

Job Turnover, Unemployment and Labor Market Institutions

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Abstract

This paper studies the role of labor market institutions on unemployment and on the cyclical properties of job flows. We construct an intertemporal general equilibrium model with search unemployment and endogenous job turnover, and examine the consequences of introducing an unemployment benefit, a firing cost and a downward wage rigidity. The model is able to reproduce the main cyclical properties of a typical European economy. It also suggests that downward wage rigidities, rather than unemployment benefit or firing cost, may well play a dominant role in explaining both the high unemployment rate and the cyclical properties of such an economy.

Keywords: Unemployment, Job flows dynamics, Institutions.

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1 Introduction

Unemployment rates are typically higher in Europe than in the US although job turnover rates are roughly similar on either side of the Atlantic, but acyclical or procyclical in Europe and countercyclical in the US (see OECD, 1994). A recent number of empirical papers suggest that the divergent pattern of European and US unemployment rates may be related to institutional differences by generating distinct responses to similar macroeconomic shocks (see for instance Nickell, 1997, Blanchard and Wolfers, 2000, or Bertola *et al.*, 2001). The institutional parameters emphasized by these studies as most important for aggregate employment are the generosity of the unemployment insurance system and the wage setting process whereas employment protection measures have no clear effect. Ljungqvist and Sargent (2002), in a general equilibrium search model, put forward the role of higher firing costs and more generous unemployment benefits to explain the weak performance of European labor market in face of higher economic turbulence. Den Haan *et al.* (2001) emphasize the effects of TFP growth, real interest rate and taxes rather than economic turbulences.

Less work has however been devoted to analyze how to explain both the similarity in job turnover rates and the differences in unemployment rates, between Europe and the US. It is now well known that job protection alone cannot explain these features since it unambiguously reduces both the job creation rate and the job destruction rate and has an ambiguous effect on the unemployment rate (see Ljungqvist, 2002). Bertola and Rogerson (1997) argue however that wage-compression and dismissal restrictions have opposite effects on job turnover and that their interaction could account for the similarity of job turnover rates in countries where these institutional regulations differ. More recently, Cahuc and Zylberberg (1999) investigate the interaction between job protection and minimum wage. They start from the standard search and matching Mortensen and Pissarides (1994) model where, with freely negotiated wages, firing taxes have a positive impact on employment. They show that this conclusion can be reversed when wage negotiations are constrained by a minimum wage rule.

A still less clarified question is how to explain the differences in the cyclical properties of job flows on European and US labor markets. Garibaldi (1998) analyses the effect of employment protection legislation and shows that introducing firing permissions has a substantial

effect on the dynamic behavior of job flows, despite a negligible impact on equilibrium unemployment. A decrease in the arrival rate of firing permissions lowers the relative volatility of the job destruction rate, so that the job turnover becomes less and less countercyclical. In Garibaldi's model, wages are set by the firms at the workers exogenous reservation utility and consequently do not depend on the business cycle.

Our objective is to build on these previous works and look more closely at the combined effects of unemployment benefits, employment protection and wage rigidities. We construct for that purpose a stochastic intertemporal general equilibrium model with search unemployment and endogenous job turnover. We examine the effects of these institutional variables, on both the stationary state values of unemployment and job flows and on their cyclical properties. Our starting point is den Haan *et al.* (2000), who insert the Mortensen and Pissarides (1994) model into an intertemporal general equilibrium framework, with endogenous interest rates and capital accumulation. One can in this way capture the interactions between capital accumulation and job destruction. We then extend their analysis by introducing the three above-mentioned labor market institutions. Unemployment benefits are exogenous and employment protection takes the form of a firing tax. The downward wage rigidity is modelled as a "minimum wage" constraint, *i.e.* as a lower bound on the outcome of wage negotiations: wages are renegotiated "at will" according to a Nash bargaining rule as long as they remain above this institutionally determined lower bound¹.

We calibrate the model so as to reproduce the main characteristics of an "average" EU economy, and show that unemployment benefits have a sizeable effect on the unemployment rate, not so much though as the wage rigidity. As in Cahuc and Zylberberg (1999), the effect of employment protection depends on the level of the minimum wage. When the minimum wage is low (resp. high), a firing tax has a positive (resp. negative) effect on equilibrium employment. These effects remain quantitatively limited though. We extend this analysis to the cyclical properties of job flows. Unemployment benefits and especially wage rigidities are shown to have a positive effect on the job turnover procyclicality. Our main result is that

¹Wage rigidities may take much more subtle forms and be much more pervasive than "minimum wage" restrictions (see Cahuc and Zylberberg (1999) for a more elaborated representation of downward wage rigidities). We will refer throughout the paper to the lower bound of the wage distribution as to the "minimum wage", keeping in mind that it is not associated with the worker's productivity. Indeed, all individuals in our model have the same skills; different jobs may however have different productivities.

the direction and size of the effects of employment protection on job flow dynamics depend on the degree of wage rigidity. With high wage rigidities, firing costs have a negative impact on the relative job destruction rate volatility (with respect to the job creation rate volatility) and increase the procyclicality of the job turnover rate. These results are compatible with Garibaldi (1998). We show however that the results are reversed in the case of flexible wages. It is thus the minimum wage, and its interaction with the firing costs (rather than the firing cost alone), that seems to matter to explain the differences between the cyclical properties of US and EU labor markets.

The rest of the paper is organized as follows. In the next section, we summarize some key empirical findings about the working of labor market in OECD countries, and report some estimates of the relative importance of unemployment benefits, job protection and wage rigidities. In section 3, we present our theoretical framework. The model is then calibrated in section 4 and simulated in section 5 to provide a quantitative assessment of the effects of our institutional variables on the steady state and the cyclical properties of our economy. The last section concludes.

