (2000) to argue that an *increase* in embodied technological progress that started in the 1970's increased unemployment in those countries with high unemployment benefits. The story we propose in this paper is more straightforward, but we are sympathetic to the idea that in some sectors embodied technological progress is important and has increased unemployment in the last few decades.

The role of taxes is studied in detail by Daveri and Tabellini (2000). Their paper documents the effect of taxes on unemployment rates and growth rates and builds an overlapping-generations model with endogenous growth to explain the empirical findings. Note that whereas we consider changes in tax rates and growth rates as two independent shocks, Daveri and Tabellini (2000) argue that the cause of the lower growth rates actually is high tax rates. The finding that tax rates affect growth is disputed in the literature,[25] but Daveri and Tabellini argue that one does find significant effects if one exploits both the cross-sectional and time series variation of the data and distinguishes among countries on the basis of their labor market institutions.

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[23] Our model basically assumes that the upgrade costs are equal to zero.

[24] See Aghion and Howitt (1994) and Hornstein, Krusell, and Violante (2000).

[25] See, for example, Nickell and Layard (1999).

5. CONCLUSION

We have reassessed the European unemployment puzzle using a job matching model that features endogenous job creation and destruction, bilateral wage bargaining, and variable worker skill levels that may rise on the job. The model considers shocks in the form of slower growth, higher interest rates, higher tax rates, and increased turbulence, and studies how these shocks interact with the replacement rate and the initial tax rate level. The variability of relation-specific productivity is also considered. Slower growth, higher interest rates, and higher tax rates are shown to induce a larger increase in unemployment when the replacement rate or the initial tax rate is higher, as was found empirically by Blanchard and Wolfers (2000) and Daveri and Tabellini (2000). Higher turbulence actually reduces unemployment, due to exerting a favorable effect on job destruction; this reverses the finding of Ljungqvist and Sargent (1998).

An important implication of our results is that the European unemployment problem should not be viewed as self-correcting. The model demonstrates that slower growth and higher interest rates produce greater unemployment, especially in the presence of generous unemployment benefits. Unless the shocks are reversed, or other institutional changes are made, unemployment may be expected to remain high.

This paper documents the importance of the cross-sectional distribution of the surplus, especially about that part of the distribution where relationships are close to breaking up. The key hypothesis in this paper is that the mass of jobs that were close to breaking up was substantially higher in Europe because of high tax rates and high outside benefits. The ideal data set to test the explanation given in this paper would be a survey held in the sixties that asked firms and workers in the U.S. and Europe how close they were to breaking up. The historical profit rates discussed in Section 4.1 support the view that a smaller share of jobs

were close to breaking up in the U.S. than in Europe, but a serious quantitative assessment of the mechanism described in this paper would require much more detailed information about the cross-sectional distribution in the sixties.

6.   APPENDIX

In the appendix we discuss details about the data sources and different types of relationships in the model.

Data Sources.   The tax data reported in Figure 3 are from Daveri and Tabellini (2000). The net-profit rates in manufacturing are from Armstrong, Glyn and Harrison (1991). All other data were provided to us by Justin Wolfers and we refer the reader for a more detailed description of these data to the data appendix of Blanchard and Wolfers (2000) that is available at http://web.mit.edu/blanchar/www/harry_data/. Data for standardized unemployment rates and durations are from the Quarterly Labor Force Statistics. The OECD replacement rates are from the OECD's database on Unemployment Benefit Entitlements and Replacement Rates. These numbers are based on an average over three family types, two income levels, and seven unemployment duration levels. The real interest rate is the nominal interest rate on long-term government securities less the annualized rate of inflation over the last five years using the GDP deflator. Finally, total factor productivity is the Solow Residual in the business sector, scaled by the labor share.

