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Redundancy Payments, Incomplete Labor Contracts, Unemployment and Welfare

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Abstract

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It is frequently argued that pure government-mandated severance transfers by the employer to the worker have neither employment nor welfare effect because they can be offset by private transfers from the worker to the employer. In this paper, using a dynamic search and matching model *à la* Mortensen and Pissarides (1994), we show that it may be not any more the case if labor contracts are incomplete and can be renegotiated by mutual agreement only. Indeed, we show that increases in high severance payments are likely to decrease unemployment but systematically decrease welfare and raise inequality. Moreover, it can be understood that insiders try to get high severance payments through political channels, although they do not fight for such a type of advantage at the firm level.

Résumé

Indemnité de licenciement, Contrats incomplets, chômage et bien-être

Cet article étudie les conséquences des primes de licenciement sur l'emploi et le bien-être. Il montre que les indemnités de licenciement ont un impact sur l'emploi lorsque les contrats de travail sont incomplets et sont renégociés par accord mutuel. Nous montrons, dans un modèle à la Mortensen and Pissarides (1994), que les indemnités de licenciement sont susceptibles de diminuer le chômage, mais ont un effet systématiquement négatif sur le bien-être. En outre, notre modèle montre que les insiders ont intérêt à obtenir des indemnités de licenciement élevées par des canaux politiques, tels que le vote, bien qu'ils n'aient pas intérêt à se mobiliser pour obtenir un tel avantage au niveau de l'entreprise.

Key Words: Unemployment, Job protection, Matching models, renegotiation.

Mots clés: Chômage, Protection de l'emploi, modèle d'appariement, renegociation.

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

1 Introduction[1]

Only very little attention has been devoted to the consequences of pure government-mandated severance transfers on unemployment and welfare. The basic result, put forward by Lazear (1990) and Burda (1992), is that any compulsory redundancy payment by the employer to the worker can be offset by a private transfer from the worker to the employer. Therefore, if labor contracts are optimal, redundancy payments have neither effect on unemployment nor on welfare. They only change wage profiles, since the private transfer needed to offset the government-mandated redundancy payment may take the form of wage drops. The very idea that compulsory redundancy payments are neutral is very often called upon to avoid considering their consequences and to focus on firing taxes or administrative dismissal restrictions —Bertola (1990), Millard and Mortensen (1997), Mortensen and Pissarides (1997, 1998b), Garibaldi (1998), Ramey and Watson (1996), Hopenhayn and Rogerson (1993) and Ljungqvist (1998).

Nevertheless, in many OECD countries, a large part of firing costs consists of government mandated redundancy payments that take the form of a transfer from employers to workers—see OECD (1994). Is it at odd with the neutrality result that has just been mentioned ? Many economists do not think so —for instance, see Lazear (1990, p. 702). Indeed, it can be easily understood that redundancy payment effects are not neutral in inefficient environments. For instance, borrowing and lending constraints may prevent the workers from willing to pay the fee at the beginning of the employment spell. The impact of such constraints may be amplified by the presence of a minimum wage that forbid any wage drop allowing to offset the effect of redundancy payment on labor cost (Cahuc and Zylberberg, 1999, Garibaldi and Violante, 1999).

In this paper, we argue that the incompleteness of labor contracts can be an important source of non neutrality of redundancy payments in an environment where wages are negotiated over and borrowing and lending constraints do not matter because individuals are risk-neutral. We focus on very simple incomplete contracts that stipulate a fixed wage that can be renegotiated by mutual agreement only —some justifications for this form of incompleteness are provided by MacLeod and Malcomson (1993) and by Malcomson (1997). Then, using a standard search and matching model with endogenous job creation and destruction *à la* Mortensen and Pissarides (1994), we show that high government-mandated redundancy payments together with incomplete labor contracts of the type referred above lead to inefficient separations, and that increases in redundancy payment lower the job destruction rate. Usually, it is assumed that labor contracts are either complete or that a renegotiation systematically occurs when an employer-worker pair is hit by a shock in standard search and matching models —see Mortensen and Pissarides (1998b) for a recent synthesis. In this context, all separations are efficient because, when a new event occurs, there is always —by assumption— a new negotiation, and workers and employers decide to separate when the surplus of their match becomes negative. However, when labor contracts are incomplete and the decision to renegotiate is endogenous, things are different. In some situations, one of the party may like to renegotiate, but the other one may refuse if it is his own interest to continue abiding by the previously signed contract. In such a context, compulsory severance payments may prevent the parties from renegotiating and entail inefficient separations.

Indeed, a high government-mandated redundancy payment allows the employer to bargain a low wage at the beginning of the unemployment spell, because both parties anticipate the transfer made by the employer in case of separation. But, as time goes, high redundancy payments, by improving the payoff to the worker in case of disagreement in a negotiation, allow him to get high wages. This implies that redundancy payments make the employer reluctant to renegotiate when the job is hit by bad productivity shocks, because he anticipates that his share of the surplus will be low. Obviously, the worker may like to renegotiate the contract when redundancy payments are high if he gets the severance transfer when he initiates a new negotiation which gives rise to a separation. But that is generally not the case: A disagreement inducing a separation due to a worker-initiated renegotiation is usually considered as a quit, and not as a firing, giving rise to redundancy payments —McLaughlin (1991). Therefore, a worker may

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be unable to take advantage of redundancy payments to initiate new negotiations. Accordingly, a high enough compulsory redundancy payment may prevent any renegotiation of the initial contract, because the employer trying to renegotiate would get a too low share of the surplus and high severance payments do not allow the worker to trigger off renegotiations. In such circumstances, when a bad productivity shock hits the job and entails a *negative surplus*, the employer may prefer to avoid destroying the job in order to keep going on with the low wage negotiated at the beginning of the employment spell and saving the firing cost. Therefore, the incompleteness of labor contract implies that high governement-mandated redundancy payments give rise to jobs with negative surplus and then to *inefficient separation decisions.*

Usually, government-mandated severance payments are introduced in order to fight against unemployment. Indeed, our framework provides some support to this view. We can show that redundancy payments diminish unemployment when they are reasonably high, whereas very large redundancy payments have an ambiguous impact on unemployment. Some calibration exercises allow us to be more precise and to suggest that plausible levels of redundancy payments decrease unemployment.

