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Job Protection, Minimum Wage and Unemployment

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ABSTRACT

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We analyze how wage setting institutions and job-security provisions interact on unemployment. The assumption that wages are renegotiated by mutual agreement only is introduced in a matching model with endogenous job destruction *à la* Mortensen and Pissarides (1994) in order to get wage profiles with proper microfoundations. Then, it is shown that job protection policies influence the wage distribution and that government mandated severance transfers from employers to workers are not any more neutral, as in the standard matching model where wages are continuously renegotiated: In our framework high redundancy transfers influence employment. Moreover, the assumption of renegotiation by mutual agreement allows us to introduce a minimum wage in a coherent way, and to study its interactions with job protection policies. Our computational exercises suggest that redundancy transfers and administrative dismissal restrictions have negligeable unemployment effects when wages are flexible or when the minimum wage is low, but a dramatic positive impact on unemployment when there is a high minimum wage.

JEL Classification: H29, J23, J38, J41, J64

Keywords: Unemployment, job protection, minimum wage, matching models, renegotiation

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1 Introduction

Much attention has been devoted to the analysis of the consequences of labor market flexibility during recent years. Job protection is known to reduce both job destruction and creation. It is possible to distinguish three classes of models that are utilized to analyze the consequences of job protection —see Ljungqvist (1998) for a slightly different classification. The first class of models represents the behavior of a firm, subject to idiosyncratic productivity shocks and adjustment cost of labor, and facing an exogenous wage —Bentolila and Bertola (1990), Bertola (1990), Bentolila and Saint-Paul (1992). The second class of models extends the analysis of the firm subject to idiosyncratic shocks to a general equilibrium framework, where a continuum of identical consumers choose their labor supply and consumption —Hopenhayn and Rogerson (1993). In this model, a rise in firing costs, which are redistributed to the consumers in the form of lump-sum transfers, corresponds to a distortion that decreases the returns of labor, giving rise to a decrease in labor supply, and eventually to a drop of employment. The last class of models considers in more detail costs associated to the match formation and takes the job —and not the firm— as the unit of analysis —Mortensen and Pissarides (1994, 1997), Garibaldi (1998), Cabrales and Hopenhayn (1998). Once created, a job gives rise to a rent which is shared between the worker and the employer, and the productivity of each job is subject to idiosyncratic shocks. This approach has the advantage to consider search costs, with endogenous wages and job destruction in a closed equilibrium model of the labor market. Every class of models provides the same type of prediction: A more stringent employment protection has an ambiguous impact on the level of overall employment, because it reduces both job creation and destruction.

The aim of our paper is to show that taking into account the interaction between wage setting and job protection policies helps understanding their consequences on job flows and employment. Indeed, the comparison of job flows in countries with flexible and rigid labor market —North America *versus* Continental Europe— is quite disturbing, since it shows job flows with the same order of magnitude. Bertola and Rogerson (1997) claim that such a similarity might stem from other differences in labor market institutions than job protection policies. They argue that the wage compression due to a much more centralized wage setting in Europe inspired by the 'equal pay for equal work' principle might be an important element that fosters job destruction and creation. The idea that unemployment and jobs flows are the product of interacting institutional features of the labor market is far from being new —see Coe and Snower (1997) for a recent account—, but is also far from being completely explored. In particular, to our knowledge, it appears that the interaction between job protection and the minimum wage, although often evoked —see e.g. Blanchard, 1998, Mortensen and Pissarides (1997)— has not attracted much attention. Yet, this is a paramount problem, since an important proportion of unskilled and young workers are paid the minimum wage in Europe, and it is for those workers that the unemployment problem is the most stringent —Dolado *et alii* (1996) and Abowd, Kramarz and Margolis (1998).

More precisely, the aim of our paper is to analyze the interaction between minimum wage and job protection policies in a dynamic search and matching framework *à la* Mortensen and Pissarides (1994). We think that several reasons justify that it is worth studying such a problem. First, on many aspects, the Mortensen and Pissarides model is well adapted to analyze the consequences of job protection: Wages, job creations and destructions are endogenous and transactions costs on the labor market are taken into account in a framework that is very tractable. But wage flexibility plays a very important role when Mortensen and Pissarides (1997) find a negative relationship between firing costs and unemployment. In their model, a rise in firing costs leads to a decrease in wages, which are assumed to be negotiated, allowing to soften the impact on profits, and then on job creation and destruction. Accordingly, one would expect job protection to be less favorable to employment when a minimum wage is binding. Second, the assumption that wages are always negotiated without any institutional constraint implies that redundancy payments do not influence neither unemployment nor job flows. Therefore, although the consequences of firing taxes and administrative dismissal restrictions are well documented —Garibaldi (1998)—, it is usual to claim that the sole effect of redundancy payments is to lower the wages —Lazear (1990) and Burda (1992). This is a drawback, since many workers concerned by job protection get either the minimum wage or a wage close to the minimum wage. An obvious and easy way to deal with such a drawback is to assume exogenous wages. But, this is not completely satisfying, because job protection policies can influence wages. Thus, it is better to introduce a minimum wage in a framework where wages are endogenous. This approach allows us to show that the impact of redundancy payments on unemployment and welfare depends on the minimum wage level in a non trivial way. In particular, redundancy payments can have very different effects when a minimum wage is binding: They can imply increases in employment and welfare in some circumstances and decreases in others. However, calibration exercises suggest that job protection is much more unfavorable to employment when a high minimum wage is binding.

Actually, introducing a minimum wage in a matching model where wages are negotiated is not straightforward. In the standard matching model of the labor market, wages are assumed to be renegotiated at all times. But this assumption is questionable. It implies a very flexible wage that fluctuates according to the shocks that hit the jobs. Moreover, the initial wage can be negative —which means that there is a bond left by the worker— if there are firing costs. Mortensen and Pissarides (1997) get rid of this problem by assuming that the wages are not renegotiated until a shock hits the jobs. Taking this direction, we assume that labor contracts specify a fixed wage that can be renegotiated by mutual agreement only. Such an assumption is worth at least for two reasons. First, it appears to be an important feature of labor contracts in England and in Continental Europe —Malcomson (1997). Second it can be justified by non-cooperative game theory in an environment where the idiosyncratic components of a job are not verifiable —see Mac Leod and Malcomson (1993) and Malcomson (1997). Indeed, if the information is unverifiable, many contract provisions may be unenforceable because a court does not have the information necessary to enforce them. In this context, a contract that specifies a fixed wage only is easy to enforce. Moreover, non-cooperative game theory shows that the contract can be renegotiated by mutual agreement only. The reason for this is very intuitive: An employer should agree to renegotiate a fixed-wage contract when a worker claims a wage increase only if he knows that the worker prefers to leave than going on to work at the current wage; in any other circumstances the employer should refuse the workers' claims. The same argument applies to the situation of a worker who faces a employer who wants a wage drop. Accordingly, the fixed-wage contract can be renegotiated by mutual agreement only, *i.e.* if the employer or the worker prefers to quit than going on at the current wage.

The assumption of fixed-wage contract renegotiated by mutual agreement only has important consequences. It allows us to yield plausible wage profiles and then to introduce the minimum wage in a coherent way. It also implies that job protection policies influence wage profiles: A more stringent job protection diminishes the frequency of downwards wage renegotiations. Moreover, our assumption about renegotiations yields new predictions on the influence of redundancy payments on employment even when a minimum wage is not binding: It will be shown that low redundancy payments are neutral, as in the standard search-matching model, but that a high level of redundancy payment influences employment.

The paper is organized as follows. Section two is devoted to the presentation of the model. The economy with a flexible wage is analyzed in section three and a minimum wage is introduced in section four. The consequences of job protection are studied in section five. Section six provides some concluding comments.

2 The model

We consider a continuous time equilibrium search and matching model *à la* Mortensen and Pissarides (1994). We begin to present the features of jobs and workers before paying some attention to the definition of profits and expected utilities.

2.1 Jobs, unemployment and production

There are two goods: Labor, which is the sole input, and a numéraire good produced and consumed. There is a continuum of infinite lived individuals, which size is denoted by ℓ. Each worker supplies one unit of labor and can be either employed and producing or unemployed and searching for a job. For the sake of simplicity, every unemployed worker gets the same income per unit of time, denoted by z. An endogenously sized continuum of competitive firms produce the numéraire good thanks to labor. Each firm has one job that can be either filled and producing or vacant and searching. The cost of a vacant job per unit of time is denoted by h.

Transaction costs imply that vacant jobs and unemployed workers are matched together in pairs through an imperfect matching process. The rate at which vacant jobs and unemployed workers meet is determined by the matching function $M(v \cdot \ell, u \cdot \ell)$

where v and u represent the vacancy and unemployment rates respectively. The matching function satisfies the standard properties: It is increasing, continuously differentiable, homogenous of degree one, and yields no hiring if the mass of unemployed workers or the mass of vacant jobs is nil. The linear homogeneity of the matching function allows us to write the transition rate for vacancies as $M(v \cdot \ell, u \cdot \ell)/v \cdot \ell = M(1, u/v) \equiv m(\theta)$, where $\theta \equiv v/u$ is the labor market tightness. Similarly, the job finding rate is given by $\theta m(\theta) \equiv M(v \cdot \ell, u \cdot \ell)/u \cdot \ell$. The properties of the matching function imply that $m(\theta)$ and $\theta m(\theta)$ are decreasing and increasing respectively.