Types of Workers.   Given tax rates and values for b one only needs to know the fraction of low-skilled workers, the fraction of high-skilled workers, the fraction of (low-skilled) unemployed not entitled to unemployment benefits, the fraction of low-skilled unemployed entitled to b_l, the fraction of low-skilled unemployed entitled to b_h, and the fraction of high-skilled unemployed. To calculate average wages (which in turn determine unemployment

benefits) and tax rates a more precise disaggregation is needed. In Table 8 we report all the different types of workers their outside option or unemployment benefits and if applicable the values of z at which they operate.
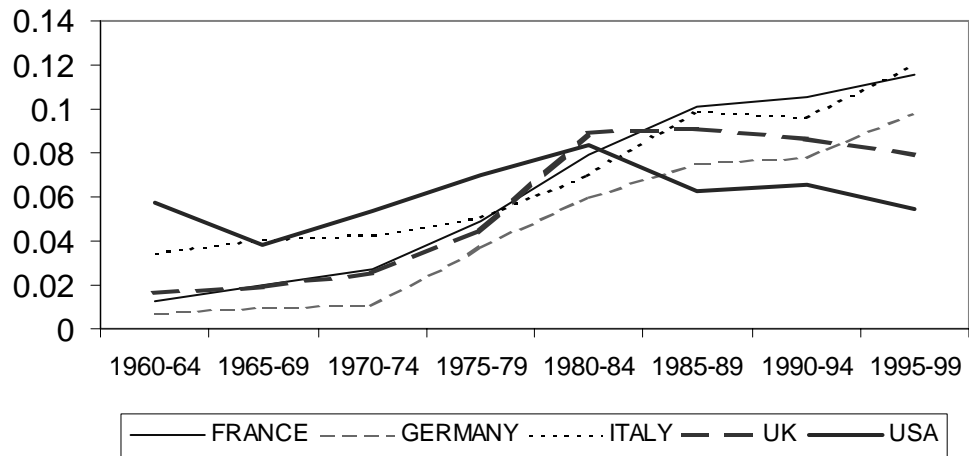
REFERENCES

[1] Aghion, P., and P. Howitt (1994), "Growth and Unemployment," *Review of Economic Studies*, 61, July, 477-494.

[2] Armstrong, A., A. Glyn, and J. Harrison (1991), *"Capitalism since World War II,"* Oxford: Basil Blackwell.

[3] Blanchard, O., (2000), *"Macroeconomics,"* 2nd edition, Upper Saddle River: Prentice Hall.

[4] Blanchard, O., and J. Wolfers (2000), "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence," *Economic Journal*, 110, March, 1-33.

[5] Daveri, F., and G. Tabellini (2000), "Unemployment, Growth and Taxation in Industrial Countries," *Economic Policy*, 15, April, 47-104.

[6] Den Haan, W.J., G. Ramey, and J. Watson (2000a), "Job Destruction and Propagation of Shocks," *American Economic Review*, 90, June, 482-498.

[7] Den Haan, W.J., G. Ramey, and J. Watson (2000b), "Job Destruction and the Experiences of Displaced Workers," *Carnegie-Rochester Conference Series on Public Policy*, 52, June, 87-128.

[8] Garibaldi, P. (1998), "Job Flow Dynamics and Firing Restrictions," *European Economic Review*, 42, February, 245-275.

[9] Gordon, R. (1997), "Is there a Trade-Off between Unemployment and Productivity Growth?" CEPR Discussion Paper #1159.

[10] Hornstein, A., P. Krusell, and G. Violante (2000), "Technology, Policy, and the Inequality-Unemployment Tradeoff," manuscript.

[11] Krusell, P., and A.A. Smith, Jr. (1998), "Income and Wealth Heterogeneity in the Macroeconomy," *Journal of Political Economy*, 106, October, 867-896.

[12] Ljungqvist, L., and T.J. Sargent (1998), "The European Unemployment Dilemma," *Journal of Political Economy*, 106, June, 514-550.

[13] Machin, S., and A. Manning (1999), "Longterm Unemployment in Europe," in: O. Ashenfelter and D. Card, eds., *Handbook of Labor Economics*, volume 3C, Amsterdam: Elsevier, 3085-3139.

[14] Marimon, R., and F. Zilibotti (1999), "Unemployment vs. Mismatch of Talents: Reconsidering Unemployment Benefits," *Economic Journal*, 109, April, 266-291.