2 Labor market flows and institutions: some stylized facts

2.1 Job turnover and unemployment

An important feature regarding job flows dynamics is that, in most OECD countries, the job turnover rate (JT) is relatively high, between 15% and 25% (see second column of table 1). This observation is more striking if we consider the third column of table 1, which provides the net employment change rate (NET), defined simply as the difference between the job creation rate (JC) and the job destruction rate (JD)². Slightly positive net employment changes are associated with very large job reallocations. If a high average level of job turnover is a common feature of most OECD countries, we nevertheless observe differences across countries in the job turnover cyclical properties. Looking at the fourth and fifth columns, we notice that in the US, the JD rate is more volatile than the JC rate. On the

²See OECD (1994) for extensive definitions of these concepts.

other hand, in the EU, the volatilities of the JD rate and the JC rate are quite similar (see column 6).

Another well known empirical finding is that, generally, job creation is procyclical while job destruction is countercyclical. It indeed seems intuitive enough to have more (resp. less) job creations and less (resp. more) job destructions during economic expansion (resp. recession). A much more open and debated question concerns the cyclical nature of job turnover. The OECD (1994) proposes a summary of relevant studies and it appears that in the US, the job turnover is negatively correlated with the net employment change rate, whereas in the EU, the correlation seems to be much less negative³ (see column 7). Consequently, in the US, the level of job reallocation is higher during a recession, while in the EU, it is quite constant over the cycle. Finally, as displayed in the last column of table 1, the unemployment rate is lower in the US than in the EU.

[INSERT TABLE 1]

2.2 Labor market institutions

Using different unemployment durations (from 1 to 5 years) and different marital status (single, couple without children, couple with two children), the OECD (2002) computes a synthetic net replacement ratio for 1999. This statistics (second column of table 2) is twice higher in most EU countries⁴ than in the US. This stresses the relative generosity of unemployment benefits in EU countries (relatively to the US). The OECD (1999) also computes a synthetic index of the strictness of the employment protection legislation in the late 1990's. This indicator (first figure of the third column) includes regular and temporary contracts and takes into account the regular procedural inconveniences, the notice and severance pay for no-fault individual dismissals and the difficulty of dismissal. A low (resp. high) index means a low (resp. high) protection of employment. The OECD also ranks the 26 countries surveyed by order of increasing employment protection legislation. This ranking is given between parentheses in the third column. We again observe a sharp difference between the EU (strong employment protection) and the US (almost no employment protection). The

³NET is taken as a measure of the cycle in empirical papers. Data are also HP filtered.

⁴The replacement ratio in Italy is quite low and even lower than in the US. This ratio however rapidly increases over time.

fourth column of table 2 reproduces the gross Kaitz index given by the OECD (1998) for the year 1997. The Kaitz index is here defined as the ratio between the minimum wage and the gross full-time mean earnings. This Kaitz index is over 0.50 for the EU countries whereas it is only 0.35 for the US. The ratio between the highest and the lowest wages provides an alternative measure of wage dispersion. The last column of table 2 gives the D9/D1 ratio⁵ (see OECD, 1996). The obvious conclusion is that the wage dispersion is substantially lower in EU countries. This may be the result of downward wage rigidities induced by minimum wage legislation, collective agreements negotiated by more powerful trade unions, *etc.*

[INSERT TABLE 2]

3 Model

We construct a two-tier productive structure by assuming the coexistence of three types of agents in the economy: intermediate firms, a representative final firm and a representative household⁶. Intermediate firms require one worker to produce x units of intermediate good. As in Mortensen and Pissarides (1994), x is a random job-specific productivity parameter drawn each period from a general cdf F ⁷. The final firm uses intermediate goods as well as capital to produce an homogeneous final good that can be either consumed or invested by the household. This representative household supplies labor to intermediate firms and capital to the final firm. We then have three types of markets for respectively labor, goods and capital.

⁵D1 and D9 refer to the upper earnings limits of, respectively, the first and the ninth deciles of employees ranked in order of their gross earning from lowest to highest.

⁶We could assume, as in den Haan *et al.* (2000), a "one-tier" productive structure with only single job firms with labor but also capital as input. Our two-tier structure however allows a simpler presentation.

⁷The assumption that the idiosyncratic shock arrival rate is equal to 1 (as for instance in den Haan *et al.*, 2000) greatly simplifies our model. Introducing some persistence for these shocks would indeed necessitate to use a discrete aggregate productivity shock (see Mortensen and Pissarides, 1999, or Garibaldi, 1998, for such aggregate productivity shock) rather than the usual specification used in RBC models (see equation (31)).

3.1 Labor market flows

We assume that the total labor force is constant and normalized to 1, with N_t employed workers and U_t unemployed workers:

$$1 = N_t + U_t. \quad (1)$$

At each period, the number M_t of new employer-worker contacts is function of the stock V_t of vacancies and of the number of efficient job seekers, *i.e.* the number of unemployed weighted by a function \mathcal{S} of their search effort S_t . More formally:

$$M_t = \mathcal{M}(V_t, \mathcal{S}(S_t)U_t), \quad (2)$$

where the matching function \mathcal{M} is increasing, concave in its arguments and $\mathcal{M}(0, \cdot) = \mathcal{M}(\cdot, 0) = 0$. The function \mathcal{S} is increasing, concave and $0 \leq S_t$. The probability for a firm with a vacancy to meet a job seeker is q_t and the probability for a job seeker to meet a vacancy is p_t , and they are respectively given by:

$$q_t = \frac{M_t}{V_t} \quad \text{and} \quad p_t = \frac{M_t}{\mathcal{S}(S_t)U_t}. \quad (3)$$

All contacts will not lead to job creation because some matches may turn out not to be productive enough. The productivity x of a new match is only revealed after the contact and may be too low to generate a positive surplus. The endogenous destruction rate of the new contacts will be denoted χ_t^0 , whereas the endogenous destruction rate of existing jobs is χ_t^1 . The difference between these two rates arises from the fact that new contacts are not covered by an employment protection, conversely to the existing jobs⁸. Total employment is the sum over two different types of jobs: "new jobs" (new contacts not destroyed) denoted by the superscript $j = 0$ and "old jobs" (existing jobs not destroyed) denoted by the superscript $j = 1$. The dynamics of total employment, in term of job seekers' search effort, is given by:

$$N_{t+1} = N_{t+1}^0 + N_{t+1}^1 = (1 - \chi_{t+1}^0)p_t\mathcal{S}(S_t)U_t + (1 - \chi_{t+1}^1)N_t. \quad (4)$$

⁸Mortensen and Pissarides (1994) assume that a new job always starts at the highest available productivity and is therefore never severed during the first period. As pointed by Caballero and Hammour (1996), this assumption is particularly suitable for growth models with creative destruction.