Each job is endowed with an irreversible technology requiring one unit of labor to produce ε units of output, where ε is a random, job-specific, productivity parameter drawn from a distribution $G(x) : \Omega \to [0, 1]$. Ω is a subset of $\mathbb{R}$ with a finite upper support ε_u and $G(x)$ has no mass point. Every new job starts with the highest productivity ε_u. On every continuing job, productivity changes according to a Poisson process with arrival rate λ. When there is a change, the new value of ε is a drawing from the distribution $G(x)$. There is an endogenous threshold value of the productivity, denoted by ε_d, below which a job is destroyed. Thus, the job destruction rate follows a Poisson process with parameter $\lambda G(\varepsilon_d)$.

Assuming that entrants on the labor market begin to search for a job, the matching technology and the job destruction process imply that the law of motion of the unemployment rate is

$$\dot{u} = g_\ell + \lambda G(\varepsilon_d)(1 - u) - u \left[\theta m(\theta) + g_\ell\right], \tag{1}$$

where g_ℓ stands for the rate of growth of the labor force. In a steady state, where g_ℓ is constant, the unemployment rate can be written as

$$u = \frac{\lambda G(\varepsilon_d) + g_\ell}{\theta m(\theta) + \lambda G(\varepsilon_d) + g_\ell}. \tag{2}$$

The matching technology and the job destruction process also influence the level of aggregate production. The law of motion of the mass of jobs that have been hit by a shock, denoted by n_s, is defined by the equation $\dot{n}_s = \lambda \left[1 - G(\varepsilon_d)\right] n_h - \lambda G(\varepsilon_d) n_s$, where

n_h stands for the mass of jobs that have not been hit by a shock. From this equation, one gets the proportion of new jobs not hit by a shock in a stationary state, which is equal to: $n_h/(n_s+n_h) = G(\varepsilon_d)$. Thus, the average production per filled job is $G(\varepsilon_d)\varepsilon_u + \int_{\varepsilon_d}^{\varepsilon_u} xdG(x)$, and the aggregate income per member of the labor force, which is equal to the sum of the production of filled jobs and the outcome of unemployed workers less the cost of vacant jobs, amounts to

$$Y = \left[\varepsilon_u + \int_{\varepsilon_d}^{\varepsilon_u} (x - \varepsilon_u)dG(x)\right](1-u) + u\left[z - h\theta\right]. \tag{3}$$

It is worth noting that aggregate output is a measure of social welfare, since it is assumed that individuals are risk-neutral.

The matching model shows that the unemployment rate and the level of production depend on the rate of job destruction, on the labor market tightness and the growth of the labor force. The equilibrium values of these variables are influenced by the expected incomes that employers and workers get on the labor market. It is then worth paying some attention to the expected payoffs on the labor market.

2.2 Job value and expected incomes

A vacant job costs h per unit of time and is filled at rate $m(\theta)$. The asset value of a vacancy, denoted by Π_v, satisfies

$$r\Pi_v = -h + m(\theta)\left[\Pi(\varepsilon_u, w_0) - \Pi_v\right], \tag{4}$$

where r is the exogenous interest rate and $\Pi(\varepsilon_u, w_0)$ the asset value of a job with productivity ε_u that pays a wage w_0. The free-entry condition reads as:

$$\Pi_v = 0. \tag{5}$$

The expected value of the stream of income of an unemployed worker satisfies:

$$rV_u = z + \theta m(\theta)\left[V(w_0) - V_u\right], \tag{6}$$

where z is the exogenous value of unemployment income and $V(w_0)$ stands for the expected value of the stream of income of worker paid a wage bargained on new matches, denoted by w_0.

The asset value of a job with current idiosyncratic component ε and offering a wage w_0, denoted by $\Pi(\varepsilon, w_0)$, satisfies

$$r\Pi(\varepsilon, w_0) = \varepsilon - w_0 + \lambda \left[\Pi_\lambda - \Pi(\varepsilon, w_0)\right], \tag{7}$$

where Π_λ denotes the expected discounted profit if a shock occurs.

The expected present value, $V(w_0)$, of the stream of incomes of a worker payed a wage w_0 satisfies

$$rV(w_0) = w_0 + \lambda \left[V_\lambda(w_0) - V(w_0)\right], \tag{8}$$

where $V_\lambda(w_0)$ denotes the expected discounted stream of incomes of a worker payed a wage w_0 if a shock occurs.

If the minimum wage is not binding, the starting wage is negotiated according to a Nash sharing rule which provides a share $\gamma \in [0, 1]$ of the surplus generated by a new match to the worker. Every new match yields a surplus which is equal to the sum of the expected present value of the workers' and the employers' future income on the job less the expected present value of their income in case of separation. An employer who accepts to be matched with a worker gets $\Pi(\varepsilon_u, w_0)$ and obtains the asset value of a vacant job, Π_v, if he refuses. A new matched worker gets an expected income $V(w_0)$, but stays unemployed otherwise, and gets an expected income V_u. Accordingly, the surplus value of a new match is

$$S_0 = \Pi(\varepsilon_u, w_0) - \Pi_v + V(w_0) - V_u, \tag{9}$$

and on every new match the sharing rule reads as:

$$V(w_0) - V_u = \gamma S_0, \;\; \Pi(\varepsilon_u, w_0) - \Pi_v = (1-\gamma) S_0. \tag{10}$$

Since the seminal contributions of Binmore, Rubinstein and Wolkinsky (1986) and Osborne and Rubinstein (1990), it has been well known that the Nash sharing rule can be derived from strategic bargaining games. A simple game that yields the Nash sharing in our particular framework is presented in appendix 1.

2.3 Wage renegotiation

Defining the renegotiation process requires to give some precisions about wage setting. It is assumed that wages can be negotiated within each firm. In order to get rid of the usual assumption that wages are continuously renegotiated or that they are chosen so as to share at all times the surplus from a job match, we assume that the employer and the employee agree on a fixed wage which can be renegotiated by mutual agreement only. The renegotiation can be initiated either by the employer or by the employee. It is assumed that only *employer-initiated separations* give rise to firing costs —on this point, see the enlightening paper of Mc Laughlin (1991)— denoted by f, which have two components. The first one is a payment to the worker, denoted by f_w, and the second one, denoted by f_g, is a tax payed to the government. This tax represents the set of administrative restrictions and procedures that the employer has to obey if he wants to fire a worker. Hence, one always has $f = f_w + f_g$.

In appendix 1, we provide a strategic renegotiation game which outcome implies that an employer-initiated renegotiation can occur if a productivity drop leads to a profit decrease such that the employer prefers to fire the worker than going on with the current wage. Similarly, an employee-initiated renegotiation may occur if an improvement of the outside option of the employee implies that he prefers to quit than abiding by the current contract. In our model, only employer-initiated renegotiations can occur, because the outside option of the employee is stationary, equal to V_u in case of quit. Since there are only employer-initiated renegotiations wages can be renegotiated downwards only, a property that may seem questionable at first glance, since the largest share of renegotiations result in real wage increases —Mc Laughlin (1994). However, it should be remarked that assuming a positive growth rate of productivity would necessarily entail upwards wage renegotiations on the jobs with sufficient durations. We avoid taking into account productivity growth, because it would complicate the presentation of the model without changing our results about the consequences of job protection and minimum wage.

Since renegotiations are employer-initiated, a disagreement during the negotiation leading to a job destruction should be interpreted as an employer-initiated separation, giving rise to firing costs. Obviously, the worker will accept a renegotiation leading to a wage decrease only if he can get a higher expected income by renegotiating the contract than by being fired and getting the redundancy payment f_w. Such a situation can occur only if $V(w_0) > V_u + f_w$, because the workers always prefers being fired than renegotiating if $V(w_0) \leq V_u + f_w$. Using the definition of the asset value of a vacancy (4), the free-entry condition (5) and the sharing rule (10), this condition implies that the starting wage can be renegotiated only if:

$$\frac{\gamma h}{(1-\gamma)m(\theta)} > f_w. \tag{11}$$

One sees that a large redundancy payment to the worker may prevent any renegotiation. If condition (11) holds, the employer may initiate a renegotiation of the starting wage only if he gets an expected profit $\Pi(\varepsilon, w_0)$ lower than the firing cost, because otherwise job destruction would not be a credible threat, and the worker would never accept to renegotiate the contract. Computing $\Pi(\varepsilon, w_0)$ allows us to derive the expression for the threshold value of productivity below which the starting wage may be renegotiated. From the definition (7) of the asset value of a job offering a wage w_0, one gets, by computing the difference between $\Pi(\varepsilon, w_0)$ and $\Pi(\varepsilon_u, w_0)$:

$$\Pi(\varepsilon, w_0) = \frac{\varepsilon - \varepsilon_u}{r+\lambda} + \Pi(\varepsilon_u, w_0). \tag{12}$$

Equation (12) shows that $\Pi(\varepsilon, w_0)$ increases with ε. Therefore, the employer may offer to renegotiate the wage if the productivity is lower than a unique threshold value of the productivity below which the expected profit is smaller than the firing cost. The threshold value, denoted by ε_r, must solve $\Pi(\varepsilon_r, w_0) = -f$. The surplus sharing rule (10), together with the free-entry condition (5), implies that (12) allows us to write the threshold value below which the starting wage may be renegotiated as:

$$\varepsilon_r = \varepsilon_u - (r+\lambda)\left[f + \frac{h}{m(\theta)}\right]. \tag{13}$$

This expression for the threshold value shows that renegotiation of the starting wage are less frequent when firing costs are high, because in such a case the employer can threat to fire a worker who would disagree to renegotiate the starting contract only if the productivity is very low.