[15] Mortensen, D.T., and C.A. Pissarides (1994), "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies*, 61, July, 397-415.

[16] Mortensen, D.T., and C.A. Pissarides (1998), "Technological Progress, Job Creation, and Job Destruction," *Review of Economic Dynamics*, 1, October, 733-753.

[17] Mortensen, D.T., and C.A. Pissarides (1999), "Unemployment Responses to 'Skill-Biased' Technology Shocks: the Role of Labour Market Policy," *Economic Journal*, 109, April, 242-265.

[18] Nickell, S., and R. Layard (1999), "Labor Market Institutions and Economic Performance," in O. Ashenfelter and D. Card, eds., *Handbook of Labor Economics*, Volume 3C, Amsterdam: Elsevier, 3029-3084.
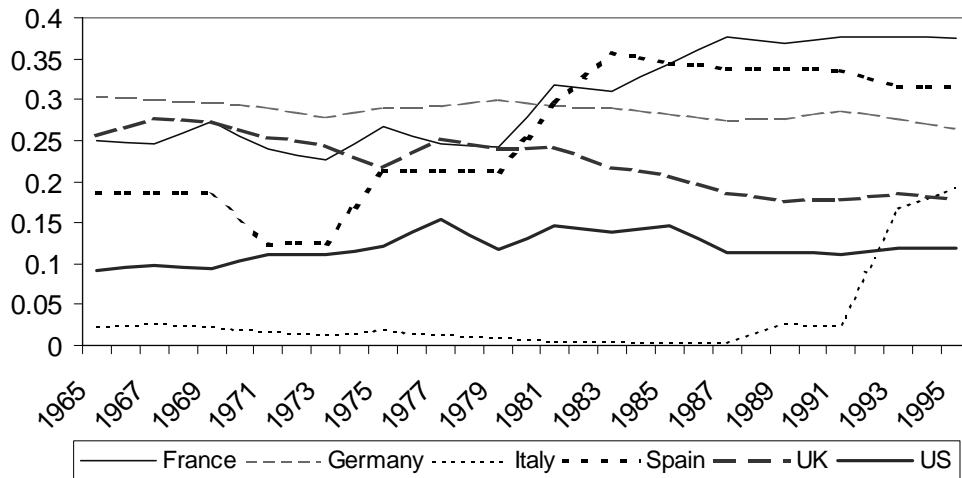
[19] Phelps, E.S. (1968), "Money-Wage Dynamics and Labor Market Equilibrium," *Journal of Political Economy*, 76, July-August, 678-711.

[20] Pissarides, C.A. (1990), *"Equilibrium Unemployment Theory,"* Cambridge, MA: MIT Press.

[21] Weil, P. (1992), "Equilibrium Asset Prices with Undiversifiable Labor Income Risk," *Journal of Economic Dynamics and Control*, 16, July-October, 769-790.

Figure 1: Standardized unemployment rates

	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	1990-94	1995-99

0.14
0.12
0.1
0.08
0.06
0.04
0.02
0

—— FRANCE — — — GERMANY ······· ITALY ▬ ▬ UK ▬▬▬ USA

Note: Data are described in the appendix.

Figure 2: OECD replacement ratio

0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0

1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995

—— France — — — Germany ······· Italy ▪ ▪ ▪ ▪ Spain ▬ ▬ UK ▬▬▬ US

Note: Data are described in the appendix.