3.2 Intermediate firms

A new contact at time t will lead to job creation at time $t + 1$ if hit by an idiosyncratic productivity shock higher both than the reservation productivity $R_{t+1}^{F,0}$ for the intermediate firm and $R_{t+1}^{H,0}$ for the household. The reservation productivity for a new job is therefore given by $R_{t+1}^0 = \max\{R_{t+1}^{F,0}, R_{t+1}^{H,0}\}$ and the asset value of an intermediate firm with a vacancy, W_t^V , is:

$$W_t^V = -a + (1 - q_t)\tilde{\beta}_t \mathbb{E}_t [W_{t+1}^V] + q_t \tilde{\beta}_t \mathbb{E}_t \left[F(R_{t+1}^0) W_{t+1}^V + \int_{R_{t+1}^0}^{+\infty} W_{t+1}^{F,0}(z) dF(z) \right]. \quad (5)$$

a is the cost of opening a vacancy, firms discount expected future profits by $\tilde{\beta}_t$ (defined in the next section), and $W_t^{F,0}$ is the asset value of a new job. The asset value of an intermediate firm with a job of type $j \in \{0, 1\}$ and with a productivity x is:

$$W_t^{F,j}(x) = x d_t - w_t^j(x) + \tilde{\beta}_t \mathbb{E}_t \left[F(R_{t+1}^1) (W_{t+1}^V - f) + \int_{R_{t+1}^1}^{+\infty} W_{t+1}^{F,1}(z) dF(z) \right]. \quad (6)$$

d_t is the unit price of the intermediate goods, f the firing tax, R_t^1 the reservation productivity for an old job ($R_{t+1}^1 = \max\{R_{t+1}^{F,1}, R_{t+1}^{H,1}\}$) and $w_t^j(x)$ the wage. For the moment, we suppose a completely general wage formation mechanism $w_t^j : \mathfrak{R} \rightarrow \mathfrak{R} : x \rightsquigarrow w_t^j(x)$. The reservation productivity $R_t^{F,0}$ for a firm with a new contact is determined by:

$$W_t^{F,0}(R_t^{F,0}) = 0. \quad (7)$$

The firms with an old job have to pay a firing tax if the match is severed and their reservation productivity $R_t^{F,1}$ is therefore determined by:

$$W_t^{F,1}(R_t^{F,1}) + f = 0. \quad (8)$$

Finally, by the free entry condition, we also have:

$$W_t^V = 0. \quad (9)$$

3.3 Household

The representative household's welfare satisfies the following Bellmann equation⁹:

$$W_t^H = \max_{C_t, S_t} \{ \mathcal{U}(C_t) - \mathcal{D}^S(S_t)U_t - \mathcal{D}^N(N_t) + \beta \mathbb{E}_t [W_{t+1}^H] \}, \quad (10)$$

where C_t is consumption, \mathcal{U} is an increasing and concave utility function, \mathcal{D}^S and \mathcal{D}^N are increasing and convex disutility functions (respectively of search and work) and β is the subjective discount parameter. Defining the average wage for a job of type j by:

$$\bar{w}_t^j = \frac{\int_{R_t^j}^{+\infty} w_t^j(z) dF(z)}{1 - F(R_t^j)}, \quad (11)$$

the household's budget constraint then writes:

$$C_t = \Pi_t + w^u U_t + \bar{w}_t^0 N_t^0 + \bar{w}_t^1 N_t^1 + (r_t + \delta)K_t - (K_{t+1} - (1 - \delta)K_t) - T_t. \quad (12)$$

The profits redistributed by the intermediate firms (value added net of labor, firing and vacancy costs) are represented by Π_t , w^u stands for the unemployment benefit, K_t is the capital stock, δ its depreciation rate and T_t is a lump sum tax levied to finance the unemployment insurance. The optimization equation (10) is subject to the budget constraint (12) and equation (4)¹⁰.

For the household, the reservation productivity $R_t^{H,j}$ for a job of type j is determined by:

$$W_{N_t^j}^H(R_t^{H,j}) = 0, \quad (13)$$

where $W_{N_t^j}^H$ is the marginal contribution to household's welfare of working on a job of type j . The job destruction rate χ_t^j for a job of type j is $F(R_t^j)$. Moreover, the firms are owned by the household and the rate at which future profits should be discounted is given by:

$$\tilde{\beta}_t = \beta \mathbb{E}_t \left[\frac{\mathcal{U}_{C_{t+1}}}{\mathcal{U}_{C_t}} \right]. \quad (14)$$

3.4 Final firm

The asset value of the representative final firm satisfies the following Bellmann equation:

$$W_t = \max_{Q_t, K_{t+1}} \left\{ \mathcal{F}(K_t, Q_t) - (r_t + \delta)K_t - Q_t d_t + \tilde{\beta}_t \mathbb{E}_t [W_{t+1}] \right\}, \quad (15)$$

⁹As usual in most of the related literature, we assume a perfect insurance mechanism between the members of the household.

¹⁰The optimality conditions are detailed in the annex.

where \mathcal{F} is an increasing and concave in its arguments production function which moreover satisfies $\mathcal{F}(0, \cdot) = \mathcal{F}(\cdot, 0) = 0$, and Q_t is the quantity of intermediate goods¹¹. Intermediate goods supplied by intermediate firms with a job of type j is:

$$Q_t^j = \frac{\int_{R_t^j}^{+\infty} z dF(z)}{1 - F(R_t^j)} N_t^j, \quad (16)$$

and the total amount of intermediate goods is simply $Q_t = Q_t^0 + Q_t^1$.