If the starting wage is renegotiated, renegotiated wages may also be renegotiated. Every renegotiation provides a share γ of the surplus of a continuing job to the worker. A continuing job yields a surplus which is equal to the sum of the expected present value of the workers' and the employers' future income on the job less the value of their future income in case of separation. Since any separation is necessarily initiated by employers, the presence of firing costs implies that the expression of the surplus of a new match is different from the expression of the surplus of a continuing job, because the cost of separation includes firing costs in the latter case. On every continuing job with current productivity ε an employer gets $\Pi(\varepsilon, w)$, and obtains $\Pi_v - f$ in case of separation. Likewise, a worker gets an expected future income equal either to $V(w)$, and obtains only $V_u + f_w$ if he is separated and then unemployed. Accordingly, the value of the surplus of a continuing job with productivity ε is:

$$S(\varepsilon) = V(w) - V_u + \Pi(\varepsilon, w) - (\Pi_v - f_g). \tag{14}$$

It is worth noting that the value of the surplus is independent of the wage since it does not hinge on the sharing rule. Moreover, there is a simple relation between the surplus of a starting job and the surplus of a continuing job. From (9) and (14), one gets

$$S_0 = S(\varepsilon_u) - f_g. \tag{15}$$

This relation shows that the surplus of a starting job is smaller than the surplus of a continuing job with idiosyncratic component ε_u because there is a firing tax which implies that the cost of separation on a continuing job is higher than on a new match. Using the definitions of the surplus on a continuing job, of the expected income and profits, it can easily be shown —see appendix 2— that the value of the surplus of a continuing job with idiosyncratic component ε satisfies the following asset pricing equation:

$$(r+\lambda)S(\varepsilon)=\varepsilon-z-\frac{\gamma h\theta}{(1-\gamma)}+rf_g+\lambda\int_{\varepsilon_d}^{\varepsilon_u}S(x)dG(x), \tag{16}$$

where ε_d stands for the threshold value of productivity below which jobs are destroyed.

One sees that the surplus is forward looking: It does not depend on the wage previously negotiated. Moreover, the surplus increases with the idiosyncratic component and with the firing tax, which effect is to raise the cost of job destruction.

When wages are renegotiated, firing costs are always payed by the employer in case of separation. Thus, the sharing rule on any continuing job with productivity ε defines a wage $w(\varepsilon)$ that satisfies

$$V\left[w(\varepsilon)\right]-(V_u+f_w)=\gamma S(\varepsilon),\ \Pi(\varepsilon,\varepsilon)-(\Pi_v-f)=(1-\gamma)S(\varepsilon). \tag{17}$$

A wage $w(y)$, negotiated when the productivity was y, may be renegotiated if the employer gets a lower discounted profit than the firing costs by abiding by the contract stipulating a wage $w(y)$. From equation (7), the asset value of a job with a wage $w(y)$ and idiosyncratic component ε can be written as

$$\Pi\left[\varepsilon,w(y)\right]=\frac{\varepsilon-y}{r+\lambda}+\Pi\left[y,w(y)\right]. \tag{18}$$

This asset value increases with ε. Therefore, there exists a unique threshold value of the productivity on a job with a wage $w(y)$, below which the asset value is smaller than the firing cost. This threshold value, denoted by $\varepsilon_r(y)$, satisfies $\Pi\left[\varepsilon_r(y),w(y)\right]=-f$. The profit $\Pi\left[y,w(y)\right]$ can be computed from the sharing rule (17), the definition of the surpluses (16), (15) and the free-entry condition (5). Substituting the value of $\Pi\left[y,w(y)\right]$ in (18) and using the definition (13) of ε_r allows us to write the threshold value as follows:

$$\varepsilon_r(y)=\varepsilon_r-\gamma(\varepsilon_u-y)+(r+\lambda)(\gamma f_g+f_w). \tag{19}$$

This equation shows that the wage is renegotiated if the new value of the productivity is low with respect to the value of the productivity for which the current wage has been negotiated. One can check that $\varepsilon_r(y) < \varepsilon_r$ if condition (11) is fulfilled.

The definition of the payoffs obtained on the labor market allows us to analyze the consequences of job protection on unemployment and welfare in different institutional environments. We will begin to look at a situation with flexible wages before introducing a minimum wage.

3 Equilibrium with flexible wages

In this section, we describe the job creation and destruction process that yields the equilibrium value of the labor market tightness and the job destruction rate in the absence of a minimum wage.

3.1 Job creation

The job creation equation is obtained from the free-entry condition (5), the definition of the asset value of a vacant job (4), and the definitions of the surplus of a continuing job (16) and a new job (15):

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)}{(r+\lambda)}\left[\varepsilon_u - z - \lambda G(\varepsilon_d) f_g + \lambda \int_{\varepsilon_d}^{\varepsilon_u} \frac{(x-\varepsilon_u)}{r+\lambda} dG(x) + \frac{h\left\{\lambda\left[1-G(\varepsilon_d)\right] - \gamma\theta m(\theta)\right\}}{(1-\gamma)m(\theta)}\right] \tag{20}$$

This equation indicates that the expected cost of a vacant job must equalize the expected profit on a starting job. Indeed, the left-hand side represents the expected cost of a vacancy. This cost increases with the labor market tightness because the bigger the market tightness the longer the time to fill a vacancy, and the more costly a vacancy is. The right-hand side represents the expected profits yielded by a starting job. Expected profits are decreasing with respect to the labor market tightness, because a bigger labor market tightness increases the exit rate from unemployment and the asset value of the unemployed workers, which, according to the sharing rule, decreases the profit on any job. The influence of the threshold level of productivity below which jobs are destroyed on the value of expected profit is not monotonic. It can easily be established —by differentiating the right-hand side of equation (20)— that the expected profit of a job increases (decreases) with this lower bound if the surplus is negative (positive) for the reservation productivity, and has a maximum for the threshold value of productivity under which jobs are destroyed that yields a zero surplus. This job creation equation is drawn on Figure 1, where it is denoted by JC.

3.2 Job destruction

3.2.1 Job destruction in the economy with renegotiations

If contracts are renegotiated, firms and employees decide to separate only if the value of the surplus becomes negative. Since the equation (16) implies that the surplus is increasing with respect to the productivity parameter ε, there exists a unique reservation productivity, denoted by ε_s, below which the surplus becomes negative, that solves $S(\varepsilon_s) = 0$. It is worth noticing that the sharing rule (17) implies that this condition is equivalent to $\Pi\left[\varepsilon_s, w(\varepsilon_s)\right] = -f$ and $V\left[w(\varepsilon_s)\right] = V_u + f_w$, which means that both the employer and the worker agree to destroy the job if $\varepsilon < \varepsilon_s$. Accordingly, from (16), one gets:

$$\varepsilon_s = z + \frac{\theta h \gamma}{1-\gamma} - r f_g - \frac{\lambda}{\lambda + r} \int_{\varepsilon_s}^{\varepsilon_u} (x - \varepsilon_s) dG(x). \tag{21}$$

The right-hand side shows that the reservation productivity depends on the opportunity cost of employment to the worker, which is the sum of the unemployment benefits z and the expected value of search —the second term. The firing tax induces firms to lower the reservation productivity, and then to destroy less jobs. The last term on the right-hand side is the option value of retaining an existing match. The job destruction curve is drawn on Figure 1 in the plane (ε_s, θ). One sees that an increase in the labor market tightness, which entails a higher expected return from search, diminishes the surplus of a job and then leads to a higher ε_s.

