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Matching, Wage Rigidities and Efficient Severance Pay*

Giulio Fella[†]

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Abstract

This paper studies the effect mandated severance pay in a matching model featuring wage rigidity for ongoing, but not new, matches and Pareto efficient spot renegotiation of mandated severance pay. Severance pay matters only if real wage rigidities imply inefficient separation under employment at will. In such a case, large enough severance payments reduce job destruction and increase job creation and social efficiency, under very mild conditions. Efficient renegotiation implies that severance pay never results in privately inefficient labour hoarding and that its marginal effect is zero when its size exceeds that which induces the same allocation that would prevail in the absence of wage rigidity. These results hold under alternative micro-foundations for wage rigidity.

JEL classification: E24, J64, J65.

Keywords: Severance pay, renegotiation, wage rigidity

1 Introduction

Mandated employment protection measures associate monetary and shadow costs to workforce adjustment. A common concern is that these “layoff” or “firing” costs result in inefficient labour hoarding and are responsible for the poor employment performance of a number of Continental European countries relative to the United States. This concern has sparked an extensive literature discussed below.

Within this literature, Lazear’s (1990) seminal contribution established that for mandated employment protection to alter the allocation of labour: (1) either employment protection measures must entail a *tax* component which is lost to the firm-worker pair; or (2) payments between firms and workers must be constrained.

*This paper is a much generalised version of a number of results in Fella (1999). I am indebted to Paola Manzini for many useful discussions.

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For this reason, the literature on employment protection falls into two main categories. Papers in the first (and larger) one study the effect of firing costs when the latter take the form of a tax on separation.¹ Papers in the second category consider the effect of severance payments in the presence of wage rigidities.

This paper belongs to the second category. It constructs a version of Mortensen and Pissarides's (1994) matching model which encompasses alternative wage setting mechanisms for ongoing matches, but in which there is no constraint on entry side payments (full bonding).² It analyses the two main micro-foundations for wage rigidity: efficiency wages and right-to-manage bargaining.

The paper derives two main results. First, if the real wage that applies to ongoing matches is downward rigid, severance payments increase job creation and efficiency as long as they reduce job destruction. For large enough severance payments this is indeed the case under very mild conditions, up to the minimum efficient size that induces the same labour allocation as under flexible wages. Second, severance payments never result in privately inefficient labour hoarding. Any increase in severance payments beyond their minimum efficient size is neutral, as long as the parties can negotiate (*spot*) side payments upon separation.

The intuition behind the first result is the following. If wage rigidity is binding – in the sense that the job destruction rate is higher than under flexible wages – separation is ex post, hence ex ante, *privately* inefficient under employment at will. To the extent that severance payments reduce separation, they increase the ex ante joint payoff from a job match, up to the point where termination is jointly optimal. Since the firm captures a positive share of the increased ex ante surplus also job creation increases. More surprisingly, *social* efficiency also improves unambiguously despite that, as known from Hosios (1990), a priori higher job creation and lower job destruction do not necessarily improve efficiency in the presence of matching externalities.

If the equilibrium under employment at will is unique, severance payments below the minimum efficient size do indeed unambiguously reduce the separation rate at the margin under mild, model-specific conditions. In general though, multiple, Pareto-ranked, steady-state equilibria cannot be ruled out in the presence of binding real wage rigidity. Some of these equilibria feature a perverse comparative statics in which higher severance payments increase job destruction and reduce job creation at the margin. Yet, only the well-behaved, (constrained) efficient equilibrium with the lowest job destruction survives for large enough severance payments. Therefore, large enough severance payments unambiguously reduce job destruction.

To understand the intuition for why severance payments do not lead to privately inefficient labour hoarding consider the extreme case in which the mandate severance payment is infinite. The marginal worker's reservation severance payment equals the difference between the present value of income if employed and if unemployed. The firm reservation severance payment is the one that gives it a payoff equal to the expected value of profits from the marginal worker. Whenever the joint payoff from separation exceeds

¹Recently, Garibaldi and Violante (2005) and Fella (2007) have argued that the tax component of mandated employment protection measures is unlikely to be quantitatively important.