Nevertheless, the analysis of welfare and distributional effects allows us to show that government-mandated redundancy payments have also undesirable consequences. Severance payment increases entail a decrease in aggregate welfare, measured by aggregate output —individuals are assumed to be risk neutral in our framework. Moreover, severance payments generally benefit to insiders at the expenses of unemployed workers. Accordingly, severance payments raise inequality, and a majority of workers, namely the insiders, should give some political support to high severance payments in order to get a long job tenure and high transfers when fired. It is worth noticing that the incompleteness of labor contract implies that insiders may vote for higher severance payments than those their wish to bargain with their employer. Indeed, high severance payments implying the existence of jobs with negative surplus cannot be bargained by worker-employer pairs, because it would give rise to an inefficient contract. But compulsory severance payments may raise the welfare of insiders, given their current wage that is not necessarily renegotiated when economic environment changes. Hence, in the presence of incomplete labor contract, it can be understood that insiders try to get high severance payments through political channels, although they do not fight for such a type of advantage at the firm level.

The paper is organized as follows. The search and matching model is introduced in section 2. Section 3 is devoted to the presentation of wage negotiation and renegotiation. The labor market equilibrium is presented in section 4. The consequences of redundancy payments on unemployment, welfare and inequality are analyzed in section 5. Section 6 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 normalized to one. 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 $M(v,u)$ 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 $M(v,u)/v = M(1,u/v) \equiv m(\theta)$, where $\theta \equiv v/u$ is the labor market tightness. Similarly, the job finding rate is given by $\theta m(\theta) \equiv M(v,u)/u$. 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 $G(x) : \Omega \rightarrow [0,1]$. 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 $\lambda G(\varepsilon_d)$.

The matching technology and the job destruction process imply that the law of motion of the unemployment rate is

$$\dot{u} = \lambda G(\varepsilon_d)(1-u) - u\theta m(\theta). \tag{1}$$

In a steady state, where u is constant, the unemployment rate can be written as

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

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 $\dot{n}_s = \lambda [1 - G(\varepsilon_d)]\, n_h - \lambda G(\varepsilon_d) n_s$, where n_h stands for the mass of jobs that have not been hit by a shock, which law of motion is defined by the equation $\dot{n}_h = \theta m(\theta)u - \lambda n_h$. From these two equations, one gets the law of motion of the gross market output, $Q = \varepsilon_u n_h + \frac{n_s}{1-G(\varepsilon_d)} \int_{\varepsilon_d}^{\varepsilon_u} x dG(x)$, which can be written as:

$$\dot{Q} = \varepsilon_u \theta m(\theta) u + \lambda \left[(1-u) \int_{\varepsilon_d}^{\varepsilon_u} x dG(x) - Q \right]. \tag{3}$$

Aggregate output, Y, is equal to the sum of the production of filled jobs and the outcome of unemployed workers less the cost of vacant jobs:

$$Y = Q + u\,[z - h\theta]\,. \tag{4}$$

It is worth noting that aggregate output is a measure of social welfare, since it is assumed that individuals are risk-neutral. Accordingly, a social planner should maximize aggregate output subject to the law of motion of the unemployment rate and of the gross market output, in order to reach the social optimum.

The matching model shows that the unemployment rate and the level of production depend on the rate of job destruction and on the labor market tightness. The equilibrium values of these variables are influenced by the expected incomes that employers and workers get on the labor market that are going to be defined now.

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

$$r\Pi_v = -h + m(\theta)\left[\Pi(\varepsilon_u, w_0) - \Pi_v\right], \tag{5}$$

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

$$\Pi_v = 0. \tag{6}$$

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

$$rV_u = z + \theta m(\theta)\left[V(w_0) - V_u\right], \tag{7}$$

where z is the exogenous value of unemployment income and $V(w_0)$ stands for the expected value of the stream of income of a worker who is paid a wage w_0.

The asset value of a job with a current productivity ε and a wage w, denoted by $\Pi(\varepsilon, w)$, solves:

$$r\Pi(\varepsilon, w) = \varepsilon - w + \lambda\left[\Pi_\lambda(w) - \Pi(\varepsilon, w)\right], \tag{8}$$

where $\Pi_\lambda(w)$ is the expected discounted profit if a productivity shock occurs when the current wage is w.

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

$$rV(w) = w + \lambda\left[V_\lambda(w) - V(w)\right], \tag{9}$$

$V_\lambda(w)$ being the expected discounted stream of income if a productivity shock occurs when the current wage is w.

It is also useful to define the surplus yielded by a job. By definition, a job yields a surplus 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. On every job with current productivity ε an employer gets $\Pi(\varepsilon, w)$ and obtains either $\Pi_v - f$ or Π_v in case of separation. Likewise, a worker gets an expected future income equal to $V(w)$ and obtains either $V_u + f$ or V_u if he is separated and then unemployed. Accordingly, since f is payed by the employer to the worker, the value of the surplus of a continuing job with productivity ε is:

$$S(\varepsilon) = V(w) - V_u + \Pi(\varepsilon, w) - \Pi_v \tag{10}$$

Using the definitions of the surplus on a continuing job and of the expected incomes and profits, it can easily be shown —see appendix 1— that the value of the surplus of a continuing job with idiosyncratic component ε satisfies the following asset pricing equation:

$$(r+\lambda)S(\varepsilon) = \varepsilon - z - \frac{\gamma h\theta}{(1-\gamma)} + \lambda\int_{\varepsilon_d}^{\varepsilon_u} S(x)dG(x) \tag{11}$$

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

The next section is devoted to a precise analysis of the influence of redundancy payments on the outcome of wage negotiations.

3 Wage negotiation

Throughout the paper, it is assumed that labor contracts are negotiated. But they are incomplete: They stipulate a fixed wage that may be renegotiated under well defined circumstances. Let us begin to present the negotiation of the starting wage before describing the renegotiation process.

3.1 Negotiation of the starting contract

When a worker and an employer have just been matched, a contract, stipulating a fixed wage, is bargained according to a game that 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.