3.2.2 Job destruction in the economy without renegotiation

When there is no renegotiation, the firm decides to fire the worker if the asset value of a job with a wage w_0 becomes lower than the firing cost. Since the asset value $\Pi\left(\varepsilon, w_0\right)$ increases

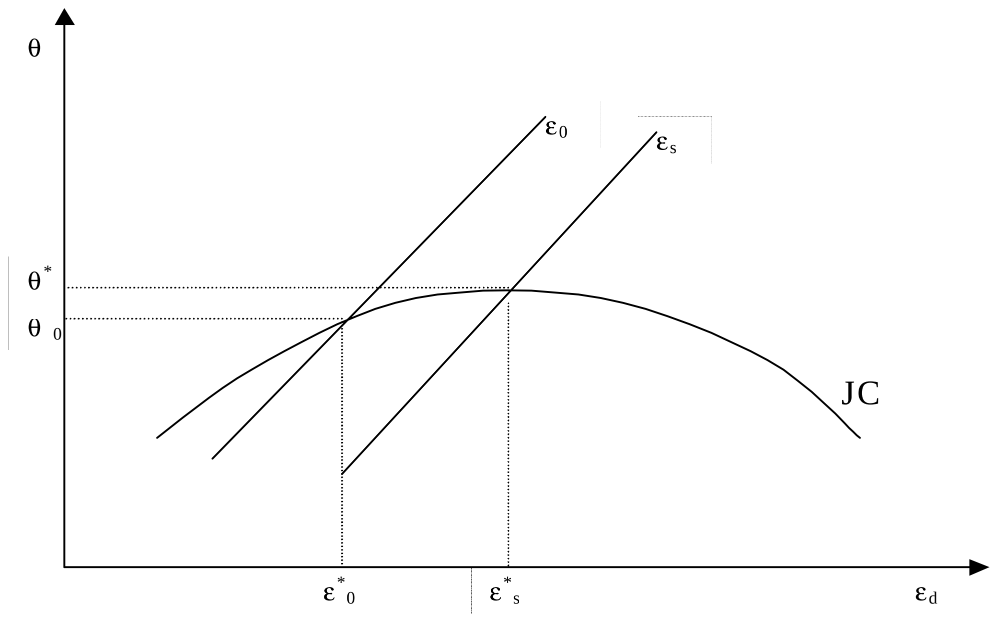

Figure 1: Equilibria with flexible wages

with idiosyncratic component ε, there exists a unique threshold value of ε , denoted by ε_0, below which jobs are destroyed, that solves[1] $\Pi(\varepsilon_0, w_0) = -f$. The definition of the asset value of a continuing job paying the starting wage (7) implies that this condition reads as:

$$\varepsilon_0 = w_0 - \lambda \Pi_\lambda(w_0) - (r + \lambda)f. \tag{22}$$

Using the free-entry condition (5), the equations (6), (8) and the sharing rule (10), one gets the following expression for the starting wage:

$$w_0 = z + \frac{\gamma h}{(1-\gamma)m(\theta)}\left[r + \lambda G(\varepsilon_0) + \theta m(\theta)\right] - \lambda G(\varepsilon_0) f_w. \tag{23}$$

Moreover, using the definition of the asset value of a continuing job implies that:

$$\Pi_\lambda = -f + \int_{\varepsilon_0}^{\varepsilon_u} \frac{(x - \varepsilon_0)}{r + \lambda} dG(x). \tag{24}$$

[1] Let us remark that ε_0 solves $\Pi(\varepsilon_0, w_0) = -f$ when there is no renegotiation while ε_r, defined equation (13), solves $\Pi(\varepsilon_r, w_0) = -f$ when there is renegotiation, formally, the expresssion for $\Pi_\lambda(w_0)$ found in equation (7) is not the same in both cases —see equations (24) and (39).

Substituting (23) and (24) into (22) yields:

$$\varepsilon_0 = z + \frac{\gamma h}{(1-\gamma)m(\theta)} \left[r + \lambda G(\varepsilon_0) + \theta m(\theta)\right] - \lambda G(\varepsilon_0) f_w - \left[r + \lambda G(\varepsilon_0)\right] f_g - \frac{\lambda}{r+\lambda} \int_{\varepsilon_0}^{\varepsilon_u} (x - \varepsilon_0) dG(x) \tag{25}$$

It can easily be shown, by differentiating this equation, that ε_0 increases with the labor market tightness. It means that job destruction increases with the labor market tightness because the starting wage increases with θ. Moreover, one can easily check that $\varepsilon_0 \leq \varepsilon_s$, for a given value of θ, if renegotiations are impossible —*i.e.* if condition (11) is not fulfilled. It means that employers are induced to destroy *less* jobs if wages cannot be renegotiated. This is a very intuitive result: The impossibility to renegotiate wages downwards arises if redundancy payments are high, which implies a low starting wage and a high separation cost to the employer. Thus, high redundancy payments lower the cost to continue a job but increase the cost of job destruction.

3.3 Equilibrium

3.3.1 Equilibrium with renegotiation

The equilibrium values of the labor market tightness and the threshold value of productivity below which jobs are destroyed, $(\theta^*, \varepsilon_s^*)$, when wages are renegotiated by mutual agreement are defined by the job creation equation (20) and the job destruction equation (21), with $\varepsilon_d = \varepsilon_s$ in equation (20) —see Figure 1. It can be checked that the equilibrium is unique. It is worth noting that the pair $(\theta^*, \varepsilon_s^*)$ is the same as in the Mortensen and Pissarides' (1994) model, where wages are more 'flexible' than in our framework, since Mortensen and Pissarides assume continuously renegotiated wages. In fact, this is not surprising: The job destruction decision is exactly the same in both frameworks, since a job is destroyed if the surplus that it generates becomes negative in both cases, and the value of the surplus does not depend on the way it is shared. The job creation equation is also the same, since it is the bargaining at *the start of the match* that determines the share of the surplus belonging to the employer, the starting surplus being also the same in both frameworks.

Like in the standard search and matching model, redundancy payments do not influence neither the labor market tightness nor the job destruction rate. However, the wage distribution depends on the redundancy payment. One can show —see appendix 3— that renegotiated wages $w(y)$ increase with productivity y, and that they are smaller than the equilibrium starting wage w_0^*. Accordingly, the wage profile on each job corresponds to a series of dropping wages that are successively renegotiated when bad productivity shocks hit the job, those wages belonging to the interval $[w(\varepsilon_s^*), w_0^*]$. An increase in the redundancy payment f_w narrows the support of the wage distribution which degenerates to a mass point when the redundancy payment is so high that renegotiations become impossible —see condition (11).

3.3.2 Equilibrium without renegotiation

The equilibrium values of the labor market tightness and the threshold value of productivity below which jobs are destroyed, $(\theta_0^*, \varepsilon_0^*)$, when wages cannot be renegotiated are defined by the job creation equation (20) and the job destruction equation (25), with $\varepsilon_d = \varepsilon_0$ in (20) —see Figure 1. It can be checked that the equilibrium is also unique.

A striking feature of the equilibrium without renegotiation is that redundancy payments influence both job destruction and job creation. Redundancy payments decrease the job destruction rate for a given value of the labor market tightness. One sees, in Figure 1, that the equilibrium value of the job destruction rate is lower than in the regime with renegotiated wage, where all jobs that generate a negative surplus are destroyed. Therefore, when renegotiation cannot occur, some jobs with negative surplus are not destroyed, and then the asset value of the new jobs is lower than in the regime with renegotiation. This implies that the equilibrium value of the labor market tightness is also lower when renegotiation is impossible, and that an increase in redundancy payments decreases both the job destruction rate and the labor market tightness. It is worth noticing that the equilibrium wage also decreases when redundancy payments are increased —see equations (23) and (11).

4 Job creation and destruction with a minimum wage

In this section, there is a minimum wage $\bar{w}$ higher than the bottom of the wages distribution. According to the results obtained in the previous section, two cases may arise: Either the minimum wage is not binding on the whole jobs, or the minimum wage is binding on every job[2]. The former case can arise only in the economy with renegotiated wages, while the latter case can occur whether wages are renegotiated or not renegotiated. Let us consider these two cases successively.

4.1 A minimum wage binding on some jobs only

If the minimum wage is not binding on the whole jobs, the upper bound of the wage distribution is still a negotiated wage. The results obtained in the previous section imply that the starting wage is still negotiated according to the surplus sharing rule (10), but there are some values of the productivity for which the minimum wage prevents the employers and the workers from bargaining wage drops. Given our characterization of the wage profiles, a renegotiation can never provide a wage increase. Therefore, a worker payed the minimum wage will get the minimum wage until the destruction of his job. Such properties of the wage profiles allow us to determine the job destruction process with a binding minimum wage very easily. The asset value of a job with a minimum wage and productivity ε, denoted by $\bar{\Pi}(\varepsilon)$, solves the following equation:

$$r\bar{\Pi}(\varepsilon) = \varepsilon - \bar{w} + \lambda \left[\int_{\varepsilon_d}^{\varepsilon_u} \bar{\Pi}(x) dG(x) - fG(\varepsilon_d) - \bar{\Pi}(\varepsilon) \right]. \tag{26}$$

Since, $\partial\bar{\Pi}(\varepsilon)/\partial\varepsilon = 1/(r+\lambda)$, $\bar{\Pi}(\varepsilon)$ increases with ε, and there exists a unique reservation productivity, denoted by ε_π, that solves $\bar{\Pi}(\varepsilon_\pi) = -f$, which expression can be written as:

$$\varepsilon_\pi = \bar{w} - \frac{\lambda}{r+\lambda} \int_{\varepsilon_\pi}^{\varepsilon_u} (x - \varepsilon_\pi) dG(x) - rf. \tag{27}$$

This equation defines the equilibrium value of the reservation productivity with a binding minimum wage. One sees that two terms imply that the reservation productivity is lower than the minimum wage. The term with the integral corresponds to the option value of retaining an existing job whereas the term rf reflects the influence of the firing cost. It can also be checked that the reservation productivity is higher with a binding

[2] Obviously, the wage distribution is influenced by the minimum wage. Appendix 4 is devoted to the presentation of the wage profile when there is a binding minimum wage on some jobs only.