3.5 Wage determination

We assume that, at each period, wages are (re)negotiated between the firms and the representative household. These bargained wages can be determined by a fairly standard Nash product problem. The wage $w_t^{b,0}(x)$ for new workers, not protected by a firing tax, is the solution of:

$$\max_{w_t^{b,0}(x)} \left(W_t^{F,0}(x) - W_t^V \right)^{1-\eta} \left(\frac{W_{N_t^0}^H(x)}{\mathcal{U}_{C_t}} \right)^\eta, \quad (17)$$

while the wage $w_t^{b,1}(x)$ for old workers is the solution of:

$$\max_{w_t^{b,1}(x)} \left(W_t^{F,1}(x) - W_t^V + f \right)^{1-\eta} \left(\frac{W_{N_t^1}^H(x)}{\mathcal{U}_{C_t}} \right)^\eta. \quad (18)$$

In both equations, η represents the household's bargaining power¹². Using equations (5) to (9), equations (10) to (13) and the definition of R_t^j , bargained wages can be rewritten in the general form:

$$w_t^{b,j}(x) = \eta(x - R_t^j)d_t + w_t^{b,j}(R_t^j). \quad (19)$$

We model wage rigidities by assuming that negotiated wages cannot fall below a lower bound w^m . The critical productivity value Q_t^j for which there is equality between the lower bound w^m and the freely bargained wage $w_t^{b,j}(x)$ is defined by:

$$w_t^{b,j}(Q_t^j) = w^m. \quad (20)$$

As a result, wages can be written as:

$$w_t^j(x) = \begin{cases} w^m & \text{if } x \leq Q_t^j, \\ w_t^{b,j}(x) & \text{if } x > Q_t^j, \end{cases} \quad (21)$$

¹¹See the annex for the optimality conditions.

¹²In these equations, the firm asset value is expressed in final good unit while the representative household's welfare is in utility unit. As for instance in Mertz (1995), we therefore divide the household's marginal welfare by the marginal utility of consumption, to normalize.

and the bargained wage equation (19) can be rewritten as:

$$w_t^{b,j}(x) = \eta(x - Q_t^j)d_t + w^m. \quad (22)$$

This equation shows that the lower bound w^m has a direct positive effect on bargained wages, but also an indirect negative effect *via* an increase in the critical value Q_t^j . It is easy to check that without a wage rigidity, *i.e.* when w^m is not binding, the decision to stop a match is jointly taken by the firm and the household; while if some wages are bounded downwards, the decision to stop a match is always taken by the firm¹³.

4 Calibration

The calibration is based on quarterly data, as in Mortensen and Pissarides (1999). The calibration is chosen to reproduce the stylized facts presented in section 2 for EU labor markets. The numerical values of the calibrated parameters are reported in table 3.

[INSERT TABLE 3]

We use the following specific functions:

$$\mathcal{F}(K, Q) = \bar{\varepsilon} (K)^\mu (Q)^{1-\mu}, \quad (23)$$

$$\mathcal{U}(C) = \ln(C), \quad (24)$$

$$\mathcal{M}(V, \mathcal{S}(S)U) = \bar{m} (V)^\lambda (\mathcal{S}(S)U)^{1-\lambda}, \quad (25)$$

$$\mathcal{S}(S) = \sigma_1 \frac{S^{\sigma_2}}{\sigma_2}, \quad (26)$$

$$\mathcal{D}^S(S) = \phi_1^S \frac{S^{\phi_2^S}}{\phi_2^S} \quad \text{and} \quad \mathcal{D}^N(N) = \phi_1^N \frac{N^{\phi_2^N}}{\phi_2^N}. \quad (27)$$

The depreciation rate δ of capital is set at 2.5% while the psychological discount factor β is 0.99, implying an annual interest rate of 4%. The aggregate productivity shock $\bar{\varepsilon}$ is normalized to 1; $\mu = 0.33$ yields a capital-output ratio around 9. Empirical estimates of the elasticity of matches with respect to unemployment are in the range of 0.5-0.7 for EU countries (see for instance Pissarides and Petrongolo, 2001). We choose an intermediate value $1 - \lambda = 0.6$. The household's bargaining power is set equal to the workers' parameter

¹³See the annex for additional properties.

of the matching function, *i.e.* $\eta = 1 - \lambda^{14}$. The cost of keeping a vacancy open is usually estimated to be small. We fix $a = 0.2$ which implies an average recruiting cost equal to 7% of the annual wage, a figure similar to Mortensen and Pissarides (1999).

Table 2 shows that the net replacement ratio is higher than 0.50 in most EU countries. This ratio must nevertheless be seen as an upper bound since it does not account for eligibility criteria and the effect of unemployment duration on benefit entitlements. In our model, we fix the replacement ratio to 0.43 which gives an unemployment benefit $w^u = 0.44$. The cost arising from employment protection is also expected to be high in EU countries but is more difficult to estimate. In our model, f is a firing tax which encompasses the cost of administrative procedurals, of social protests, *etc.* We therefore follow Mortensen and Pissarides (1999) who estimate this cost to be about three times as large as the cost of keeping a vacancy open and we set $f = 0.50^{15}$. Table 2 reports a gross Kaitz index above 0.50 in the EU countries. The net Kaitz index is therefore higher and we fix it to 0.58 in our model leading to a minimum wage level $w^m = 0.6$. This minimum wage implies that 14% of the employed workers are paid at the minimum wage (the OECD, 1998, reports for instance a figure of 11% for France in 1996) and a D9/D1 ratio of 2.5, which seems realistic enough.

Following Mortensen and Pissarides (1999), we assume that idiosyncratic shocks are uniformly distributed, so that: $F(x) = x$, $\forall x \in [0, 1]$. It remains to determine the 7 following parameters: \bar{m} , σ_i and ϕ_i^j , with $i \in \{1, 2\}$ and $j \in \{S, N\}$. By simplicity, we assume a quadratic (resp. linear) search (resp. work) disutility function and the slope parameters of the search efficiency and the search disutility functions are set to 1. \bar{m} , σ_2 and ϕ_1^N are finally determined so as to recover particular steady state values for the unemployment rate, the mean duration of the unemployment spell, and the job destruction rate. The chosen values imply an unemployment rate of 10.5% (close to the value observed, see table 1); and an average unemployment spell duration of 2.4 quarters. In their model calibrated on Europe, Mortensen and Pissarides (1999) use an average unemployment spell duration of 9 months, instead of 3 months in their calibration on US data. As shown in section 2, the average

¹⁴See for instance Andolfatto (1996) and Mertz (1995) for a similar assumption. Their motivation is that this so-called Hosios condition implies, in their simpler model, a competitive equilibrium of the decentralized economy equivalent to the equilibrium of the social planner's problem.