(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 there is no firing cost in case of disagreement on a new match. This is because no contract has been signed yet. It can be shown —see appendix 2— that the outcome of this strategic bargaining game yields a Nash sharing rule which provides a share $\gamma \in [0,1]$ of the surplus generated by a new match to the worker[2]. In our framework, such a sharing rule reads as:

$$V(w_0) - V_u = \gamma S(\varepsilon_u), \; \Pi(\varepsilon_u, w_0) - \Pi_v = (1-\gamma)S(\varepsilon_u). \tag{12}$$

Since the seminal contributions of Binmore, Rubinstein and Wolinsky (1986) and Osborne and Rubinstein (1990), it has been known that the Nash sharing rule can be derived from strategic bargaining games. Here, we offer a very simple game, inspired by Osborne and Rubinstein (1990) and MacLeod and Malcomson (1993) that yields the sharing rule written equation (12). Obviously, this simple game is very peculiar and one knows that many other strategic bargaining games could provide the same sharing rule. Indeed, this simple game has been chosen for the sake of simplicity and to provide a useful tool to understand the renegotiation process.

3.2 Renegotiation

The initial contract may be renegotiated by both parties. The presence of redundancy payments urges us to distinguish carefully firings from quits when the issue of renegotiation is raised. Actually, the definition of firing hinges on the labor market institutions, and may be very different among countries. In Continental Europe, according to the so-called renegotiation by mutual agreement rule, any attempt to change an 'essential' element of the labor contract without the agreement of the worker is considered as a contract breach by the employer, that gives rise to redundancy payments if the worker refuses and if a separation occurs —Malcomson (1997). Since the wage is usually considered as an essential element of the labor contract, the renegotiation by mutual agreement rule implies that the worker can force the employer to abide by the current contract if he knows that a renegotiation would yield a lower wage and that the employer prefers to continue than destroy the job for the current wage. Accordingly, 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.

[2]Two things are worth noticing. First, the sharing rule (12) corresponds to the subgame perfect equilibrium payoffs of the bargaining strategic game when the time delay in step *(iii)* goes to zero, this time delay being introduced in order to guarantee the unicity of the subgame perfect equilibrium of the bargaining game. Second, in this peculiar game, one gets the same solution if the worker makes the offer in step (i) instead of the employer.

3.2.1 The renegotiation game

One can simply represent the situation emerging under the renegotiation by mutual agreement rule thanks to the following renegotiation game:

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

b) The other party either accepts or refuses to renegotiate.

c) In case of acceptance in step *b*, the bargaining game described previously begins. Every separation entailed by a refusal in step (iv) of the bargaining game gives rise to redundancy payments whoever initiated the renegotiation game[3].

In case of refusal in step *b*, the party who has initiated the renegotiation either continues abiding by the current contract or separates. Redundancy payments are paid only if the separation is employer-initiated.

We think that this game provides a relevant representation of the difference between quits and layoffs under the renegotiation by mutual agreement rule. A separation is a layoff either if the employer destroys the job because the worker refuses to lower the wage, or if the renegotiation, once accepted by both parties, fails. Accordingly, a separation is a quit only if the worker decides to leave the match knowing that the current contract may continue to apply. The assumption that redundancy payments are paid if the bargaining process in step *c* fails whoever initiated renegotiation may appear questionable at first glance. From our viewpoint, this illustrates the fact that an employer who accepts to renegotiate a contract and who is unable to reach an agreement is usually considered as responsible when job destruction occurs. If one is not convinced by this justification, it should be noticed that such an assumption is not essential. It has been chosen to lighten the proofs, and it can be easily checked that our results hold if it is assumed that redundancy payments are not paid when a bargaining initiated by the worker and accepted by the employer fails in step *c*.

It is possible to derive the surplus sharing rule from the renegotiation process and the values of productivity that give rise to renegotiations. One can also show that there are only employer initiated renegotiations —see appendix 2—. Indeed, this result is quite intuitive. Since both the employer and the employee must agree to renegotiate the current contract, an employer-initiated renegotiation can occur only if a productivity drop leads to a profit decrease such that the employer prefers to fire the worker and pay redundancy payments than going on with the current wage. Similarly, a worker-initiated renegotiation may occur only if an improvement of the outside option of the worker implies that the worker prefers to quit than abiding by the current contract. In our framework, only employer-initiated renegotiations can occur, because the outside option of the employee is stationary, equal to V_u in case of quit.

3.2.2 Renegotiation of the starting wage

Let us denote by $w(\varepsilon)$ the wage obtained if there is a renegotiation when productivity amounts to ε. The renegotiation game implies that the wage $w(\varepsilon)$ is defined by the following sharing rule —see appendix 2:

$$V\left[w(\varepsilon)\right] - \left[V_u + f\right] = \gamma S(\varepsilon), \ \Pi\left[\varepsilon, w(\varepsilon)\right] - \left[\Pi_v - f\right] = (1-\gamma)S(\varepsilon) \tag{13}$$

which shows that the share of the surplus obtained by the employer is reduced by redundancy payments.

Because there are only employer-initiated renegotiations in our simple framework wages can be renegotiated downwards only. 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. Such a situation can occur only if $V(w_0) > V_u + f$, because the workers always prefers being fired than renegotiating if $V(w_0) \leq V_u + f$. Using the definition of the asset value

[3] The assumption that the employer has to pay redundancy payments when the bargain fails if both parties agree to renegotiate is made for convinience: It allows us to lighten the proofs. It can be easily shown that one obtains exactly the same result if separations occuring in step (iv) of a worker-initiated bargaining game do not give rise to redundancy payments.

of a vacancy (5), the free-entry condition (6) and the sharing rule (12), this condition implies that the starting wage can be renegotiated only if

$$\frac{\gamma h}{(1-\gamma)m(\theta)} \equiv \overline{f} > f. \tag{14}$$

One sees that large redundancy payments may prevent any renegotiation. If inequality (14) holds, the employer may initiate a renegotiation of the initial contract when gets an expected profit $\Pi(\varepsilon, w_0)$ lower than the firing cost. 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 (8) of the asset value of a job offering a wage w_0, one gets, by substracting $\Pi(\varepsilon, w_0)$ to $\Pi(\varepsilon_u, w_0)$:

$$\Pi(\varepsilon, w_0) = \frac{\varepsilon - \varepsilon_u}{r+\lambda} + \Pi(\varepsilon_u, w_0). \tag{15}$$

Equation (15) 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_m, must solve $\Pi(\varepsilon_m, w_0) = -f + \Pi_v$. The definition (5) of the asset value of a vacant job, together with the free-entry condition (6), implies that (15) allows us to write the threshold value below which the starting wage may be renegotiated by mutual agreement as:

$$\varepsilon_m = \varepsilon_u - (r+\lambda)\left[f + \frac{h}{m(\theta)}\right]. \tag{16}$$

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 productivity is very low.