Figure 3: Effective tax rate
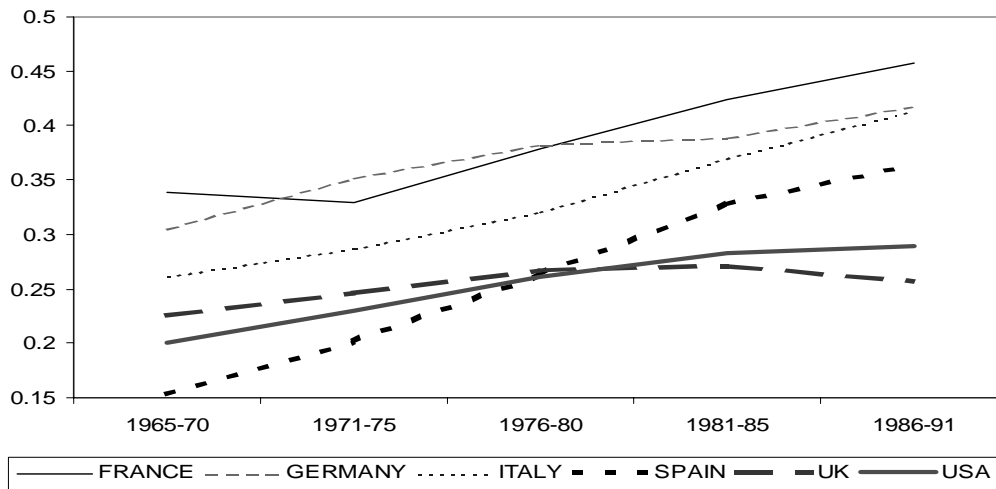
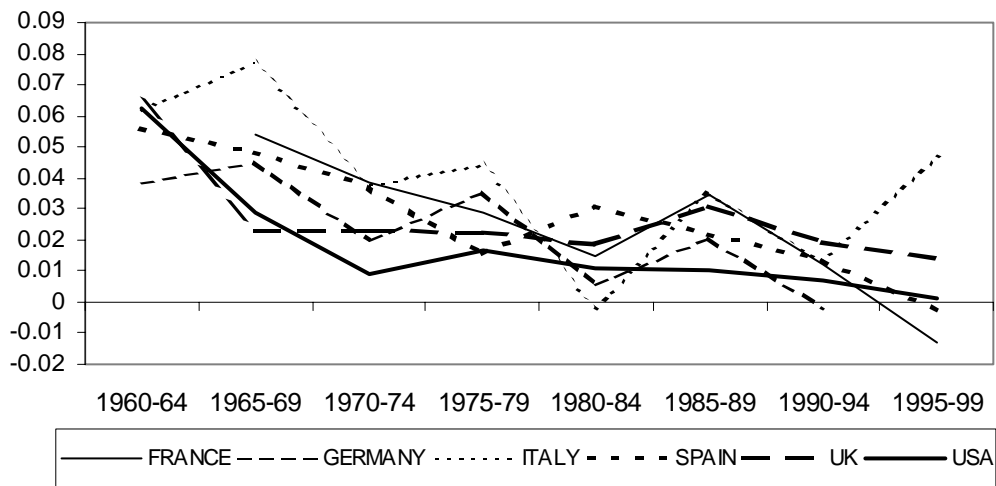Note: Data are from Daveri and Tabellini (2000).

Figure 4: Total factor productivity growth

Note: Data are described in the appendix.

Figure 5: Real interest rate
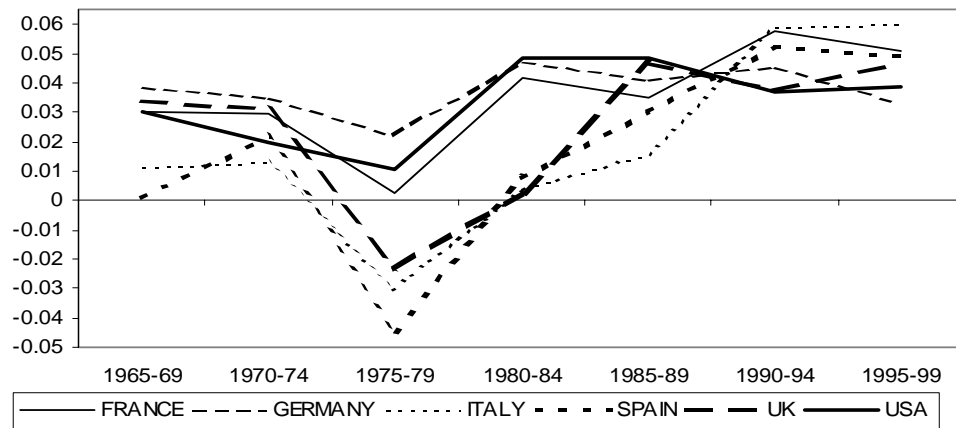
Note: Data are described in the appendix.