¹⁵We show in the annex that our results are still valid using different calibrations for f .

annual job turnover is estimated to be in between 15% and 25% in EU countries. Taking the mean value (20%) would imply an annual job destruction rate of 10%¹⁶ and therefore a quarterly job destruction rate of 2.5%. This figure however underestimates the true job destruction rate, because it does not take into account the jobs created and destroyed within the year. We thus set the job destruction rate $\chi^1 = 4\%$.

5 Simulations

In this section, we simulate our model and examine both steady state and dynamic properties. The focus is on the effects of labor market institutions on the unemployment rate and on job flows. The unemployment rate U_t is defined by equation (1). Using a uniform idiosyncratic shock distribution, the job destruction rate is given by $JD_t = R_t^1$, while the job creation rate JC_t is:

$$JC_t = \frac{(1 - R_t^0)M_{t-1}}{N_{t-1}}. \quad (28)$$

The job turnover JT_t and the net employment change NET_t are respectively the sum and the difference between these two rates:

$$JT_t = JCR_t + JDR_t, \quad (29)$$

$$NET_t = JCR_t - JDR_t = \frac{N_t - N_{t-1}}{N_{t-1}}. \quad (30)$$

5.1 Steady state effects

We focus on this subsection on the long-run, steady state effects of changes in our three institutional parameters (the unemployment benefit w^u , the lower bound w^m for the bargained wage and the firing tax f). The results are displayed in table 4 and figure 1.

[INSERT TABLE 4]

A 10% increase in the unemployment benefit reduces the household's search effort, thereby lengthening unemployment duration by 8.3%. This is in line with the result of Layard *et al.* (1991) according to which the elasticity of the unemployment duration to the unemployment benefit is estimated to be between 0.2 and 0.9. By strengthening the worker's

¹⁶At the steady state, the job creation is equal to the job destruction.

bargaining position, an increase in w^u has a direct positive impact on bargained wages. The destruction rate and the average wage increase, unemployment rises and output falls. We hence recover empirical and theoretical results showing a negative relationship between the unemployment benefit and the employment level.

A strengthening of the wage rigidities via a 10% increase in w^m has a positive effect on the job destruction rate and the fraction of workers paid at the minimum wage. The average wage increases, employment and output decrease.

The effect of *an increase in the firing tax* is known to be ambiguous: it decreases the job destruction rate, but also reduces job creation and increases unemployment duration. This, in turn, negatively affects the bargaining position of the worker and leads to a lower bargained wage. If wages are flexible (low w^m), this wage effect is sufficient to ensure a decrease in equilibrium unemployment. However, if wages are rigid (high w^m), the decrease in the bargained wage is no longer large enough and unemployment rises. We illustrate these interactions between f and w^m in figure 1. We reproduce the effects on the unemployment rate of a 10% increase in the firing tax, for different levels of the minimum wage. As in Cahuc and Zylberberg (1999), the effect is negative for low values of w^m , whereas it becomes positive for larger values. However, whatever the level of w^m , the quantitative effect of f on the unemployment rate is quite small.

[INSERT FIGURE 1]

5.2 Cyclical properties

We now focus on the effects of institutions on the cyclical properties of job flows. We introduce an autocorrelated aggregate productivity shock. In equation (23), $\bar{\varepsilon}$ is replaced by:

$$\varepsilon_t = \bar{\varepsilon}^{1-\gamma} \varepsilon_{t-1}^\gamma e^{u_t}, \quad (31)$$

where γ is the coefficient of autocorrelation and u_t is drawn from a normal distribution $N(0, \sigma^u)$. As in den Haan *et al.* (2000), we set $\gamma = 0.95$ and we calibrate $\sigma^u = 0.03$ in order to have realistic volatilities for the job flows. We linearize our model, using a first order

Taylor expansion¹⁷, and we simulate it during 10000 periods. Table 5 displays the main cyclical properties for the job flows¹⁸.

[INSERT TABLE 5]

The job flows are highly autocorrelated and, by calibration, their volatilities are similar to those observed in table 1, although the relative job destruction volatility may be somewhat too high for a European economy. We also obtain the job creation rate procyclicality (with respect to the net employment change) and the job destruction rate countercyclicality observed in the data. The job turnover is more acyclical, as seems to be the case in EU countries.

We vary our institutional parameters ($\pm 10\%$) and we evaluate their effects on the relative volatility of the job destruction rate and on the procyclicality of the job turnover rate.

[INSERT TABLE 6]

As shown in table 6, *unemployment benefit changes* have almost no effects on the cyclical properties of job flows. *Changes in wage rigidities* do however have substantial consequences. More wage rigidities leads to a lower relative volatility of the job destruction rate and, consequently, to a less countercyclical job turnover. The intuition is that, on the job destruction side, only low productivity jobs, paid at the exogenous minimum wage, are destroyed; the adjustments on this side of the labor market will thus be in quantities (job destruction rate) rather than in prices (exogenous minimum wage). On the job creation side, most jobs will be paid at a bargained wage, larger than the minimum wage, and the adjustments can go through both wages and job creation. In this context, an increase in the minimum wage will have little effect on the volatility of the job destruction rate, while on the job creation side, it will reduce the proportion of bargained wages and thereby increase the volatility of the job creation rate.

¹⁷We use the stochastic version of the software Dynare developed at CEPREMAP, Paris (see Juillard and Collard, 1999). Our results are similar if we use a second order Taylor expansion.

¹⁸In the annex, we report the same simulations but with fixed capital. We show it does not alter our qualitative results although flexible capital may magnify the effects of shocks. Moreover, we see that flexible capital is important if we want to retain a reasonable value for consumption volatility.