3.2.3 Renegotiation of renegotiated wages

A wage $w(y)$ negotiated when productivity was y may be renegotiated if the employer gets a lower discounted profit than the firing costs by abiding by the contract stipulating the wage $w(y)$. From equation (8), the asset value of a job with a wage $w(y)$ and idiosyncratic component ε can be written as

$$\Pi\left[\varepsilon, w(y)\right] = \frac{\varepsilon - y}{r+\lambda} + \Pi\left[y, w(y)\right]. \tag{17}$$

This asset value increases with ε, therefore, there exists a unique threshold value of the productivity on a job with a wage $w(y)$, that has been negotiated by the employer when the productivity was y, below which the asset value is smaller than the firing cost. This threshold value, denoted by $\varepsilon_m(y)$, satisfies $\Pi\left[\varepsilon, w\left[\varepsilon_m(y)\right]\right] = -f + \Pi_v$. The profit $\Pi\left[y, w(y)\right]$ can be computed from the sharing rule (13), the definition of the surplus (11) and the free-entry condition (6). Substituting the value of $\Pi\left[y, w(y)\right]$ in (17) and using the definition of ε_m given equation (16) allows us to write the threshold value as follows:

$$\varepsilon_m(y) = \varepsilon_m - \gamma(\varepsilon_u - y) + (r+\lambda)f \tag{18}$$

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 $\varepsilon_m(y) < \varepsilon_m$ if condition (14) is fulfilled.

It has just been shown that high redundancy payments may prevent employers from renegotiating labor contracts when bad productivity shocks occur. Now that we have described the influence of the redundancy payments on the negotiation process, let us turn to the analysis of the consequences of redundancy payments on unemployment and welfare.

4 Labor market equilibrium

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.

4.1 Job creation

The job creation equation is obtained from the free-entry condition (6), the definition of the asset value of a vacant job (5), the definition of the surplus (11) and the sharing rule (12):

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)}{(r+\lambda)}\left[\varepsilon_u - z + \lambda\int_{\varepsilon_d}^{\varepsilon_u}\frac{(x-\varepsilon_u)}{r+\lambda}dG(x) + \frac{h\{\lambda\left[1-G(\varepsilon_d)\right] - \gamma\theta m(\theta)\}}{(1-\gamma)m(\theta)}\right] \tag{19}$$

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 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 is not monotonic. It can easily be established —by differentiating the right-hand side of equation (19)— that the expected profit of a job reaches a maximum for the value of ε_d that yields a zero surplus. This job creation equation is drawn on Figure 1, where it is denoted by JC.

4.2 Job destruction

In order to analyze job destruction decisions, we begin to focus on the case where renegotiations effectively occur before turning to the situation where the redundancy payments are so high that renegotiation is impossible.

4.2.1 Job destruction when renegotiations occur

It can be easily understood that firms and employees decide to separate only if the value of the surplus becomes negative when renegotiations occur. The employer decides to destroy the job instead of continuing the job with a new contract if the current productivity, ε, satisfies $\Pi\left[\varepsilon, w(\varepsilon)\right] < -f + \Pi_v$. Using the sharing rule (13), one sees that this condition amounts to $S(\varepsilon) < 0$. Therefore, thanks to the definition of the surplus (11), which implies that the surplus increases with productivity, one can compute the reservation productivity, denoted by ε_s, below which the surplus becomes negative. This threshold value solves $S(\varepsilon_s) = 0$, hence (11) implies that:

$$\varepsilon_s = z + \frac{\theta h\gamma}{1-\gamma} - \frac{\lambda}{\lambda+r}\int_{\varepsilon_s}^{\varepsilon_u}(x-\varepsilon_s)dG(x). \tag{20}$$

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—, but does not depend on the redundancy payment. 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.

4.2.2 Job destruction in the economy without renegotiation

Obviously, when there is no renegotiation —*i.e.* if condition (14) is not fulfilled—, job destruction decisions do not hinge on renegotiation opportunities. 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 $\Pi(\varepsilon, w_0)$ increases with idiosyncratic component ε, there exists a unique threshold value of ε, denoted by ε_0, below which jobs are destroyed, that solves[4] $\Pi(\varepsilon_0, w_0) = -f + \Pi_v$. The definition (8) of the asset value of a continuing job paying the starting wage together with the free-entry condition (6) implies that this condition reads as:

$$\varepsilon_0 = w_0 - \lambda\Pi_\lambda(w_0) - (r+\lambda)f \tag{21}$$

Using the free-entry condition (6), the equations (7), (9) and the sharing rule (12), one gets the following expression for the starting wage:

$$w_0 = z + \frac{\gamma h}{(1-\gamma)m(\theta)}\left[r + \lambda G(\varepsilon_0) + \theta m(\theta)\right] - \lambda G(\varepsilon_0) f. \tag{22}$$

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

$$\Pi_\lambda(w_0) = -f + \int_{\varepsilon_0}^{\varepsilon_u} \frac{x - \varepsilon_0}{r+\lambda} dG(x) \tag{23}$$

Substituting (22) and (23) into (21) yields:

$$\varepsilon_0 = z + \frac{\gamma h}{(1-\gamma)m(\theta)}\left[r + \lambda G(\varepsilon_0) + \theta m(\theta)\right] - \lambda G(\varepsilon_0) f - \frac{\lambda}{r+\lambda}\int_{\varepsilon_0}^{\varepsilon_u} (x - \varepsilon_0) dG(x) \tag{24}$$

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 (14) 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.

4.3 Equilibrium

4.3.1 Equilibrium with renegotiations

When renegotiations occur, the equilibrium values of the labor market tightness and the reservation productivity below which jobs are destroyed, $(\theta^*, \varepsilon_s^*)$, are defined by the job creation equation (19) and

[4] Let us remark that ε_0 solves $\Pi(\varepsilon_0, w_0) = -f + \Pi_v$ when there is no renegotiation while ε_m, defined equation (16), solves $\Pi(\varepsilon_m, w_0) = -f + \Pi_v$ when there is renegotiation. Formally, the expresssion for $\Pi_\lambda(w_0)$ found in equation (8) is not the same in both cases. It is defined by equations (23) when there is no renegotiation and by $\Pi_\lambda(w_0) = \int_{-\infty}^{\varepsilon_s} -f dG(x) + \int_{\varepsilon_s}^{\varepsilon_m} \Pi\left[x, w(x)\right] dG(x) + \int_{\varepsilon_m}^{\varepsilon_u} \Pi(x, w_0) dG(x)$ otherwise.