²The latter assumption is not only a common benchmark in the literature (see e.g. Mortensen and Pissarides 1999, Garibaldi and Violante 2005) but it also usefully helps insulating issues of quantity flexibility from issues of entry wage flexibility.

the joint return from continuation, the two reservation payments define a non-empty set of transfers which leave one party at least indifferent to, while making the other one strictly prefer, separation to continuation. Therefore even if it is not optimal for the firm to pay the mandated severance payment and lay the worker off, it is Pareto-optimal for the parties to agree to exchange a lower transfer and separate. The parties can implement this outcome in two equivalent way. They can agree to label the separation a quit (or a voluntary redundancy), in which case transfers between them are unconstrained by legislation. Alternatively, they can label the separation a layoff, with the worker rebating to the firm, on the spot, the difference between the legislated and the Pareto optimal severance transfer. The ability to renegotiate the mandated severance payment just requires that Pareto-improving spot side payments upon separation are unconstrained. Therefore, severance payments do not affect the marginal separation payment and job destruction when they exceed their minimum efficient value which ensures efficient separation. Since the ex post spot payments are foreseen at the time of match is formed, job creation is also unaffected as workers fully prepay for the higher (infra-marginal) severance payment.

The results in the paper have implications for possible labour market reforms. If the effects of severance payments stem from the downward rigidity of wages in ongoing matches, large enough severance payments are efficient provided entry wages are flexible. Though it is possible and even likely that entry wages are not flexible enough, the paper implies that the constrained-efficient policy response is to increase the flexibility of entry wages, or subsidise job creation, rather than removing legislated severance payments. A reform that removed existing severance payments would constitute a windfall loss for workers in existing jobs and a windfall gain for their employers and would result in inefficiently high destruction of existing jobs. This provides an additional argument, over and above political economy considerations (see e.g. Saint-Paul 2002), for a reform to apply only to newly created jobs.

The paper is obviously related to the broad literature applying Lazear's result to study the effect of firing costs in flexible wage models³ and to a number of papers which study the equilibrium effect of severance payments when wages are downward rigid.

Within the second class of models, Saint-Paul (1995) and Fella (2000) study the effect of severance payments in a dynamic version of Shapiro and Stiglitz's (1984) efficiency wage model under the assumption that severance payments are paid only in case of economic but not disciplinary dismissals. Alvarez and Veracierto (2001) study the same problem in a competitive, one-sided search model with state-independent, hence rigid, wages. In all these models severance payments reduce job destruction and, at least over a range, increase job creation and efficiency. Yet, high enough severance payments eventually reduce efficiency. In contrast, I show that, to the extent that job destruction is reduced, efficiency never falls once mutually beneficial renegotiation is allowed for. Furthermore, these results generalise to all rigid-wage models as long as severance pay increases the present value of wages less than proportionally. This is true even in the presence of matching externalities, which are absent from the papers above.

Galdón-Sánchez and Güell (2003) show that severance payments reduce job creation and efficiency in Shapiro and Stiglitz's (1984) shirking model, as long as there is a strictly positive probability that they are also paid in the case of disciplinary dismissal. With an

³An incomplete list includes Bertola (1990), Burda (1992), Millard and Mortensen (1997), Blanchard and Portugal (2000), Ljungqvist (2002).

exogenous separation rate, severance payments cannot increase the ex ante joint surplus. Furthermore, since bonding is ruled out, the increase in the ex post rent stemming from the inability to distinguish perfectly between economic and disciplinary dismissal reduces firms' profits from new matches. I endogenise job destruction and allow for bonding in their model. I show that their result is reversed in my set up, as long as the probability that severance payments are erroneously paid for disciplinary dismissals is strictly less than the probability that they are correctly paid for economic redundancies.