Figure 6: Transformed discount factor
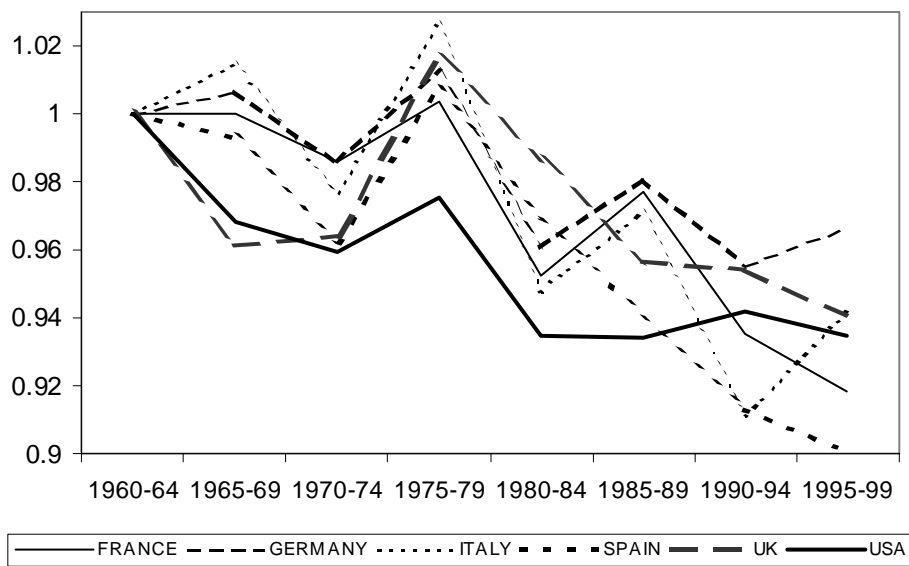
Note: This graph plots $(1+\xi)/(1+r)$, where ξ is the TFP growth rate of Figure 4 and r is the interest rate of Figure 5. For each country the ratio is scaled such that it is equal to one in 1960.