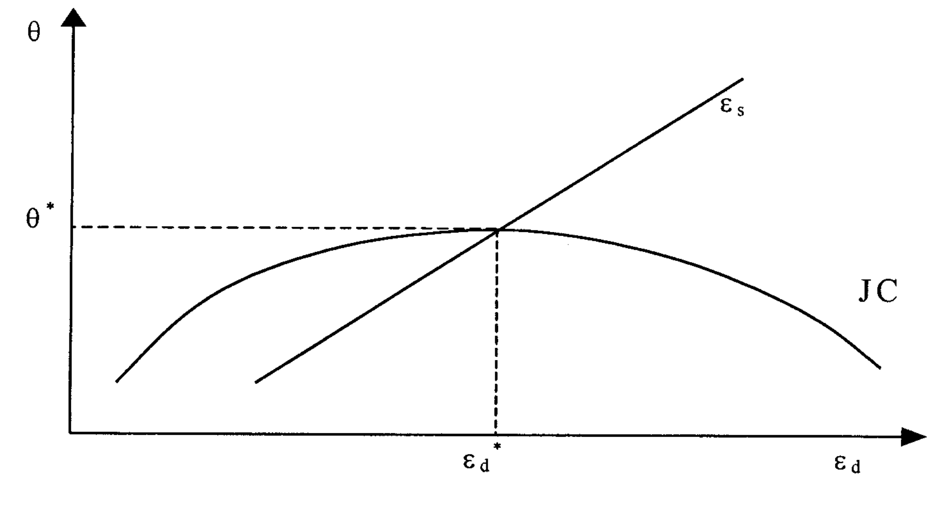

Figure 1: Labor market equilibrium with wage renegotiation

the job destruction equation (20), with $\varepsilon_d = \varepsilon_s$ in equation (19) —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 condition under which jobs are created 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 profiles depend on redundancy payments. It can be shown that renegotiated wages $w(y)$, increase with productivity y, that they are smaller than the equilibrium starting wage w_0^*. Accordingly, wages belong to the interval $[w(\varepsilon_s^*), w_0^*]$, and an increase in the redundancy payment f narrows the support of the wage distribution which degenerates to a mass point when the redundancy payment is so high that renegotiation becomes impossible —see condition (14).

4.3.2 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 (19) and the job destruction equation (24), with $\varepsilon_d = \varepsilon_0$ in (19) —see Figure 2. 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, by comparing Figures 1 and 2, that the equilibrium value of the job destruction rate is lower than in the regime with renegotiated wages, 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

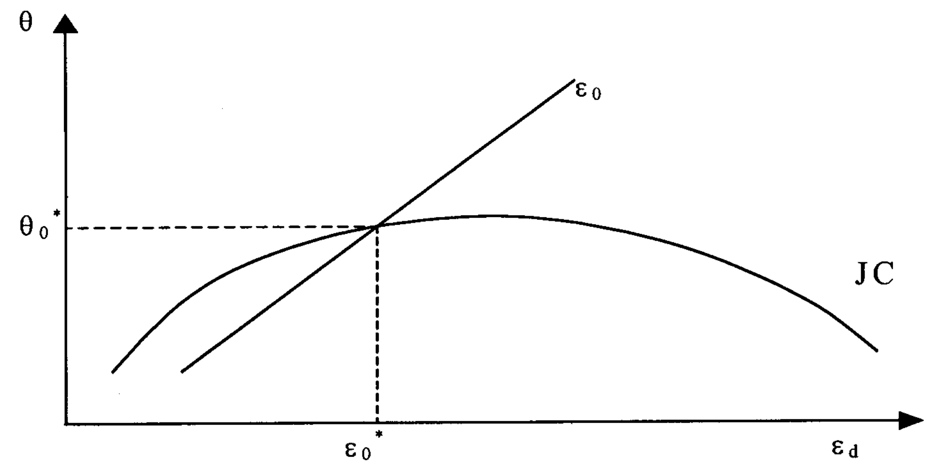

Figure 2: Labor market equilibrium without renegotiation

when renegotiation is impossible, and that an increase in redundancy payments decreases both the job destruction rate and the labor market tightness.

It has been shown that high compulsory redundancy payments may prevent any renegotiation and influence job creation and destruction. Let us now turn to their consequences in terms of unemployment and welfare.

5 Unemployment, welfare and distributional effects of redundancy payments

In this section, we focus on the qualitative consequences of government mandatory redundancy payments in the equilibrium without renegotiation. Then we provide some numerical exercises that allow us to show that reasonable values of redundancy payments may lead to an equilibrium without renegotiation, and to evaluate their impact on unemployment and welfare.

5.1 Unemployment

Since redundancy payments have a negative impact on both job creations and destructions, their global effect on unemployment is *a priori* ambiguous. However, it can be easily shown that increases in redundancy payments diminish unemployment in the neighboring of $\bar{f} \equiv \gamma h/(1-\gamma)m(\theta^*)$. This result can be understood by looking at Figure 2. Redundancy payment increases, which entail shifts of the ε_0 curve towards the left, have a very weak effect on the labor market tightness —the JC curve being independent of f and horizontal in the neighboring of $\bar{f}$— and a relative strong effect on job destruction.

Accordingly, there is a range of parameter values such that severance payment increases have a negative impact on unemployment. Hence, pure compulsory severance transfers have different qualitative effects than administrative dismissal costs, which are known to have an ambiguous impact on unemployment (Mortensen and Pissarides, 1997). In our framework, administrative dismissal cost increases would shift the ε_0 curve towards the left, and the JC curve towards the bottom.

5.2 Welfare and distributional effects

When renegotiation is impossible, redundancy payment increases have a negative effect on welfare whatever the value of the share parameter γ. One knows —see Caballero and Hammour (1996) and Mortensen and Pissarides (1998b)— that the decentralized equilibrium yields a too low job destruction rate if the share parameter differs from the elasticity of the matching function with respect to unemployment. One can also show that redundancy payments larger than $\bar{f}$, by decreasing the job destruction rate below its efficient level, can only decrease steady state welfare. More precisely, restricting the analysis to steady state policicy rules, it is shown —see appendix 3— that a social planner choosing a stationary job destruction rate, but leaving labor market tightness determined by the free-entry condition chooses the same job destruction rate as the one that emerges in a decentralized equilibrium with renegotiation.