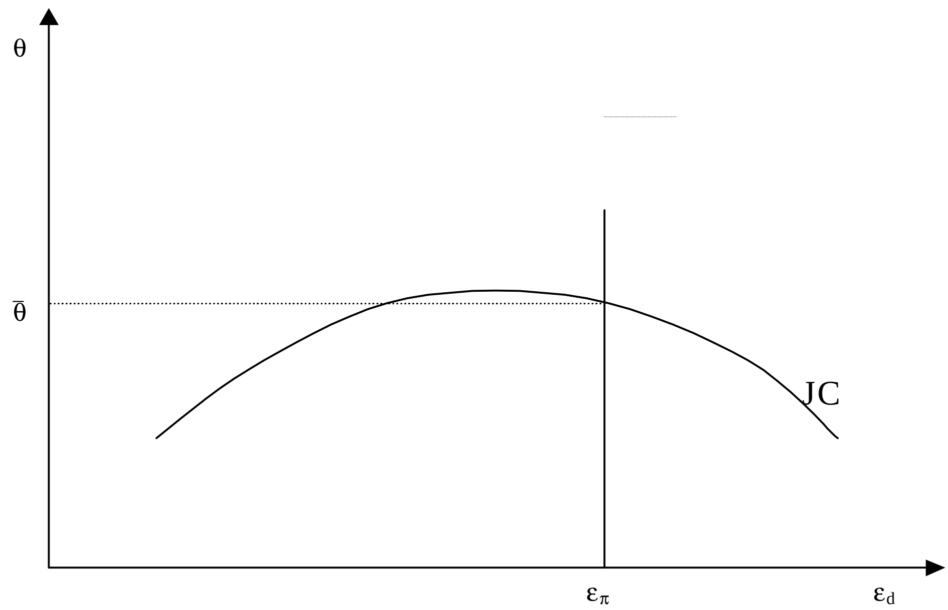

Figure 2: Equilibrium with a minimum wage binding on some jobs only

minimum wage than with flexible wages, since $\varepsilon_\pi = \varepsilon_s^*$ for $w(\varepsilon_s^*) = \bar{w}$ and ε_π increases with the minimum wage.

The equilibrium value of the labor market tightness, denoted by $\bar{\theta}$, is still defined by the job creation equation —equation (20)—, since the starting wages are negotiated. The equilibrium is drawn on Figure 2. One sees that the economy with a binding minimum wage has a lower value of the labor market tightness and a higher reservation productivity than an economy with flexible wages.

4.2 A minimum wage binding on every job

Now, the minimum wage is so high that the starting wage is not negotiated any more. Formally, we are in a situation where the wage is exogenous. In that case, the equilibrium value of the reservation productivity is still defined by equation (27). The job creation equation can be obtained from the free-entry condition (5), which implies that $\bar{\Pi}(\varepsilon_u) = h/m(\theta)$, and the definition (26) of $\bar{\Pi}(\varepsilon_u)$:

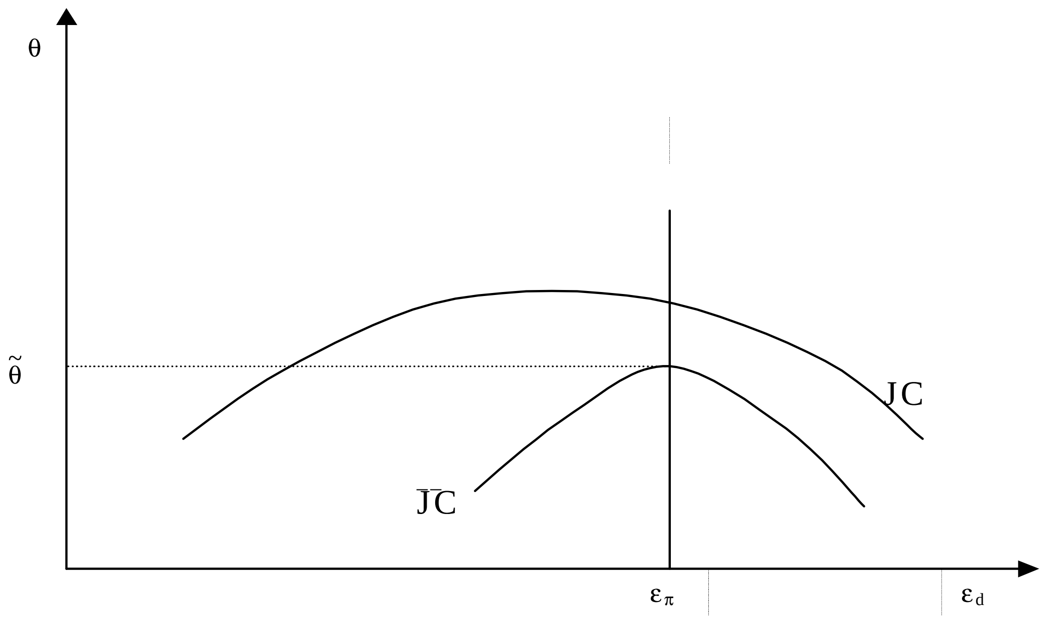

Figure 3: Equilibrium with a minimum wage binding on the whole jobs.

$$\frac{h(r+\lambda)}{m(\theta)} = \varepsilon_u - \bar{w} + \lambda \left[\int_{\varepsilon_d}^{\varepsilon_u} \bar{\Pi}(x) dG(x) - f G(\varepsilon_d) \right]. \tag{28}$$

Figure 3 represents the equilibrium values of the labor market tightness, denoted by $\tilde{\theta}$ when the wage is exogenous. The job creation equation, denoted by $\overline{JC}$, defines a hump-shaped relation between the reservation productivity ε_d and the labor market tightness θ. The latter takes a maximum value for $\varepsilon_d = \varepsilon_\pi$. It can be checked that the job creation curve, defined by (28), is necessarily below the job creation curve, defined by (20), in the case where the starting wage is negotiated.

Up to now, different types of equilibria have been described. The following section is devoted to the analysis of the properties of these equilibria, with a special focus on the consequences of job protection in the presence of a minimum wage.

5 Job protection and the minimum wage

The consequences of job protection and the minimum wage on jobs and workers flows, on unemployment and on aggregate production are first studied in a qualitative perspective

	A				A'				B				C			
	θ^*	$\lambda G(\varepsilon_s^*)$	u	Y	θ_0^*	$\lambda G(\varepsilon_0^*)$	u	Y	$\bar{\theta}$	$\lambda G(\varepsilon_\pi)$	u	Y	$\tilde{\theta}$	$\lambda G(\varepsilon_\pi)$	u	Y
f_w	0	0	0	0	$-$	$-$	?	?	$+$	$-$	$-$	$+$	$-$	$-$	?	?
f_g	$-$	$-$	?	?	$-$	$-$	?	?	$-$	$-$	?	?	$-$	$-$	?	?
$\bar{w}$									$-$	$+$	$+$	$-$	$-$	$+$	$+$	$-$

Table 1: Comparative static properties of the economy with flexible renegotiated wages (case A), with flexible but not renegotiated wages (case A'), with a minimum wage and a starting negotiated wage (case B), and with a minimum wage always binding (case C).

before paying some attention to some quantitative predictions.

5.1 Qualitative results

5.1.1 Job flows and unemployment

The qualitative properties of the three types of equilibria are summarized in table 1, which indicates the sign of variation in the labor market tightness, the job destruction rate, the unemployment rate and aggregate production when there is an increase in the redundancy payment, the firing tax and the minimum wage.

The results obtained in the economy with flexible renegotiated wages are the same as those of Mortensen and Pissarides (1997). It is worth noting that redundancy payments do not influence any variable considered in the table, but that they influence the level of the negotiated wages, which drops when redundancy payments are raised —Burda (1992). However, in the other cases, things are different since redundancy payments influence both labor market tightness and job destruction. We already explained the influence of redundancy payments in the economy with flexible, but not renegotiated wages. Now, let us look at the impact of firing costs when the minimum wage is binding.

If the minimum wage is lower than the starting wage, any increase in the redundancy payment decreases the rate of job destruction and raises labor market tightness. This can be easily understood by looking at Figure 2, where an increase in redundancy payments reduces ε_π, which is necessarily bigger than ε_s^*. Accordingly, the equilibrium value of the labor market tightness moves along the job creation curve, which implies an increase in $\bar{\theta}$ and a drop in the unemployment rate. Therefore, redundancy payments raise both the job tenure and the exit rate from unemployment. The consequences of the firing tax are different from those of redundancy payments. The firing tax has a negative impact on the labor market tightness, and then an ambiguous effect on unemployment.

Obviously, the economy stays in the regime with a negotiated starting wage for sufficiently low values of redundancy payments and firing taxes. If firing costs are big enough, the prevailing situation is necessarily a case where the minimum wage is binding on every job. In that case (case C), table 1 shows that redundancy payments have quite different effects than in the case where the starting wage is negotiated (case B). They have a negative impact on the labor market tightness, because the starting wage cannot decrease when redundancy payments are raised, contrarily to the case where the starting wage is negotiated. The accentuation in wage rigidity implies that redundancy payments are entirely passed on to profits, and then that the negative effect on job creation is stronger than when wages are more flexible. Accordingly, redundancy payments, as the firing tax, are conducive to a lower job reallocation, and have an ambiguous impact on unemployment.