Figure 7: Effect of decrease in TFP growth on rejection and destruction margin
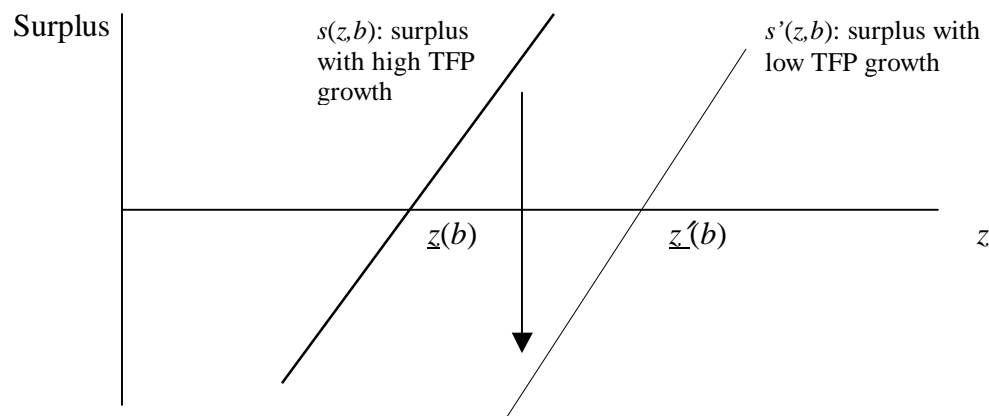
Figure 8: A Decrease in β and the effect of replacement rates on zero-surplus margin (identical cross-sectional distributions)
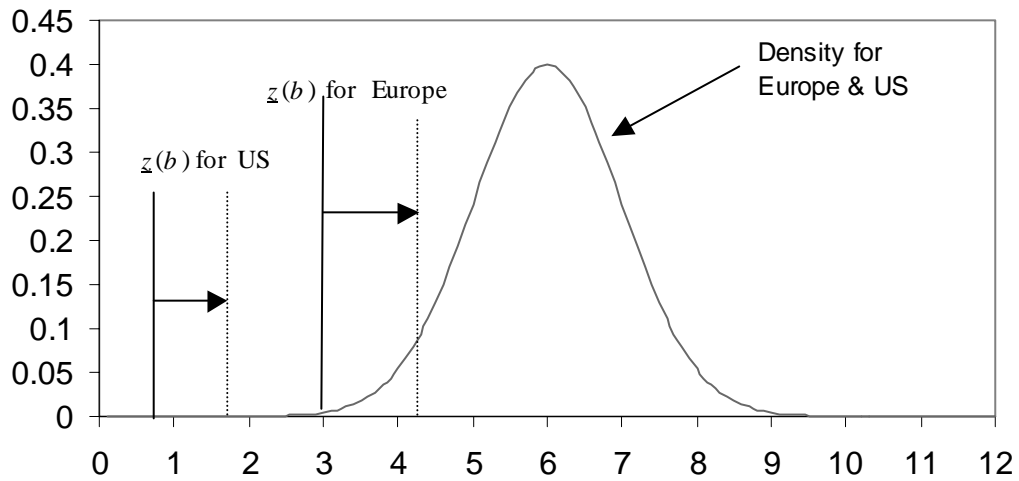
Figure 9: A Decrease in β and the effect of replacement rates on zero-surplus margin (higher rate of exogenous destruction in US)
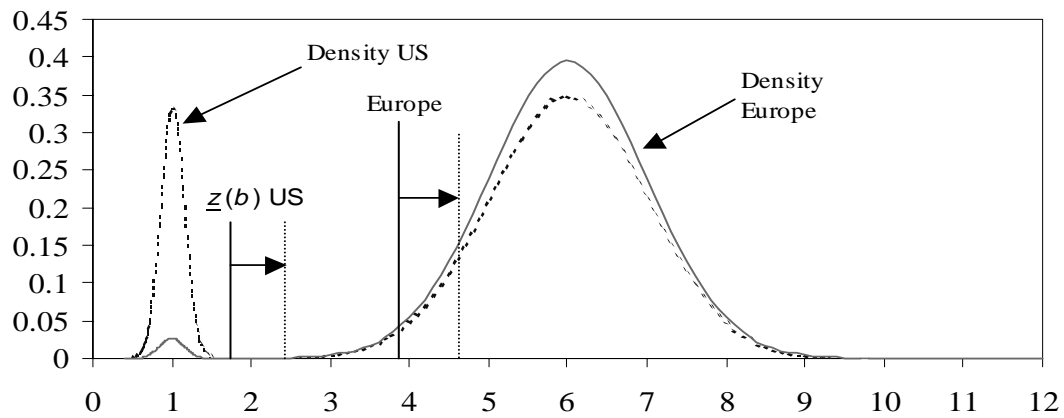
Figure 10: Manufacturing Net-Profit Rate
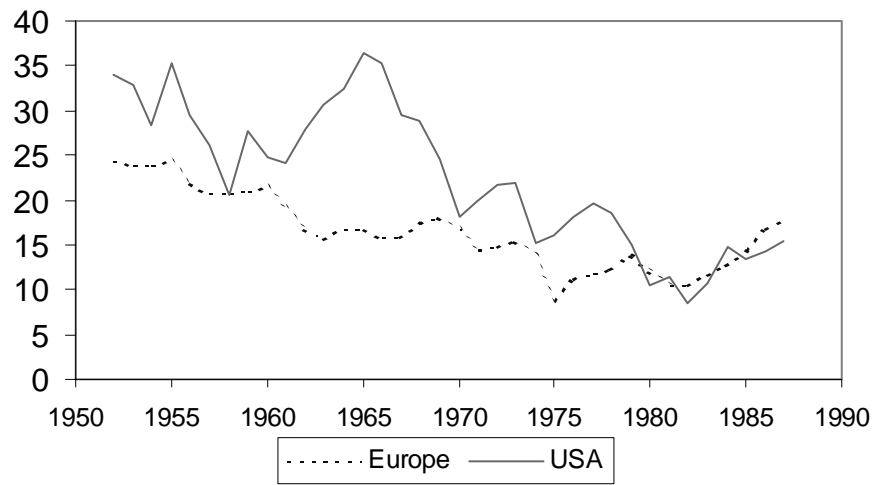
Note: Data are described in the appendix.