If *an increase in the firing tax* unambiguously reduces volatilities of job destruction and job creation rates, its effect on the relative value of these two volatilities is however ambiguous and depends on the level of the minimum wage (see figures 2 and 3). When wages are flexible, aggregate productivity shocks are partly absorbed by wage changes. With a minimum wage constraint, productivity shocks have larger effects on the job destruction rate, whose volatility increases (see before). Firing taxes thus have a much larger impact on the job destruction rate in a minimum wage economy, as it counteracts the effects of the wage rigidity. As a result, an increase in f combined with flexible wages leads to a higher relative job destruction volatility; while an increase in f combined with rigid wages leads to a lower relative job destruction volatility. Using a model with completely rigid wages, Garibaldi (1998) shows that increasing employment protection may explain the European labor market cyclical properties. We find the same results but we extend them by showing that these results are no more valid with flexible wages.

[INSERT FIGURES 2 AND 3]

6 Conclusion

We construct a stochastic intertemporal general equilibrium model to study the role of labor market institutions on the unemployment rate and on the cyclical properties of job creation and job destruction flows. Not surprisingly, we obtain that unemployment benefits and especially wage rigidities (taking the form of a lower bound on the negotiated wages), are able to explain high unemployment rate. We also obtain, as other authors, that firing taxes have small effects on the unemployment rate. The effects can be positive or negative depending on the level of the minimum wage. These steady states results are in line with recent empirical studies on labor market performances. Focusing on job flows, the model suggests that their cyclical properties depend crucially on the level of the wage rigidity. With a relatively high minimum wage, firing costs have a negative impact on volatility of the job destruction rate (with respect to the job creation rate volatility) and makes the job turnover rate less countercyclical. These effects are reversed if the minimum wage is relatively low. The interaction between minimum wage and firing restrictions thus seems to play a significant role in explaining the differences between EU and US labor markets.

These results suggest that further developing the model to introduce more sophisticated representations of wage rigidity and employment protection mechanisms is a worthwhile research venue. Our representation of wage rigidities remains much too simple compared to institutional features that characterize the wage setting process, in Europe. The specification adopted in this paper remains tractable and could serve as a useful starting point for future developments. Another way of improving this paper would be to take into account the complex protection employment device that associates long term protected jobs and short term unprotected jobs. As pointed out recently by Cahuc and Postel-Vinay (2002), these two policy instruments have conflicting effects on the job turnover rate and, according to our results, are likely to interact with wage rigidities.

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Country	JT	NET	$\sigma(JC)$	$\sigma(JD)$	$\sigma(JD)/\sigma(JC)$	$\text{corr}(JT, NET)$	U
Belgium	15.2%	0.2%	-	-	-	-	11.2%
France	24.4%	0.9%	1.7	0.9	0.5	> 0	9.9%
Germany	16.5%	1.5%	0.8	0.8	1.0	≈ 0	7.5%
Italy	21.0%	1.0%	1.2	0.9	0.7	≈ 0	9.3%
Netherlands	15.4%	1.0%	-	-	-	-	7.7%
United States	18.6%	2.6%	2.0	3.0	1.5	< 0	6.8%

Yearly data. JT : job turnover, average 1984-1991 (may vary according to the country), source: OECD (1996), table 5.1, p.163. NET : net employment change, average 1984-1991 (may vary according to the country), source: OECD (1996), table 5.1, p.163. $\sigma(JC)$: job creation standard deviation, average 1980's (may vary according to the country), HP filtered, source: Boeri (1996). $\sigma(JD)$: job destruction standard deviation, average 1980's (may vary according to the country), HP filtered, source: Boeri (1996). $\text{corr}(JT, NET)$: summary from OECD (1994), table 3.2, p.109. U : unemployment rate, average 1983-1993, source: OECD (1996), table 1.3, p.4.

Table 1: Job flows and unemployment: some empirical facts

Country	Repl. ratio	EPL strictness	Kaitz index	Wage dispersion
Belgium	0.70	2.1 (13)	0.53	2.2
France	0.52	3.0 (21)	0.55	3.3
Germany	0.63	2.5 (18)	-	2.3
Italy	0.13	3.3 (23)	-	2.8
Netherlands	0.76	2.1 (14)	0.51	2.6
United States	0.32	0.2 (1)	0.35	4.4

Repl. ratio: synthetical net replacement ratio, 1999, source: OECD (2002), table 3.10, p.41. EPL strictness: synthetical index of the strictness of employment protection legislation and country ranking (between brackets), late 1990's, source: OECD (1999), table 2.5, p.66. Kaitz index: gross Kaitz index, mid-1997, source: OECD (1998), table 2.3, p.37. Wage dispersion: gross D9/D1 ratio, 1995 (may vary according the country), source: OECD (1996), table 3.1, p.62.

Table 2: Labor market institutions: some empirical facts

Symbol	Value	Symbol	Value
Matching function			
\bar{m}	0.60	λ	0.4
Production function			
$\bar{\varepsilon}$	1	μ	0.33
Search function			
σ_1	1	σ_2	0.55
Disutility functions			
ϕ_1^S	1	ϕ_2^S	2
ϕ_1^N	0.16	ϕ_2^N	1
Costs			
a	0.20	f	0.50
Wages determination			
η	0.60	w^u	0.44
w^m	0.60		
Discount and depreciation			
β	0.99	δ	0.025

Table 3: Numerical parameter values

	\mathcal{F}	JT	U	pop w^m	U duration	\bar{w}
benchmark	1.43	9.8%	10.5%	14.5%	2.4	1.03
w^u (+10%)	-2.0%	+2.1	+2.6	-1.0	+8.3%	+0.5%
w^m (+10%)	-4.0%	+6.8	+6.9	+4.6	+5.7%	+1.6%

pop w^m : percentage of the workers paid at the lower bound wage. U duration: mean unemployment spell duration (expressed in quarters). \bar{w} : mean wage.