Welfare analysis also shows that high redundancy payments are unfavorable to the unemployed workers, who are the individuals in the most disadvantageous situation in our economy. Indeed, any increase in redundancy payments that decreases labor market tightness is also conducive to a drop of the welfare of the unemployed workers, V_u, which satisfies $rV_u = z + [\gamma h\theta/(1-\gamma)]$. Accordingly, applying Rawls criterion does not allow for recommending to introduce high government-mandated severance payments. It is also obvious that high compulsory severance payments have a negative impact on the welfare of entrants —*i.e.* workers who are just matched and negotiate their starting contract—, which amounts to $V(w_0) = V_u + [\gamma h/m(\theta)(1-\gamma)]$.

But some individuals may benefit from high redundancy payments. Indeed, the insiders, whose wages are fixed by previously negotiated contracts, can benefit from redundancy payments larger than $\bar{f}$, if such an advantage is obtained without any contract renegotiation, for instance thanks to a government decision. In order to understand why this may be the case, let us begin to remark that since variations in f do not influence welfare and profits on new jobs if $f \leq \bar{f}$, workers and employers are indifferent to bargain a contract stipulating a wage, w, only, or a pair, (w, f), as long as $f \leq \bar{f}$. The counterpart of higher redundancy payments being simply a lower wage. However, in our framework, none employer-worker pair will negotiate a contract with $f > \bar{f}$, because it would be inefficient. Accordingly, $f > \bar{f}$ cannot arise from a decentralized equilibrium, even if workers have a very large bargaining power. However, it can be shown —see appendix 4— that a rise in f in the neighboring of $f = \bar{f}$ increases the welfare of insiders given their current wages, previously negotiated. Actually, these wages should remain unchanged, since any increase in redundancy payments leads to a drop of the welfare of unemployed workers, V_u, which implies that the insiders cannot take advantage of redundancy payments to renegotiate their wages. Therefore, the insiders should give political support to redundancy payments bigger than $\bar{f}$: It allows them to get longer job tenures and higher severance transfers without any wage drop. Obviously, high compulsory redundancy payments, by decreasing the welfare of unemployed workers, have also a negative impact on the welfare of insiders. This negative effect, which is systematically dominated in the neighboring of $\bar{f}$, becomes stronger when f is very large.

So far, our analysis has shown that redundancy payments may have a positive effect on employment if they are large enough, but a negative effect on welfare. Moreover, they raise inequality at the expenses of the most disadvantageous individuals. Overall, governement-mandated redundancy payments have both desirable and undesirable consequences. It is worth providing some quantitative evaluations in order to get a more precise idea of their advantages and drawbacks.

5.3 Calibration

We take parameter values not too different from those of the base line values chosen by Mortensen and Pissarides (1998a) which are supposed to represent the main features of a 'representative' European labor market over the past ten 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 $[0, 1]$. The other parameter values used in the computations are reported in Table 1.

For these benchmark values, the unemployment rate is about 6% when there is no redundancy payment. One can check that the values of the job destruction rate and of the exit rate from unemployment

γ	z	λ	h	r
.5	.5	.1	.2	.02

Table 1: Parameter Values

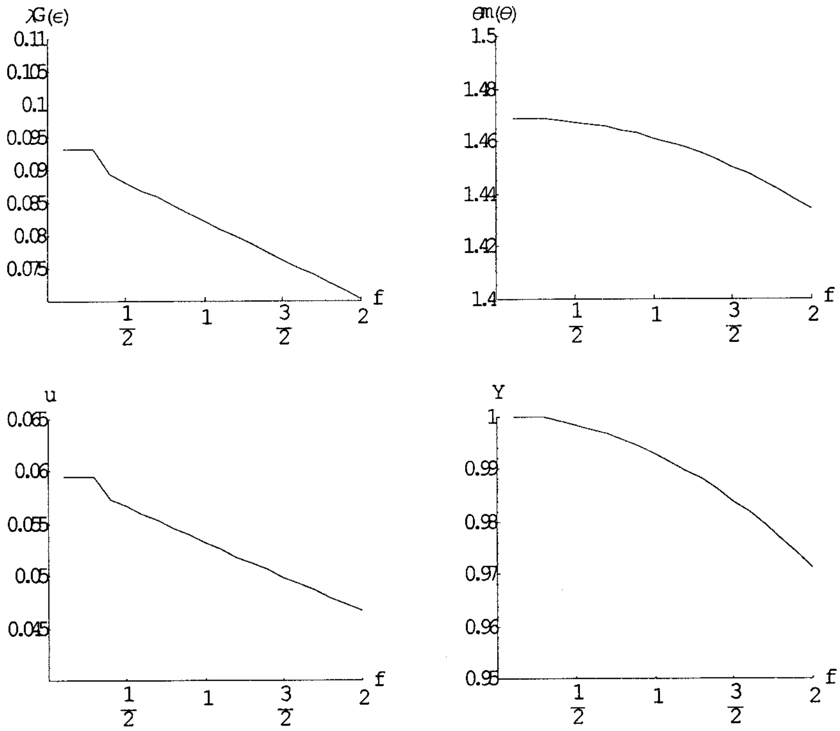

Figure 3: The effect of redundancy payments on the job destruction rate, the exit rate from unemployment, the unemployment rate and welfare.

are reasonable. The threshold value, $\bar{f}$, over which redundancy payments have effects on unemployment and welfare is about 0.29, which is a bit less than one third of the average quarterly production of a job —which amounts to 0.997 when redundancy payments are nil. Therefore, redundancy payments may have non neutral effects in a reasonable range of values. Indeed, this is not surprising. Looking at the definition (14) of $\bar{f}$, one sees that it is equal to the expected cost of a vacancy when $\gamma = 1/2$, a value that should be lower than compulsory redundancy payments found in most countries of European Union.

An increase in redundancy payments entails an important decrease in the job destruction rate and the unemployment rate in the neighboring of $\bar{f}$. When redundancy payments become large enough, their impact becomes smaller, but remains significant.