Table 1: Benefit measures (1989-1994)

	benefit replacement rate	benefit duration (years)
France	57	3
Germany	63	indefinite
Italy	20	0.5
Spain	70	3.5
U.K.	38	indefinite
U.S.	50	0.5

Source: Nickell and Layard (1999, p. 3045).

Table 2: Benchmark parameter values

γ^s	0.8
ρ^x	1.05%
ρ^r	0.5%
$E(z)$	1.0
σ_z	2.32
λ	0.5
π	0.5
ζ	0

Table 3: Equilibrium unemployment rates and decreases in the discount factor

Part A: Benchmark specification

		$\phi = 0.3$	$\phi = 0.5$
discount	**0.97**	4.97	6.62
factor β	**0.98**	4.97	5.64
	0.99	4.97	4.97

Note: Here ϕ is the replacement rate and the values of other parameters are given in Table 2.

Part B: Alternative Specifications

		$\phi = 0.5$	$\phi = 0.3$		
			$\lambda^w = 0.3$		$\lambda^w = 0.5$
		$\rho^x = 0$ $\sigma^{\tilde{z}} = 2.43$	$\rho^x = 1.05\%$ $\sigma^{\tilde{z}} = 2.43$	$\rho^x = 0$ $\sigma^{\tilde{z}} = 3.18$	$\rho^x = 0$ $\sigma^{\tilde{z}} = 2.04$
discount	**0.97**	6.75	4.97	7.85	5.71
factor β	**0.98**	5.75	4.97	6.24	5.35
	0.99	5.01	4.97	4.99	5.01

Note: Here ϕ is the replacement rate, λ^w is the matching probability, ρ^x is the rate of exogenous breakups, and $\sigma^{\tilde{z}}$ is the standard deviation of the idiosyncratic productivity shock. The values of other parameters are given in Table 2. In all economies the parameters are chosen such that the unemployment rate is approximately 5% when $\beta = 0.99$. In the first column this is done by adjusting $\sigma^{\tilde{z}}$. Then in column 2 the value of ρ^x is increased to again get a 5% unemployment rate at the lower value of ϕ. In the third and fourth column the value of $\sigma^{\tilde{z}}$ is used to get a 5% unemployment rate at the indicated matching probability.

Table 4: Equilibrium unemployment rates and increases in the tax rate

Part A: Low initial tax rates

		government expenditure ζ		
		0.0	**0.025**	**0.05**
discount	**0.97**	6.75	7.63	8.78
factor β	**0.98**	5.75	6.43	7.34
	0.99	5.01	5.54	6.24

Note: The value of $\phi = 0.5$. The value of $\sigma_z = 2.43$ which insured that the unemployment rate was approximately equal to 5% when $\zeta = 0$ and $\beta = 0.99$. The other parameter values are given in Table 2.

Part B: High Initial Tax Rates

		government expenditure ζ		
		0.10	**0.125**	**0.15**
discount	**0.97**	6.75	8.19	10.52
factor β	**0.98**	5.76	6.88	8.73
	0.99	5.03	5.89	7.32

Note: The value of $\phi = 0.5$. The value of $\sigma_z = 2.32$ which insured that the unemployment rate was approximately equal to 5% when $\zeta = 0$ and $\beta = 0.99$. The other parameter values are given in Table 2.

Table 5: Parameter Values for Model with Turbulence

γ^S	0.8
ρ^r	0.5%
$E(z_l)$	0.8
$E(z_h)$	0.8
λ	0.5
π	0.5

Table 6: Equilibrium Unemployment with all shocks

Part A: Replacement rate $\phi = 0.5$ & upgrade probability $\gamma^U = 0.15$

		discount factor β		
		0.97	**0.98**	**0.99**
downgrade	**0.0**	28.7	26.9	25.1
probability	**0.05**	20.9	17.0	12.6
γ^P	**0.1**	14.4	8.8	5.0
	0.15	8.0	4.0	2.7

Note: The value of $\rho^x = 0$ and the value of $\sigma^z = 3.81$. The values of other parameters are given in Table 5. The value of σ^z is chosen in such a way that the unemployment rate is approximately equal to 5% when $\beta = 0.99$ and $\gamma^P = 0.1$.