Garibaldi and Violante (2005) show that severance payments reduce job destruction and increase the value of new jobs in a matching model with exogenously rigid wages in ongoing matches and full bonding. They show that they are neutral if wages for ongoing matches are endogenously determined by a monopoly union. I generalise their union model and show that their neutrality result is restricted to the monopoly union case. Under right-to-manage severance pay is non-neutral as long as severance payments are not due if workers quit unilaterally.

Postel-Vinay and Turon (2011) find the firing costs increase employment in a version of Mortensen and Pissarides's (1994) with on-the-job search and rigid exogenous wages.

The paper is structured as follow. Section 2 introduces the economic environment. Section 3 studies the equilibrium with exogenous, rigid wages in ongoing matches. Section 4 studies the equilibrium under two micro-foundations for wage rigidity: efficiency wages and right-to-manage bargaining. The concluding Section 5 summarises and discusses some of the assumptions underlying the results.

2 The model

2.1 Environment

The economic environment is effectively the same as in Mortensen and Pissarides (1994). Time is continuous. All agents have linear preferences, live forever and discount the future at the constant rate $r > 0$. The economy is composed by an endogenous number of establishments (or firms) and a unit mass of workers. Workers are endowed with one indivisible unit of leisure whose utility is z .

Each establishment requires one worker in order to produce and can either have a vacancy and be looking for a worker or be matched to a worker. Firms with vacant positions and unemployed workers are brought together by a random matching process according to a constant returns to scale, strictly increasing and concave, matching technology $m(u, v)$, where u is the number of unemployed workers, v the number of vacancies and $m(\cdot)$ the associated flow of new matches. With constant returns, instantaneous matching rates depend only on market tightness $\theta = v/u$. Contact rates are denoted by $q(\theta) = m(u, v)/v$, for vacant firms, and $p(\theta) = m(u, v)/u$, for unemployed workers. Keeping an open vacancy entails a flow cost $c > 0$ and there is free entry in vacancy posting.

Firm-worker matches (or jobs) are ex ante identical, but subject to idiosyncratic productivity shocks. Following standard practice, it is assumed, without loss of generality, that all new matches start out at the top of the productivity support, normalised to 1, and

that there are positive gains from forming a new match.⁴ Shocks hit all jobs at Poisson rate λ . Following a shock, the match productivity y takes a new value, i.i.d. across time and drawn from a continuous cumulative density function $G(y)$ with support $[0, 1]$.

When a new match is formed, the parties negotiate a sign-up payment S from the firm to the worker and a state-independent wage w that applies throughout the duration of the match. The pair (S, w) is assumed to maximise the Nash bargaining solution with weight $\beta \in (0, 1)$ on the worker's gain. The bargained wage has to satisfy a lower bound \underline{w} , which captures, possibly binding, wage rigidities.⁵ We consider first the case in which the constraint is not binding and then the case in which it is binding. The binding lower bound \underline{w} is assumed to be exogenous in Section 3 and is endogenous in Section 4.

Employment protection legislation (EPL) mandates that firms have to transfer a severance payment F to workers in case a separation is labelled a layoff but not if it is a quit or a voluntary redundancy. Namely, separation payments are contingent on which party takes verifiable steps to end the relationship. A separation is deemed a layoff, if the firm gives written notice that the worker's services are no longer required. On the other hand, a separation is deemed a quit, and no payment is due, if the worker gives written notice that he or she no longer intends to continue in employment (or simply stops showing up for work without obtaining leave). Any claim by one party that the other has unilaterally severed the relationship must be supported by documentation. This accords with existing practises in most industrialised countries.

I allow for the possibility that at the time of separation the parties "renegotiate" the mandated layoff payment F , and agree to separate with a lower transfer, if doing so yields a Pareto improvement. Indeed, the parties can achieve this outcome in two equivalent ways. They can agree to call the separation a quit (or voluntary redundancy) rather than a dismissal, in which case transfers between them are unconstrained by legislation. Alternatively, they can label the separation a layoff, with the worker rebating to the firm, on the spot, the difference between the legislated and the Pareto optimal severance transfer.