It is also worth stressing that the introduction of the minimum wage in the matching model sheds some light on the similarities in job flows, and the differences in workers flows, found in economies with strong dismissal protections and a high minimum wage on the one hand, and economies with flexible labor markets and a low minimum wage on the other hand. Indeed, the minimum wage counteracts the effect of the firings costs on job destruction. Thus, a stringent job protection with a high minimum wage can lead to a similar rate of job destruction than no job protection and a low minimum wage. Moreover, one sees that the minimum wage decreases the exit rate from unemployment, as the firing costs (except for redundancy payments in case B). Accordingly, the unemployment spell is longer in the economies with a stringent job protection and a high minimum wage although the rate of job destruction can be similar in both types of economies.

5.1.2 Production

Overall, firing taxes, by decreasing both job destruction and labor market tightness, have an ambiguous effect on aggregate production, which is a measure of social welfare, since individuals are risk-neutral. Namely, the effect depends on the features of the matching technology and the productivity shocks. The same thing arises for redundancy payments, except in case B, where the minimum wage is not binding for the starting jobs. In this regime, redundancy payments increase job and unemployment spells, and counteract the negative impact of the minimum wage on employment and production. More precisely, redundancy payments allow for improving welfare when the minimum wage is binding on some jobs only.

5.2 Quantitative results

We have just seen that job protection has an ambiguous theoretical impact on unemployment in most cases. The only situation where job protection has a very clear theoretical effect is the case of a variation in redundancy payments when the minimum wage is binding on jobs with low productivity, but not on the starting jobs. In that case, an increase in redundancy payments decreases unemployment.

However, computational exercises done by Millard and Mortensen (1997), Mortensen and Pissarides (1997, 1998) and Cabrales and Hopenhayn (1998) shed some light on the consequences of job protection on employment. Mortensen and Pissarides show that increases in firing tax raise employment when the replacement ratio is low, but have an opposite effect when the replacement ratio is high, because in that case wages are downwards rigid and job creation becomes very sensitive to any labor cost increase. Cabrales and Hopenhayn (1998) argue that the stochastic process of the shocks to the worker-firm match plays an important role. They show that a stochastic process that yields more persistent shocks than those considered by Mortensen and Pissarides implies that firing tax increases are conducive to very important employment drops: Introducing a firing tax of about one month of mean wages leads to a 6% unemployment increase in Cabrales and Hopenhayn exercise.

Our computational exercises allow us to show that job protection policies are likely to be very unfavorable to employment in the presence of a minimum wage, even in the cases where they are favorable to employment in the absence of a minimum wage. We take parameter values close to those of the base line values chosen by Mortensen and Pissarides (1998) which are supposed to represent the main features of a 'representative' European labor market over the past twenty years on quarterly data. A matching function of the Cobb-Douglas form is assumed, such that $\ln[m(\theta)] = \frac{1}{2}\ln(\theta)$. The distribution of idiosyncratic shocks is assumed to be uniform on the support $[.5, 1]$. The other parameter

γ	z	g_ℓ	λ	h	r
.5	.5	.002	.115	.4	.02

Table 2: Parameter Values

values used in the computations are reported in Table 2.

Figure 4 represents the effect of a firing tax increase on unemployment when redundancy payments amount to 0.2. The firing tax varies between zero and one. The upper bound of the firing tax amounts to the quarterly production of the most productive jobs. The dashed line corresponds to the case of flexible wages. One finds the same effect as Mortensen and Pissarides when the replacement ratio is sufficiently low. Basically, one sees that a more stringent job protection leads to a weak decrease in the unemployment rate. The continuous line corresponds to the case with a minimum wage, which is not binding on the whole jobs for $f_g = 0$. Since wages drop when the firing tax is increased, the minimum wage is always binding along the continuous line. For low values of the firing tax, the economy is in regime B, where the minimum wage is not binding on the starting jobs, but is binding on jobs with sufficiently low productivity. In this regime, firing costs have a very weak negative impact on the unemployment rate. If the firing tax is above a threshold value, which is about 0.30, the minimum wage is binding on all jobs, which means that the economy is in regime C. In this regime, there is no more downwards wage flexibility that can soften the impact of firing tax increases on profits. Accordingly, job protection has a strong positive impact on the unemployment rate, because it has exactly the same effect on the rate of job destruction as in regime B, but a stronger negative effect on labor market tightness.

Figure 5 illustrates the consequences of a firing tax increase for the same parameter values as in Figure 4 except that redundancy payments amount to 0.5 instead of 0.2. The higher level of redundancy payments implies that the minimum wage is binding on the whole jobs and that a firing tax increase as a dramatic positive impact on unemployment, even for very low levels of the firing tax.

The consequences of redundancy payments can be seen on Figure 6. In the absence of a minimum wage, redundancy payments below a threshold value, which amounts to about 0.55, have no effect on unemployment. One also sees, as indicated by our theoretical

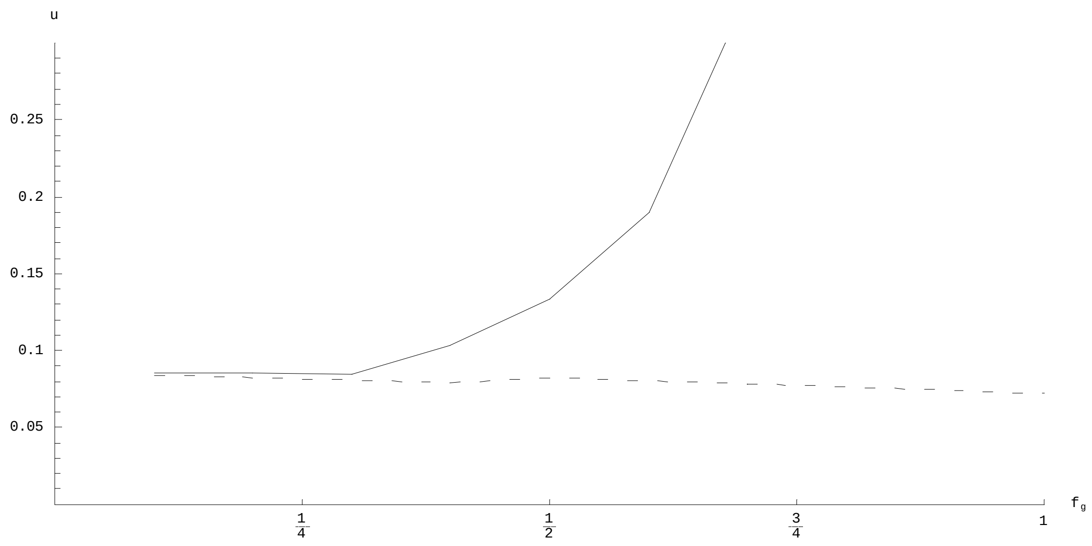

Figure 4: The impact of a firing tax increase with low redundancy payments

- - - Flexible wages;— Downwards rigid wages
$f_w = 0.2, \bar{w} = 0.91$, for $f_g = 0$, one has: $w_0^* = 0.931, w(\varepsilon_s^*) = 0.906, \bar{w}_0 = 0.93$.

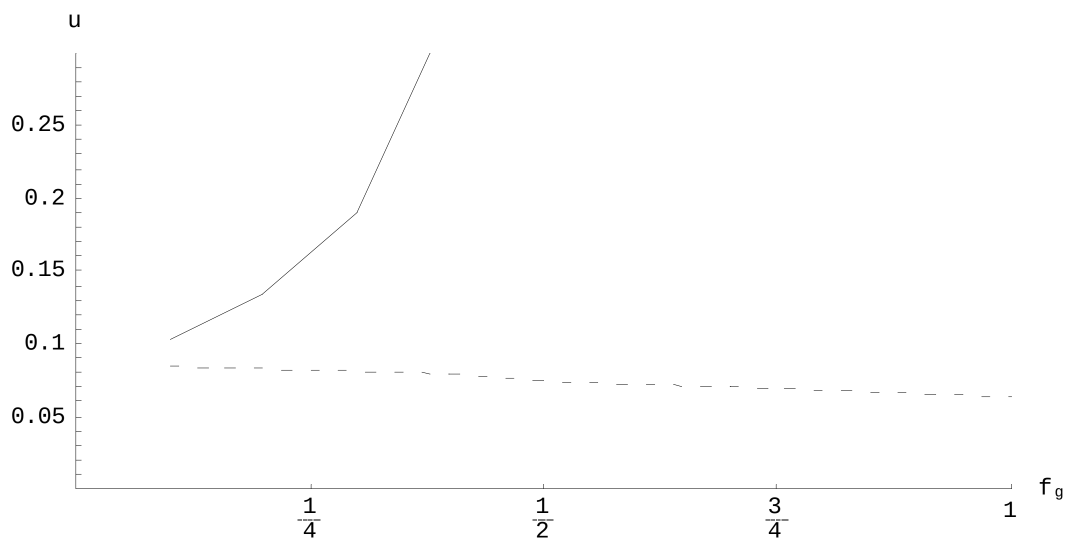

Figure 5: The impact of a firing tax increase with high redundancy payments

- - - Flexible wages;— Downwards rigid wages
$f_w = 0.5, \bar{w} = 0.91$,for $f_g = 0$, one has: $w_0^* = 0.90, \bar{w}_0 = \bar{w}$.