Figure 3 shows that introducing government-mandated redundancy payments representing about two quarters of average production per job allows for a reduction in unemployment of about 1.2 points of percentage. Obviously, there are also counterparts: There is a 2.8% decrease in aggregate production and a drop of the exit rate from unemployment.

6 Conclusion

This paper shows that government-mandated severance transfers by the employer to the worker can have employment and welfare effects if labor contracts are incomplete and renegotiated by mutual agreement only. We believe that the type of labor contract incompleteness that has been considered can be found in many actual labor markets, and especially in Continental Europe. Therefore, our analysis suggests that government-mandated severance transfers, which benefit to the insiders, do act on unemployment, and may increase employment in some circumstances. However, we also stressed that severance transfers can decrease aggregate production, the exit rate from unemployment and the welfare of the unemployed, who are the individuals in the most disadvantageous situation.

The consequences of government-mandated severance transfers have been studied in a very simple economic environment. It is worth stressing that introducing moral hazard into the employment relationship, or borrowing constraints, would enrich the analysis and might reverse some of our results. In particular, our analysis of efficiency and welfare would be very different, because the decentralized job destruction rate would not be necessarily efficient in a richer environment. More analysis is needed in this field to begin to have a precise idea of the consequences of government-mandated severance transfers.

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Appendix 1: The surplus

From equation (10) 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:

$$S(\varepsilon) = V\left[w(y)\right] - V_u + \Pi\left[\varepsilon, w(y)\right], \tag{25}$$

where $V\left[w(y)\right]$ is defined in equation (9) and $\Pi\left[\varepsilon, w(y)\right]$ is defined in equation (8). Let us define by ε_d the threshold value of productivity below which jobs are destroyed and by $\varepsilon_m(y)$ the threshold value of productivity below which a wage $w(y)$ is renegotiated —$\varepsilon_m(y)$ is derived formally in section 3.2. One can define the expected income of a worker who is paid a wage $w(y)$ when the job is hit by a shock as:

$$V_\lambda\left[w(y)\right] = \int_{-\infty}^{\varepsilon_d}\left[f + V_u\right]dG(x) + \int_{\varepsilon_d}^{\varepsilon_m(y)} V\left[w(x)\right]dG(x) + \int_{\varepsilon_m(y)}^{\varepsilon_u} V\left[w(y)\right]dG(x). \tag{26}$$

Similarly, the expected value of a job which pays a wage $w(y)$ and is hit by a shock reads as:

$$\Pi_\lambda\left[w(y)\right] = \int_{-\infty}^{\varepsilon_d} -f dG(x) + \int_{\varepsilon_d}^{\varepsilon_m(y)} \Pi\left[x, w(x)\right]dG(x) + \int_{\varepsilon_m(y)}^{\varepsilon_u} \Pi\left[x, w(y)\right]dG(x). \tag{27}$$

The two last equations together with the definition of the surplus (25) imply:

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

Using the expression for $V\left[w(y)\right]$ and $\Pi\left[\varepsilon, w(y)\right]$ defined in equation (9) and (8) respectively, together with this last equation and the definition of the surplus (25) allows us to write:

$$(r+\lambda)S(\varepsilon) = \varepsilon - r(V_u - f) + \lambda\int_{\varepsilon_d}^{\varepsilon_u} S(x)dG(x). \tag{28}$$

The definition of the discounted expected income of an unemployed worker (7) together with the sharing rule (12) and the free-entry condition (6) yields:

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

Substituting this expression for rV_u into (28) yields (11).

Appendix 2: The strategic negotiation game

Negotiation on new matches

The subgame perfect equilibria of the strategic bargaining game on the new matches 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 $V_u + S(\varepsilon_u)$ 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 amounts to $e^{-r\Delta}\left[V_u + \gamma S(\varepsilon_u)\right]$. In the first step, the employer offers the lowest possible share of the surplus to the worker, which implies that the worker gets $V(w_0) = e^{-r\Delta}\left[V_u + \gamma S(\varepsilon_u)\right]$, which is the sharing rule given equation (12) when $\Delta \longrightarrow 0$. 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

Let us show that the subgame perfect equilibrium of the renegotiation game corresponds to the sharing rule given equation (13). 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. Accordingly, 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 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. Let us begin to analyze this negotiation process. In step (iv), the worker and the employer accept any payoff larger than $V_u + f$ and $\Pi_v - f$ respectively. Thus, in step (iii), the worker offers —with probability γ— a profit $\Pi_v - f$ and gets $S(\varepsilon) + V_u + f$, whereas the employer offers $V_u + f$ and gets $S(\varepsilon) + \Pi_v - f$, with probability $1-\gamma$. Therefore, in step (ii), the expected payoff to the worker is $e^{-r\Delta}\left\{V_u + \gamma S(\varepsilon) + f\right\}$ In step (i), the employer offers the lowest wage that provides at least $e^{-r\Delta}\left\{V_u + \gamma S(\varepsilon) + f\right\}$ to the worker. Accordingly, when $\Delta \longrightarrow 0$, 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 (13).

Step b

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

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

Similarly, the employer agrees to renegotiate the initial contract if and only if $\Pi\left[\varepsilon, w(\varepsilon)\right] > \Pi(\varepsilon, w_0)$, a condition which is equivalent to

$$f < \gamma \frac{\varepsilon_u - \varepsilon}{r + \lambda} \tag{30}$$

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 $\Pi\left[\varepsilon, w(\varepsilon)\right] = (1-\gamma)S(\varepsilon) - f$ 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 $\Pi\left[\varepsilon, w(\varepsilon)\right] < \Pi(\varepsilon, w_0)$. 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 $\Pi\left[\varepsilon, w(\varepsilon)\right] = (1-\gamma)S(\varepsilon) - f$ if the worker accepts to renegotiate. The worker accepts only if $V\left[w(\varepsilon)\right] \geq V_u + f$ which is equivalent, according to the sharing rule (13) derived in step c, to $S(\varepsilon) \geq 0$. Similarly, $\Pi\left[\varepsilon, w(\varepsilon)\right]$ is bigger than $-f + \Pi_v$ 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 accepts if condition (30) holds, and step c that the worker gets $V\left[w(\varepsilon)\right] = \gamma S(\varepsilon) + V_u$. Using the definition of the surplus (10) and the sharing rule (12), one gets $V\left[w(\varepsilon)\right] > V_0 \Leftrightarrow f > \gamma \frac{\varepsilon_u - \varepsilon}{r+\lambda}$, which implies, together with condition

(30) that the worker cannot increase his payoff by triggering off a renegotiation, because the employer refuses to renegotiate when $V[w(\varepsilon)] > V_0$. Accordingly, the worker never initiates a renegotiation of the initial contract.