2.2 Analysis

2.2.1 Bellman equations

The joint return $Z(y, w)$ from production in a match with current productivity y and wage w satisfies

$$rZ(y, w) = y + \lambda \left[\int_R^1 Z(y', w) dG + G(R)(U + V) - Z(y, w) \right]. \quad (1)$$

Equation (1) assumes that when a shock hits the match, the latter survives if the new productivity realisation y' is above some reservation value R and is destroyed otherwise.⁶ Note that the equation implies that $Z(y, w)$ depends on w if and only if the latter affects the reservation productivity R .

⁴This last assumption ensures the existence of a non-trivial equilibrium with positive employment.

⁵The bargaining mechanism is similar - in fact isomorphic - to that in Rocheteau (2002)

⁶Since $Z(y)$ is increasing in y , it will become clear later in the analysis that the assumption is indeed satisfied.

The lifetime utility of a worker in an ongoing match with wage w satisfies

$$rW(w) = w + \lambda \int_0^R [U + Q(y', w) - W(w)] dG. \quad (2)$$

The worker receives the wage w until the match is hit by a shock that results in separation. In the latter case, the worker's payoff equals the return to search U plus the equilibrium separation transfer $Q(y', w)$ from the firm to the worker, conditional on the productivity draw y' . The equilibrium transfers $Q(y, w)$ differs from the mandated payment F whenever the latter is renegotiated.

The corresponding value of an ongoing job with productivity y is

$$J(y, w) = Z(y, w) - W(w). \quad (3)$$

Finally, the value of search for an unemployed job seeker satisfies

$$rU = z + p(\theta)(W(w) + S - U), \quad (4)$$

as the lifetime income of a new hire exceeds that of a worker in an ongoing match by the amount of the sign-up fee S . The corresponding value of a vacancy is

$$rV = -c + q(\theta)(Z(1, w) - W(w) - S - V). \quad (5)$$

Before continuing, a few remarks on the above modelling framework are appropriate. First, allowing for entry fees introduces a two-tier payoff structure and implies that bonding is unrestricted.⁷ Assuming full bonding allows to evaluate the effect of severance payments, usually associated with quantity flexibility, in isolation from the conceptually different issue of the flexibility of (the present value of) wages for new hires.

Secondly, the assumption that the wage is state-independent buys tractability with no loss of generality. It is well known that, from an allocational perspective, the mapping between productivity realisations and wages is irrelevant and, given risk-neutrality, the same is true for welfare. In the present set up, the only relevant quantities are the payoff to the marginal worker and the ex ante expected payoff to a new hire. The combination of the wage and sign-up fee allows to decouple the two payoffs in the same way as, the standard, instantaneous bargaining.

2.2.2 Job destruction

Given the payoff from employment $W(w)$, a worker is indifferent between continuing employment and separating with a transfer equal to $W(w) - U$. Similarly, if the match productivity is y , the firm is indifferent between continuing the match and separating with a transfer equal to $V - J(y, w)$. Since, the firm has also the option to unilaterally lay the worker off by paying her the mandated severance payment F , the firm reservation severance payment is $\min\{V - J(y, w), F\}$.

It follows that separation with a transfer between the two reservation severance payments is a Pareto improvement relative to continuing the match; or more formally

⁷Full bonding is a standard benchmark assumption. While sign-up fees are rarely observed in reality, upward-sloping wage profiles would be another, more realistic, way to generate a two-tier payoff structure. This is the route chosen by Mortensen and Pissarides (1999) and Garibaldi and Violante (2005) who allow S to be spread over time by means of an initial wage w_0 which applies over some initial time period. Given risk neutrality, the two modelling choices are isomorphic.