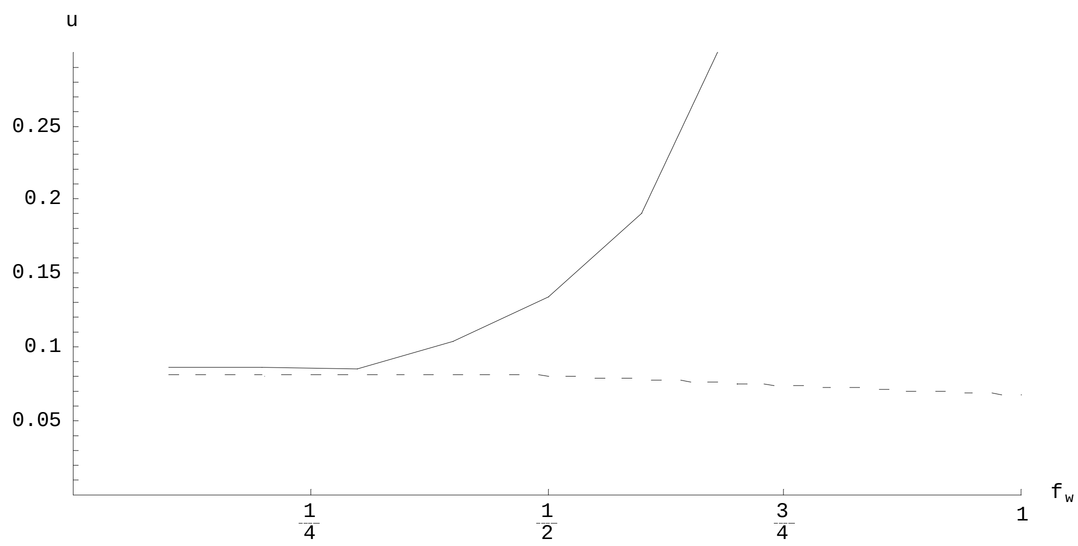

Figure 6: The impact of an increase in redundancy payments

- - - Flexible wages;— Downwards rigid wages
$f_g = 0.2, \bar{w} = 0.91$, for $f_w = 0$, one has: $w_0^* = 0.96, w(\varepsilon_s^*) = 0.89, \bar{w}_0 = 0.92$.

analysis, that redundancy payments bigger than this threshold value slightly decrease unemployment. Things are dramatically different when there is a minimum wage. In Figure 6 the minimum wage is not binding on the whole jobs when $f_w = 0$. Therefore, the economy is in regime B for redundancy payments lower than about 0.30. In regime B, redundancy payment increases have a very small negative impact on unemployment. However, when redundancy payments are bigger than 0.30, the economy is in regime C, and redundancy payment increases have a very strong positive impact on unemployment.

Overall, our quantitative results suggest that job protection might decrease, in certain circumstances, the unemployment rate of relatively skilled workers, whose wages are higher than the minimum wage, but might systematically increase the unemployment rate for the less skilled workers. An unpleasant result, when one knows that job protection is often used to fight against unemployment of the less skilled workers. Our result also suggest that job protection is likely to increase unemployment in countries with a high minimum wage, such as France, for instance, but to decrease unemployment in countries with a low minimum wage.

6 Conclusion

Our paper suggests that the impact of job protection policies on unemployment is strongly influenced by the wage setting. First, it appears that redundancy payments may have very different consequences depending on the minimum wage level: They increase employment if the minimum wage is binding and sufficiently low, but they have an opposite effect if the minimum wage is sufficiently high. Second, redundancy payments and administrative dismissal restrictions have a different effect on unemployment, except when a minimum wage is binding on all jobs. It means that it is worth distinguishing different components of dismissal restrictions when one looks at the consequences of job protection policies, since there are cases where increases in redundancy payments and in administrative dismissal restrictions have opposite effects on unemployment. Third, plausible parameter values suggest that it is likely that job protection policies have a very strong positive impact on unemployment when the minimum wage is high, but has an ambiguous impact on unemployment when wages are downwards flexible. This result suggests that job protection policies may have a strong positive impact on unemployment of the less skilled and the young workers in continental European countries, where the minimum wage is relatively high —Dolado *et alii* (1996), Abowd *et alii* (1998)— but might have a weak impact on unemployment in other countries, such as the UK or the North American countries.

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Appendix 1: The strategic negotiation game

Negotiation on new matches

In this appendix, we provide a very simple non-cooperative negotiation game that yields the sharing rule given equation (10). For a more general treatment, see Osborne and Rubinstein (1990) and MacLeod and Malcomson (1993). The game proceeds in the following way.

(i) The employer makes a wage offer.

(ii) The worker either agrees and signs the contract, or refuses.

(iii) In case of disagreement in step (ii), the worker (resp: the employer) makes a wage offer with probability γ (resp: $1-\gamma$), after a very short delay denoted by Δ.

(iv) The player who has not made the offer in step (iii) either accepts and sign the contract, or refuses.

(v) In case of disagreement in step (iv), the job is destroyed.

Let us remark that the assumption that the employer makes the first offer is not essential and has been chosen for the sake of simplicity. The subgame perfect equilibria of this game can be found by backward induction. In the last step, the employer accepts any offer that yields $\Pi(\varepsilon_u, w_0) \geq \Pi_v$, which implies that the worker gets $V_u + S_0$ if he makes the wage offer in step (iii). Similarly, the worker gets V_u if the employer makes the offer in step (iii). Therefore, in step (ii), the expected discounted income of a worker amouts to $e^{-r\Delta}\left[V_u + \gamma S_0\right]$. In the first step, the employer offers the lowest possible share of the surplus to the worker, which implies that the worker gets $V(w_0) = e^{-r\Delta}\left[V_u + \gamma S_0\right]$, which is the sharing rule given equation (10) when $\Delta \rightarrow 0$. Notice that the existence of the delay in the bargaining game implies that there is a unique subgame perfect equilibrium —see Osborne and Rubinstein (1990).

Renegotiation

Under the renegotiation by mutual agreement rule, each party can only force the other one either to separate or to continue abiding by the current contract. One can simply represent this situation thanks to the following renegotiation game.

a) Either party can initiate a renegotiation. There is no production during the renegotiation process.

b) The other party either accepts of refuses.

c) In case of acceptance in step *b*, the bargaining game described previously begins. In case of refusal, the party who has initiated the renegotiation either continues abiding by the current contract or separate. Only employer-initiated separations give rise to redundancy payments.

Let us show that the subgame perfect equilibrium of the renegotiation game corresponds to the sharing rule given equation (17) and that renegotiations are initiated by employers only. The proof is given for the renegotiation of the starting wage on a job with current productivity ε, but it can be applied straightforwardly to the renegotiation of a renegotiated wage. The renegotiation game has to be solved by backward induction. Let us begin by step c.

Step c

-In case of refusal in step *b* the employer who initiated a renegotiation prefers to separate than going on abiding by the previous contract if $\Pi(\varepsilon, w_0) < -f + \Pi_v$. Similarly, the worker who initiated a renegotiation prefers to separate if $V(w_0) < V_u$.

-In case of acceptance in step *b*, the wage is bargained according to the strategic bargaining game described by steps (i)-(v), except that the employer has to pay redundancy payments if the job is destroyed when he initiated the renegotiation Let us begin to study an employer-initiated renegotiation.

-If the renegotiation is initiated by the employer, in step (iv), the worker and the employer accept any payoff larger than $V_u + f_w$ and $\Pi_v + f$ respectively. Thus, in step (iii), the worker offers —with probability γ— a profit $\Pi_v + f$ and gets $S(\varepsilon) + V_u + f_w$, whereas the employer offers $V_u + f_w$ and gets $S(\varepsilon) + \Pi_v - f$. Therefore, in step (ii), the expected payoff to the worker is $e^{-r\Delta}\left\{V_u + \gamma S(\varepsilon) + f_w\right\}$. In step (i), the employer offers the lowest wage that provides at least $e^{-r\Delta}\left\{V_u + \gamma S(\varepsilon) + f_w\right\}$ to the worker. Accordingly, when $\Delta \to 0$, the worker gets the payoff $V\left[w(\varepsilon)\right]$ and the employer the expected profit $\Pi\left[\varepsilon, w(\varepsilon)\right]$ defined by the sharing rule (17).

-If the renegotiation is initiated by the worker, in step (iv), the worker and the employer accept any payoff larger than V_u and Π_v respectively. Thus, in step (iii), the worker offers —with probability γ— a profit Π_v and gets $S(\varepsilon) + V_u$, whereas the employer offers V_u and gets $S(\varepsilon) + \Pi_v$. Therefore, in step (ii), the expected payoff to the worker is $e^{-r\Delta}\left\{V_u + \gamma S(\varepsilon)\right\}$. In step (i), the employer offers the lowest wage that provides at least $e^{-r\Delta}\left\{V_u + \gamma S(\varepsilon)\right\}$ to the worker. Accordingly, when $\Delta \to 0$, the worker gets a payoff $V\left[w_w(\varepsilon)\right] \equiv V_u + \gamma S(\varepsilon)$ and the employer an expected profit $\Pi\left[\varepsilon, w_w(\varepsilon)\right] \equiv \Pi_v + (1-\gamma)S(\varepsilon)$, where $w_w(\varepsilon)$ stands for the wage bargained over when productivity amounts to ε if the renegotiation is worker-initiated.