Table 4: Long run effects of institutional shocks (deviations from the benchmark)

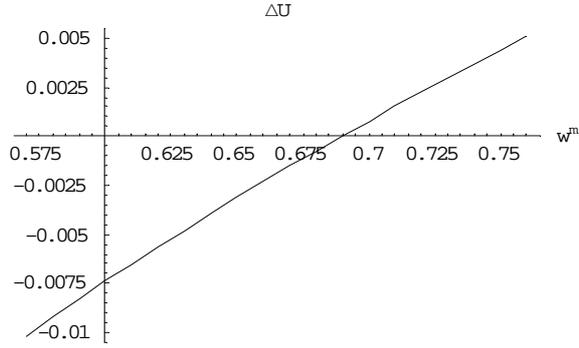


Figure 1: Effect on unemployment of a firing tax 10% increase, for different values of w^m

	JC_t	JD_t	JT_t
$AR(1)$	0.88	0.69	0.89
σ	0.82	1.00	1.50
$\text{corr}(., NET_t)$	0.46	-0.68	-0.21

All series are HP filtered. $AR(1)$: autocorrelation of order 1. σ : standard deviation. $\text{corr}(., NET_t)$: correlation with respect to net employment change.

Table 5: Cyclical properties of job flows in reference calibration

$w^u =$	0.40	0.42	0.44	0.46	0.48
$\sigma(JD_t)/\sigma(JC_t)$	1.22	1.21	1.22	1.21	1.21
$\text{corr}(JT_t, NET_t)$	-0.21	-0.21	-0.21	-0.20	-0.19
$w^m =$	0.54	0.57	0.60	0.63	0.66
$\sigma(JD_t)/\sigma(JC_t)$	1.28	1.26	1.22	1.18	1.12
$\text{corr}(JT_t, NET_t)$	-0.27	-0.24	-0.21	-0.16	-0.12

All series are HP filtered. σ : standard deviation. $\text{corr}(., NET_t)$: correlation with respect to net employment change.

Table 6: Sensitivity of cyclical properties to w^u and w^m

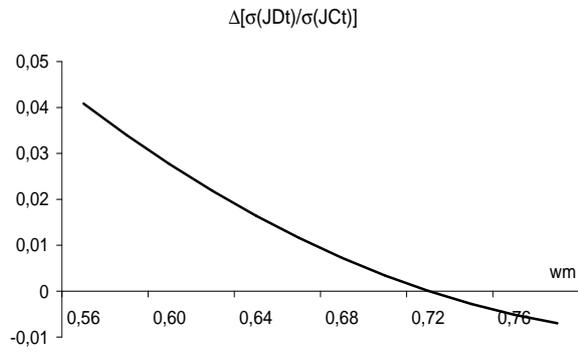


Figure 2: Effect on the relative job destruction rate volatility of a firing tax 10% increase, for different values of w^m

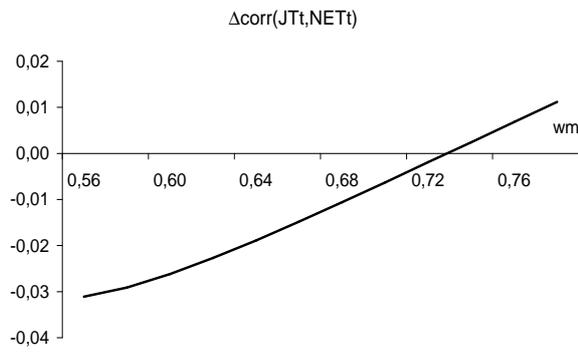


Figure 3: Effect on the job turnover cyclicality of a firing tax 10% increase, for different values of w^m

Appendix

Optimality conditions

Household

The first order optimality conditions are:

$$\mathcal{U}_{C_t} = \beta \mathbb{E}_t [(1 + r_{t+1}) \mathcal{U}_{C_{t+1}}], \quad (32)$$

$$\mathcal{D}_{S_t}^S = \beta p_t \mathcal{S}_{S_t} \mathbb{E}_t \left[\int_{R_{t+1}^0}^{+\infty} W_{N_{t+1}^0}^H(z) dF(z) \right]. \quad (33)$$

\mathcal{U}_{C_t} is the first derivative of \mathcal{U} with respect to C_t , $\mathcal{D}_{S_t}^S$ the first derivative of \mathcal{D}^S with respect to search intensity S_t . The marginal contribution $W_{N_t^j}^H$ to household's welfare of working on a job of type j , is given by the envelope theorem:

$$\begin{aligned} W_{N_t^j}^H(x) = & \mathcal{U}_{C_t}(w_t^j(x) - w^u) + \mathcal{D}^S(S_t) - \mathcal{D}_{N_t^j}^N + \\ & \beta(1 - p_t \mathcal{S}(S_t)) \mathbb{E}_t \left[\int_{R_{t+1}^1}^{+\infty} W_{N_{t+1}^1}^H(z) dF(z) \right], \end{aligned} \quad (34)$$

where $\mathcal{D}_{N_t^j}^N$ is the first derivative of \mathcal{D}^N with respect to a job of type j .

Final firm

The first order optimality conditions can be written as follows:

$$\mathcal{F}_{K_t} = r_t + \delta, \quad (35)$$

$$\mathcal{F}_{Q_t} = d_t. \quad (36)$$

Wages properties

Using some arithmetic, we can derive several analytical properties. Firstly, it is easy to check that without wage rigidity, *i.e.* when w^m is not binding, the decision to stop a match is jointly taken by the firm and the household. In other words:

$$\text{if } Q_t^j \leq R_t^j \quad \text{then} \quad R_t^{F,j} = R_t^{H,j} = R_t^j.$$

On the other hand, if some wages are bounded downwards, the decision to stop a match is always taken by the firm:

$$\text{if } Q_t^j > R_t^j \quad \text{then} \quad R_t^{H,j} = -\infty \quad \text{and} \quad R_t^{F,j} = R_t^j.$$

Secondly, we have the following relationships between the reservation productivity R_t^j , the critical values Q_t^j and the bargained wages $w_t^{b,j}(x)$, of the new jobs and the old jobs:

$$(R_t^0 - R_t^1)d_t = f, \quad (37)$$

$$Q_t^1 - R_t^1 = Q_t^0 - R_t^0, \quad (38)$$

$$w_t^{b,1}(x) - w_t^{b,0}(x) = \eta f. \quad (39)$$

We obtain that the firing tax increases the difference both between the two job destruction rates and the two wages. Moreover the distance between R_t and Q_t is identical in new firms and old firms.