Definition 1 For given y , $W(w)$ and R , the interval

$$\Omega(y, w) = [W(w) - U, \min\{V - J(y, w), F\}] \quad (6)$$

is the set of Pareto-improving and individually-rational separation transfers.

Therefore, if the parties bargain efficiently over separation payments, they will separate in all states in which $\Omega(y, w)$ is non-empty. If $\Omega(y, w)$ is non-empty and does not contain F , they will agree to separate with a transfer strictly smaller than F . If

$$W^r(w) = \frac{w + \lambda G(R)(U + F)}{r + \lambda G(R)} \quad (7)$$

denotes the value of $W(w)$, from equation (2), when $Q(y', w) = F$ for all $y' \leq R$, the following proposition holds.

Proposition 1 For given w :

1. If $w \geq r(U + F)$, the equilibrium separation transfer $Q(y, w)$ equals F for all $y \leq R$. The reservation productivity satisfies $Z(R) = W^r(w) + V - F \geq U + V$ with strict inequality if and only if $w > r(U + F)$.
2. If $w < r(U + F)$ and bargaining over separation is efficient, the equilibrium separation transfer $Q(y, w)$ is strictly smaller than F for some $y \leq R$. The reservation productivity satisfies $Z(R) = U + V$.

Proof. See Appendix. ■ Note that $w \geq r(U + F)$ is equivalent to $W \geq U + F$. Therefore, if $w \geq r(U + F)$, the worker's reservation severance payment $W(w) - U$ is (weakly) larger than the mandated payment F and $\Omega(y, w)$ is either empty – if $w > r(U + F)$ – or contains the single point F . The mandated severance payment is never renegotiated – $W(w) = W^r(w)$ – and the firm lays the worker off whenever the payoff from continuation $J(y, w) = Z(y) - W(w)$ falls below the return from firing $V - F$. If $w > r(U + F)$ the joint payoff from employing the marginal worker $Z(R)$ exceeds the joint payoff from separation $U + V$ and job loss is involuntary. The worker would strictly prefer to accept a wage cut to being laid off. Conversely, if $w = r(U + F)$, the separation rule maximises joint wealth – $Z(R) = U + V$.

If instead $w < r(U + F)$, it is not optimal – $Z(y) - W(w) > V - F$ – for the firm to unilaterally fire the worker when the productivity is marginally below the joint-wealth-maximising reservation value $Z(R) = U + V$. Yet, this does not imply privately inefficient labour hoarding. Since wage rigidity does not constrain spot wealth transfers upon separation and $\Omega(y, w)$ is non-empty when $Z(y) < U + V$, it is jointly optimal for the parties to agree to separate with a separation payment below the mandated one⁸ whenever $W(w) + V - F < Z(y) < U + V$.

It follows that, for given U , the separation rate is either higher than – if $w > r(u + F)$ – or the same as under flexible wages. Mandated severance payments can never induce privately inefficient labour hoarding and the reservation productivity satisfies

$$Z(R) = U + V + \max\{W^r(w) - F - U, 0\}. \quad (8)$$

⁸Appendix A.2 derives the value of the equilibrium transfer $Q(y, w)$ under one particular (efficient) bargaining solution.

This is the first main result in the paper.⁹ It contrasts with results in Bentolila and Bertola (1990), Fella (2000), Alvarez and Veracierto (2001) and Garibaldi and Violante (2005) that imply that in the presence of wage rigidities large enough severance payments induce privately (and possibly socially) inefficient labour hoarding up to the point where all separations other than bankruptcies are prevented. The difference is that those papers assume that a firm-worker pair always exchange the legislated severance payment upon separation. This implies that the parties leave money on the table, despite the fact that, whenever $Z(y) < U + V$, they can be both better off by agreeing to separate with a lower consensual severance payment in the non-empty interval $\Omega(y, w)$.