Step b

Step c implies that the worker agrees to renegotiate the initial contract if and only if

$$\begin{cases} V\left[w(\varepsilon)\right] > V(w_0) \text{ if } \Pi(\varepsilon, w_0) \geq -f + \Pi_v \\ V\left[w(\varepsilon)\right] \geq V_u + f_w \text{ if } \Pi(\varepsilon, w_0) < -f + \Pi_v \end{cases} \tag{29}$$

Similarly, the employer agrees to renegotiate the initial contract if and only if $\Pi\left[\varepsilon, w_w(\varepsilon)\right] > \Pi(\varepsilon, w_0)$, a condition which is always fulfilled, since it is equivalent to $\varepsilon_u > \varepsilon$.

Step a

-Let us begin to assume that the employer decides to renegotiate.

-If $\Pi(\varepsilon, w_0) \geq -f + \Pi_v$, step c implies that the employer gets $\Pi\left[\varepsilon, w_w(\varepsilon)\right] = (1-\gamma)S(\varepsilon) - f$ if the worker accepts. But step b—see equation (29)— implies that the worker accepts to renegotiate only if $V\left[w(\varepsilon)\right] > V(w_0)$, which implies that $\Pi\left[\varepsilon, w_w(\varepsilon)\right] < \Pi(\varepsilon, w_0)$. Thus the employer never initiates a renegotiation of the initial contract if $\Pi(\varepsilon, w_0) \geq -f + \Pi_v$.

-If $\Pi(\varepsilon, w_0) < -f + \Pi_v$, step c implies that the employer gets $\Pi\left[\varepsilon, w_w(\varepsilon)\right] = (1-\gamma)S(\varepsilon) - f$ if the worker accepts to renegotiate. The worker accepts only if $V\left[w(\varepsilon)\right] \geq V_u + f_w$ which is equivalent, according to the sharing rule (17) derived in step c, to $S(\varepsilon) \geq 0$. Similarly, $\Pi\left[\varepsilon, w_w(\varepsilon)\right]$ is bigger than $-f$ if and only if $S(\varepsilon) \geq 0$. Therefore, the employer initiates a renegotiation if $\Pi(\varepsilon, w_0) < -f + \Pi_v$ and $S(\varepsilon) \geq 0$.

-If the worker initiates a renegotiation of the initial contract, step b implies that the employer always accepts, and step c that the worker gets $V\left[w_w(\varepsilon)\right] = \gamma S(\varepsilon) + V_u < V(w_0) = \gamma S_0 + V_u$, $\forall \varepsilon \neq \varepsilon_u$. Accordingly, the worker never initiates a renegotiation of the initial contract.

Appendix 2: The surplus

From equation (14) and the free-entry condition, the surplus of a continuing job with idiosyncratic component ε and a wage renegotiated when the idiosyncratic component was y can be written as:

$$S(\varepsilon) = V\left[w(y)\right] - V_u + \Pi\left[\varepsilon, w(y)\right] + f_g, \tag{30}$$

where $V\left[w(y)\right]$ is defined in equation (8) with:

$$V_\lambda\left[w(y)\right] = \int_{-\infty}^{\varepsilon_d} \left[f_w + V_u\right] dG(x) + \int_{\varepsilon_d}^{\varepsilon_r(y)} V\left[w(x)\right] dG(x) + \int_{\varepsilon_r(y)}^{\varepsilon_u} V\left[w(y)\right] dG(x), \tag{31}$$

$\varepsilon_r(y)$ being the threshold value of productivity below which a wage that has been negotiated when productivity was y is renegotiated —see equation (19).

Similarly, $\Pi\left[\varepsilon, w(y)\right]$ is defined in equation (7) with

$$\Pi_\lambda\left[w(y)\right] = \int_{-\infty}^{\varepsilon_d} -f dG(x) + \int_{\varepsilon_d}^{\varepsilon_r(y)} \Pi\left[x, w(x)\right] dG(x) + \int_{\varepsilon_r(y)}^{\varepsilon_u} \Pi\left[x, w(y)\right] dG(x). \tag{32}$$

The two last equations together with the definition of the surplus (30) imply:

$$V_\lambda\left[w(y)\right] + \Pi_\lambda\left[w(y)\right] = V_u - f_g + \int_{\varepsilon_d}^{\varepsilon_u} S(x) dG(x).$$

Using the expression for $V\left[w(y)\right]$ and $\Pi\left[\varepsilon, w(y)\right]$ defined in equation (8) and (7) respectively, together with this last equation and the definition of the surplus (30) allows us to write:

$$(r+\lambda) S(\varepsilon) = \varepsilon - r(V_u - f_g) + \lambda \int_{\varepsilon_d}^{\varepsilon_u} S(x) dG(x). \tag{33}$$

The definition of the discounted expected income of an unemployed worker (6) together with the sharing rule (10) and the free-entry condition (5) yields:

$$rV_u = z + \frac{\gamma h \theta}{(1-\gamma)}.$$

Substituting this expression for rV_u into (33) yields (16).

Appendix 3: The wage profile in the economy with flexible wages

We define the wage profile in the economy with renegotiated wages. The lowest wage can be computed from the definition of the asset value of a continuing job —given equation (7)—, for the lowest level of productivity, namely, $\Pi\left[\varepsilon_s^*, w(\varepsilon_s^*)\right]$, which implies:

$$w(\varepsilon_s^*) = \varepsilon_s^* + rf + \frac{\lambda}{r+\lambda} \int_{\varepsilon_s^*}^{\varepsilon_u} (x - \varepsilon_s^*) dG(x) \tag{34}$$

where ε_s^* can be written as, from (20) and (21):

$$\varepsilon_s^* = \varepsilon_u - (r+\lambda)\left[f_g + \frac{h}{(1-\gamma)m(\theta^*)}\right]. \tag{35}$$

Noticing that $(r+\lambda)\{\Pi[\varepsilon, w(\varepsilon)] - \Pi[\varepsilon, w(y)]\} = w(y) - w(\varepsilon)$, equation (18) implies:

$$w(y) = w(\varepsilon_s^*) + \gamma(y - \varepsilon_s^*), \forall y \in [\varepsilon_s^*, \varepsilon_r^*[\tag{36}$$

This equation shows that the renegotiated wage increases with the level of productivity. The starting wage can be computed from the asset value of a starting job, which implies:

$$w_0 = \varepsilon_u - (r+\lambda)\Pi(\varepsilon_u, w_0) + \lambda\Pi_\lambda(w_0) \tag{37}$$

with,

$$\Pi_\lambda(w_0) = \int_{-\infty}^{\varepsilon_s} -f dG(x) + \int_{\varepsilon_s}^{\varepsilon_r} \Pi[x, w(x)]\, dG(x) + \int_{\varepsilon_r}^{\varepsilon_u} \Pi(x, w_0)\, dG(x) \tag{38}$$

or, after some computations:

$$\Pi_\lambda(w_0) = -f + \int_{\varepsilon_s}^{\varepsilon_u} \frac{(x-\varepsilon_s)}{(r+\lambda)} dG(x) + (1-\gamma)\left[1 - G(\varepsilon_r)\right]\left[f_w + \frac{h}{(1-\gamma)m(\theta^*)}\right] \tag{39}$$

Using the free-entry condition and substituting this last equation into (37) yields

$$w_0^* = \varepsilon_r^* + rf + \frac{\lambda}{r+\lambda}\int_{\varepsilon_s^*}^{\varepsilon_u} (x - \varepsilon_s^*) dG(x) + \lambda(1-\gamma)\left[1 - G(\varepsilon_r^*)\right]\left[f_w + \frac{h}{(1-\gamma)m(\theta^*)}\right]. \tag{40}$$

Appendix 4: The wage profile in the economy with a binding minimum wage

The introduction of a minimum wage influences the wage structure. The initial wage, denoted by $\bar{w}_0$, can be computed as it has just been done in the flexible wage economy. One obtains:

$$\bar{w}_0 = \bar{\varepsilon}_r + rf + \frac{\lambda}{r+\lambda}\int_{\varepsilon_\pi}^{\varepsilon_u} (x - \varepsilon_\pi) dG(x) + \lambda(1-\gamma)\left[1 - G(\bar{\varepsilon}_r)\right]\left[f_w + \frac{h}{(1-\gamma)m(\bar{\theta})}\right]. \tag{41}$$

with

$$\bar{\varepsilon}_r = \varepsilon_u - (r + \lambda) \left[f + \frac{h}{m(\bar{\theta})} \right]. \tag{42}$$

Denoting by $\bar{\varepsilon}$ the threshold value of productivity below which the minimum wage is binding, the renegotiated wages, denoted by $\bar{w}(y)$, $y \in [\bar{\varepsilon}, \bar{\varepsilon}_r[$, satisfy:

$$\bar{w}(y) = \bar{w} + \gamma(y - \bar{\varepsilon}). \tag{43}$$