General cyclical properties

In the first columns of table 7, we report the cyclical properties of consumption, investment, labor and output. We see that our model is able to reproduce stylized facts about the behavior of these variables. We also do the same simulations than in the paper but with fixed capital instead of variable capital (see last columns of table 7, and tables 8, 9, 10). We see that introducing variable capital allows to better reproduce the cyclical properties of consumption (consumption is much too volatile with fixed capital) and also allows to magnify the effects of the shocks.

	C_t	I_t	N_t	\mathcal{F}_t	C_t	I_t	N_t	\mathcal{F}_t
	Variable capital				Fixed capital			
$AR(1)$	0.77	0.81	0.90	0.79	0.78	-	0.90	0.78
σ	0.51	3.08	0.52	1	1.47	-	0.48	1
$corr(., \mathcal{F}_t)$	0.97	0.99	0.94	1	1	-	0.94	1

All series are HP filtered. $AR(1)$: autocorrelation of order 1. σ : standard deviation. $corr(., \mathcal{F}_t)$: correlation with respect to output. I_t : investment.

Table 7: Cyclical properties in reference calibration

	\mathcal{F}	JT	U	pop w^m	U duration	\bar{w}
benchmark	1.43	9.8%	10.5%	14.5%	2.4	1.03
w^u (+10%)	-1.1%	+1.8	+2.4	-1.2	+6.7%	+1.0%
w^m (+10%)	-2.2%	+6.1	+5.9	+4.0	+2.8%	+2.1%

pop w^m : percentage of the workers paid at the lower bound wage. U duration: mean unemployment spell duration (expressed in quarters). \bar{w} : mean wage.

Table 8: Long run effects of institutional shocks (deviations from the benchmark) with fixed capital

	JC_t	JD_t	JT_t
$AR(1)$	0.87	0.69	0.89
σ	0.81	0.99	1.49
$\text{corr}(\cdot, NET_t)$	0.43	-0.67	-0.21

All series are HP filtered. $AR(1)$: autocorrelation of order 1. σ : standard deviation. $\text{corr}(\cdot, NET_t)$: correlation with respect to net employment change.

Table 9: Cyclical properties of job flows in reference calibration, with fixed capital

$w^u =$	0.40	0.42	0.44	0.46	0.48
$\sigma(JD_t)/\sigma(JC_t)$	1.23	1.22	1.22	1.22	1.22
$\text{corr}(JT_t, NET_t)$	-0.22	-0.22	-0.21	-0.21	-0.20
$w^m =$	0.54	0.57	0.60	0.63	0.66
$\sigma(JD_t)/\sigma(JC_t)$	1.29	1.25	1.22	1.20	1.16
$\text{corr}(JT_t, NET_t)$	-0.28	-0.24	-0.21	-0.18	-0.15

All series are HP filtered. σ : standard deviation. $\text{corr}(\cdot, NET_t)$: correlation with respect to net employment change.

Table 10: Sensitivity of cyclical properties to w^u , w^m and f , with fixed capital

Results sensitivity to different calibrations for f

In figures 4, 5 and 6, we reproduce the effects on the unemployment rate and on the cyclical properties of the job flows, of a 10% increase in w^m , but for different values of f . We see that, whatever the calibration of f , a rise in the minimum wage always increases the unemployment rate and decreases the relative volatility of the job destruction rate.

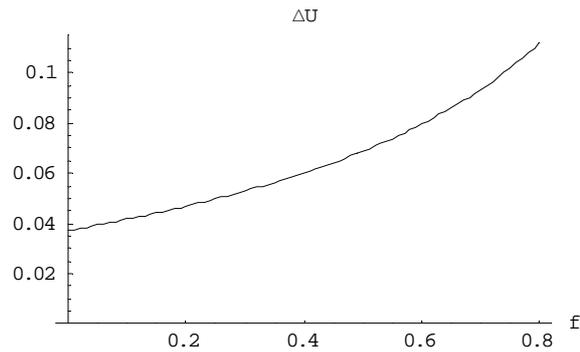


Figure 4: Effect on unemployment of a minimum wage 10% increase, for different values of f

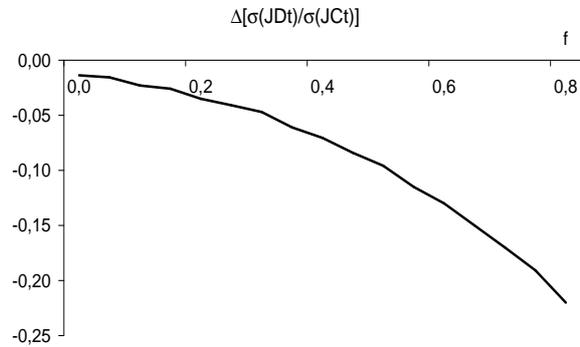


Figure 5: Effect on the relative job destruction rate volatility of a minimum wage 10% increase, for different values of f

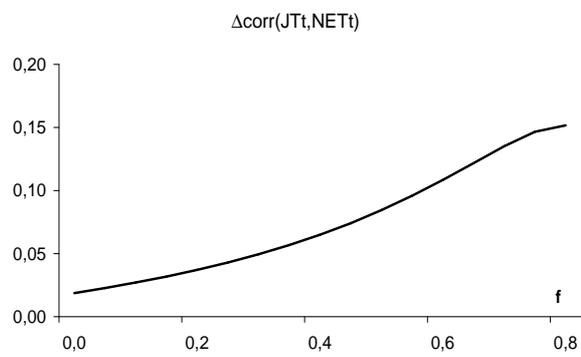


Figure 6: Effect on the job turnover cyclicality of a minimum wage 10% increase, for different values of f