2.2.3 Bargaining with a new hire

The pair (S, w) solves the standard Nash bargaining problem

$$\max_{S, w} (W(w) + S - U)^\beta (Z(1) - W(w) - S)^{1-\beta}, \quad (9)$$

$$\text{s.t } w \geq \underline{w}, \quad (10)$$

where it is assumed, without loss of generality, that $\underline{w} \geq rU$, so that it is not necessary to impose a separate participation constraint for the worker.

The first-order necessary and sufficient conditions for an optimal choice of S and w can be written as

$$\frac{W(w) + S - U}{\beta} = \frac{Z(1) - W(w) - S - V}{1 - \beta}, \quad (11)$$

$$\frac{\partial Z(1)}{\partial w} = [U + V - Z(R)] \frac{\partial R}{\partial w} \leq 0, \quad w \geq \underline{w} \quad (12)$$

where the two inequalities in (12) hold with complementary slackness.

Equation (11) implies that the sign-up payment S ensures that the firm and worker's surpluses from a new match are proportional to each other and to the joint match surplus $Z(1) - U - V$. The parties' respective shares equal their bargaining weights.

One can use equation (11) to solve for the sign-up payment

$$S = U + \beta[Z(1) - U - V] - W(w). \quad (13)$$

The transfer is negative - the worker pays an entry fee - if and only if the worker's continuation payoff $W(w)$ exceeds a new hire's ex ante return $U + \beta[Z(1) - U - V]$. Given perfect bonding, severance payments do not effect the ex ante division of the surplus as workers are not entitled to them if a worker is not hired. To the extent that they increase the worker's ex post rent $W(w) - U$ they are fully prepaid through a lower value of S .

Equation (12), instead, makes clear that the role of the wage is to ensure that the reservation productivity maximises the ex post - hence the ex ante $Z(1)$ - joint payoff subject to the wage rigidity constraint.

⁹An early, static, version of this result was first circulated as Proposition 4 in Fella (1999), the working paper on some of whose early ideas this paper is based.

If $\underline{w} > r(U + F)$, it follows from Proposition 1 and equation (8), that $\partial R/\partial w > 0$, and the square bracket is negative. Therefore, the first inequality is strict for any $w > \underline{w}$ and the optimal wage satisfies $w = \underline{w}$.

Conversely, Proposition 1 implies that the first inequality holds as an equality, and there is a continuum of equilibria indexed by w , for any $w \in [\underline{w}, r(U + F)]$. Yet all such equilibria are allocationally equivalent as they imply the same separation rule $Z(R) = U + V$ and, from equation (11), the same division of the surplus from a new match that would prevail under flexible wages.

Therefore from an allocational perspective one can restrict attention, without loss of generality, to equilibria in which $\underline{w} \geq r(U + F)$; i.e. equilibria for which equation (12) reduces to

$$w = \underline{w} \tag{14}$$

and $Q(y, w) = F$ whenever separation takes place.

3 Equilibrium with exogenous wage rigidity

3.1 Decentralised equilibrium

We can now define a stationary equilibrium for an economy in which the value of \underline{w} is exogenous. To keep the exposition focused, we restrict the formal definition alone to the case in which $w \geq r(U + F)$.¹⁰

Definition 2 *Given $\underline{w} \geq r(U + F)$ and F , a stationary equilibrium is a set of value functions $\{Z(y), W(w), J(w), U, V\}$, payments $\{w, S, Q(y, w)\}$, a market tightness θ , a reservation productivity R and an unemployment rate u such that: 1) free entry of vacancies implies $V = 0$; 2) the value functions $\{Z(y), W(w), J(w), U\}$ satisfy (1)-(4); 3) $\{S, w, Q(y, w)\}$ are determined by (11), (14) and (A.11); 4) market tightness satisfies (5); 5) the reservation productivity is determined by (8); 6) the unemployment rate satisfies the flow equilibrium condition $u = \frac{\lambda G(R)}{p(\theta) + \lambda G(R)}$.*

As usual in this class of models, the system of equations in the previous section can be collapsed into a job destruction and a job creation equations which, together, determine the equilibrium values of the pair (θ, R) .