Appendix 3: Welfare

We are looking for the optimal destruction rate chosen by a social planner maximizing the discounted aggregate product knowing that the decentralized job creation condition is given by equation (19). This equation implicitly defines θ as a function of ε_d. Let us denote by $\phi(\varepsilon_d) = \theta$ this function. Then, the model presented in section 2 implies that the socially optimum sequence of aggregate production solves the following program:

$$\underset{\{\varepsilon_d\}}{Max} \int_0^{\infty} \{Q + u[z - h\phi(\varepsilon_d)]\} e^{-rt} dt \tag{31}$$

subject to:

$$\dot{u} = \lambda G(\varepsilon_d)(1-u) - u\phi(\varepsilon_d)m[\phi(\varepsilon_d)], \tag{32}$$

$$\dot{Q} = \varepsilon_u \phi(\varepsilon_d) m[\phi(\varepsilon_d)] u + \lambda \left[(1-u)\int_{\varepsilon_d}^{\varepsilon_u} x dG(x) - Q\right].$$

Let μ and ν denote the costate variable associated with unemployment and production respectively. The Hamiltonian reads as:

$$\begin{aligned} H &= \{Q + u[z - h\phi(\varepsilon_d)]\} e^{-rt} + \mu \{\lambda G(\varepsilon_d)(1-u) - u\phi(\varepsilon_d)m[\phi(\varepsilon_d)]\} \\ &\quad + \nu \left\{\varepsilon_u \phi(\varepsilon_d) m[\phi(\varepsilon_d)] u + \lambda \left[(1-u)\int_{\varepsilon_d}^{\varepsilon_u} x dG(x) - Q\right]\right\}, \end{aligned} \tag{33}$$

and the transversality conditions are:

$$\lim_{t\to\infty} e^{-rt}\mu = \lim_{t\to\infty} e^{-rt}\nu = 0. \tag{34}$$

The first-order conditions can be written as:

$$\frac{\partial H}{\partial \varepsilon_d} = 0 \Leftrightarrow -\phi'(\varepsilon_d)\left\{he^{-rt} + m(\theta)u(1+\eta)(\mu - \nu\varepsilon_u)\right\} = \lambda G'(\varepsilon_d)(\mu - \varepsilon_d \nu), \tag{35}$$

$$\frac{\partial H}{\partial u} = -\dot{\mu} \Leftrightarrow (z - h\theta)e^{-rt} - \mu[\lambda G(\varepsilon_d) + \theta m(\theta)] + \nu\left[\varepsilon_u \theta m(\theta) - \lambda \int_{\varepsilon_d}^{\varepsilon_u} x dG(x)\right] = -\dot{\mu}, \tag{36}$$

$$\frac{\partial H}{\partial Q} = -\dot{\nu} \Leftrightarrow e^{-rt} - \lambda\nu = -\dot{\nu}. \tag{37}$$

Using the transversality conditions (34), (36) and (37) can be rewritten as:

$$e^{rt}\mu = \frac{(z - h\theta)(r+\lambda) + \varepsilon_u \theta m(\theta) - \lambda \int_{\varepsilon_d}^{\varepsilon_u} x dG(x)}{(r+\lambda)[r + \theta m(\theta) + \lambda G(\varepsilon_d)]}, \tag{38}$$

$$e^{rt}\nu = \frac{1}{r+\lambda}. \tag{39}$$

Using these two last equations and the definition of $\phi(\varepsilon_d)$ given by (19), one can show that:

$$\mu - \varepsilon_d \nu = 0 \Leftrightarrow \phi'(\varepsilon_d) = 0. \tag{40}$$

(40) together with (35), (38) and (39) implies that ε_d such that $\phi'(\varepsilon_d) = 0$ satisfies the first-order conditions of the welfare maximization program (31). One can also check that the two equations $\phi'(\varepsilon_d) = 0$ and $\theta = \phi(\varepsilon_d)$ define the job destruction rate and the labor market tightness $(\varepsilon_s^*, \theta^*)$ obtained in the decentralized equilibrium —it is straightforward by looking at Figure 1 where JC corresponds to $\theta = \phi(\varepsilon_d)$ and the job destruction curve ε_s cuts JC at its maximum.

Appendix 4: Distributional effects

We want to show that the welfare of insiders increases with respect to f in the neighboring of $\overline{f}$. For the sake of simplicity, let us assume that we are in a steady state with $f = \overline{f}$. Such a situation may arise from a market equilibrium, since workers and employers are indifferent to bargain a contract stipulating a wage, w, only, or a pair, (w, f), for any $f \leq \overline{f}$. In such circumstances, the whole insiders get the same wage w_0, satisfying $V(w_0) = V_u + \overline{f}$, which is not renegotiated when there is an increase in f. Given this wage w_0 and the new value of severance payments, using the definition (8) of the asset value of a job, $\Pi(\varepsilon, w)$, one can define the threshold value of productivity, denoted by ε_π, below which the jobs of the insiders, whose wages have been negotiated before the shock on f, are destroyed:

$$\varepsilon_\pi = w_0 - rf - \frac{\lambda}{r+\lambda}\int_{\varepsilon_\pi}^{\varepsilon_u} (x - \varepsilon_\pi) dG(x). \tag{41}$$

The welfare of insiders, denoted by $V(w_0)$, can be computed from the definitions (9) and (26), of $V(w)$ and $V_\lambda(w)$:

$$rV(w_0) = \frac{w_0 + \lambda G(\varepsilon_\pi)(f + V_u)}{r + \lambda G(\varepsilon_\pi)}, \tag{42}$$

From the shape of the Job Creation curve, presented Figure 1, one knows that $\underset{f \to \overline{f}}{\text{Lim}} \frac{d\theta}{df} = 0$. Therefore, by remembering that $V(w_0) = \overline{f} + V_u$, (42) implies that:

$$\left.\frac{drV(w_0)}{df}\right|_{f=\overline{f}} = \frac{\lambda G(\varepsilon_\pi)}{r + \lambda G(\varepsilon_\pi)} > 0.$$