B: Replacement Rate $\phi = 0.3$ & upgrade probability $\gamma^U = 0.15$

		discount factor β		
		0.97	**0.98**	**0.99**
downgrade	**0.0**	5.0	5.0	5.0
probability	**0.05**	5.0	5.0	5.0
γ^P	**0.1**	5.0	5.0	5.0
	0.15	5.0	5.0	5.0

Note: The value of $\sigma^z = 3.81$ as in part A and the value of $\rho^x = 0.0106$. The values of other parameters are given in Table 5. The value of ρ^x is chosen in such a way that the unemployment rate is approximately equal to 5% when $\beta = 0.99$ and $\gamma^P = 0.1$.

C: Replacement Rate $\phi = 0.5$ & upgrade probability $\gamma^U = 0.1$

		discount factor β		
		0.97	**0.98**	**0.99**
downgrade	**0.0**	34.5	33.0	31.2
probability	**0.05**	27.7	23.9	18.5
γ^p	**0.1**	23.2	16.3	5.01
	0.15	18.5	4.23	3.91

Note: The value of $\rho^x = 0$ and the value of $\sigma^z = 4.051$. The values of other parameters are given in Table 5.
The value of σ^z is chosen in such a way that the unemployment rate is approximately equal to 5% when
$\beta = 0.99$ and $\gamma^p = 0.1$.

D: Replacement Rate $\phi = 0.3$ & upgrade probability $\gamma^U = 0.1$

		discount factor β		
		0.97	**0.98**	**0.99**
downgrade	**0.0**	9.6	7.8	6.4
probability	**0.05**	5.4	5.1	4.8
γ^p	**0.1**	5.6	5.3	5.0
	0.15	5.7	5.4	5.1

Note: The value of $\sigma^z = 4.051$ as in part A and the value of $\rho^x = 0.0098$. The values of other parameters are given in Table 5.
The value of ρ^x is chosen in such a way that the unemployment rate is approximately equal to 5% when
$\beta = 0.99$ and $\gamma^p = 0.1$.

Table 7: Equilibrium Unemployment with all shocks
(Mortensen & Pissarides type increase in turbulence)

		discount factor β		
		0.97	**0.98**	**0.99**
cross-sectional	**2.83**	8.75	5.11	3.32
standard	**2.91**	14.36	8.77	5.01
deviation σ_z	**2.99**	19.72	14.37	8.39

Note: Here $\rho^x = 0$, $\phi = 0.5$, and $\gamma^p = 0$. The values of other parameters are given in Table 5.

Table 8: Different types of agents in model with turbulence

Part A: Unemployed workers

	skill level	unemployment benefit
New labor market entrant	low	0
Formerly low-skilled worker	low	b_l
Downgraded high-skilled worker	low	b_h
Formerly high-skilled worker	high	b_l

Part B: Employed workers

	outside option	range of z values
Young low skilled who accept job to become Eligible for unemployement benefit	$w_l(0)$	$[\underline{z_l}(0), \underline{z_l}(b_l)]$
Low-skilled worker, formerly entitled to b_h, in 1st period of employment	$b_h + w_l(b_h)$	$[\underline{z_l}(b_h), \infty]$
Low-skilled worker, formerly entitled to b_h, after 1st period of employment	$b_l + w_l(b_l)$	$[\underline{z_l}(b_h), \infty]$
Other low skilled workers	$b_l + w_l(b_l)$	$[\underline{z_l}(b_l), \infty]$
High-skilled worker who just got upgraded	$b_l + w_l(b_l)$	$[\underline{z_h}(b_h), \infty]$
Other high-skilled workers	$b_h + w_h(b_h)$	$[\underline{z_h}(b_h), \infty]$