One can use the ex ante surplus sharing condition (11) and free entry to replace in (5) to obtain

$$\frac{c}{q(\theta)(1 - \beta)} = Z(1) - U = \frac{1 - R}{r + \lambda} + Z(R) - U, \tag{15}$$

where the last equality follows from (1). Similarly, substitution of (15) and (11) into (4) yields the standard equation

$$rU = z + \frac{\beta}{1 - \beta} c\theta \tag{16}$$

for the value function of an unemployed worker.

¹⁰As discussed in the previous section, the restriction is without loss of generality from the allocational perspective. It just implies that the mandated severance payment is never renegotiated and allows to relegate details of bargaining over separation to Appendix A.2.

The job destruction locus can be derived by integrating equation (1) by parts and evaluating it at the reservation productivity R to obtain

$$Z(R) - U = \frac{h(R, \theta)}{r + \lambda G(R)}, \quad (17)$$

with

$$h(R, \theta) = R + \lambda \int_R^1 \frac{1 - G(y)}{r + \lambda} dy - \left(z + \frac{\beta}{1 - \beta} \theta \right), \quad (18)$$

where the term in bracket is the permanent income from unemployment from (16).

Using (17) to replace for $Z(R) - U$ in (15) implies the job creation condition

$$\frac{c}{q(\theta)(1 - \beta)} = \frac{1 - R}{r + \lambda} + \frac{h(R, \theta)}{r + \lambda G(R)}. \quad (19)$$

Finally, replacing for $Z(R) - U = \max\{W^r(w) - U(\theta) - F, 0\}$ in (17) and using (7) yields, after some rearrangement, the job destruction condition

$$\max\{\underline{w} - rU(\theta) - rF, 0\} = h(R, \theta). \quad (20)$$

For given w , equations (17) and (19) form a system of two equations in the two unknowns θ and R .

Before studying the general case, it is useful to consider first the case in which w is so low that $w \leq r(U(\theta) + F)$ for any value of θ . It follows from Proposition 1 that equation (17) reduces to $h(R, \theta) = 0$ which is the same job destruction equation as in Mortensen and Pissarides (1994) and, from (18), describes an upward sloping locus $R^f(\theta)$ in the (R, θ) space. This is the curve JD^f in Figure 1, where the superscript f stands for flexible wages. It is only slightly more involved to show that the job creation condition (19) implies the JC curve in Figure 1. The curve is positively sloped, and lies below JD^f , for values of R such that $Z(R) < U$; i.e. $h(R, \theta) < 0$ from equation (17). Conversely JC is negatively sloped (vertical for R high enough), and lies above JD^f , for values of R such that $Z(R) > U$. The flexible-wage equilibrium solution $(\hat{\theta}^f, \hat{R}^f)$ lies at the unique intersection A of the two curves in Figure 1. It is straightforward to verify that it is the same solution as in Mortensen and Pissarides (1994) as equation (19) collapses to their job creation equation when one imposes $h(R, \theta) = 0$.¹¹

Consider now the case in which for θ low enough it is $w > r(U(\theta) + F)$. The term $rU(\theta)$ cancels out in equation (20); the reservation productivity is a function of $w - rF$ alone and the JD curve is horizontal. Yet, since the left hand side of equation (20) is decreasing in θ , there exist a value of θ above which it is zero and the JD curve coincides with JD^f . The thick curve in Figure 1 is one possible such JD curve.

If, as in Figure 1, the horizontal section of the JD curve intersects the JC above point A the following result holds.

Proposition 2 (Involuntary layoff) *If $\underline{w} > r(U(\hat{\theta}^f) + F)$, job creation is lower and job destruction is higher than under flexible wages. An increase in F , reduces job destruction and increases job creation.*

¹¹The advantage of writing the job creation as in equation (19) is that it is unaffected by wage rigidity and severance pay. These two enter only the job destruction condition (17).

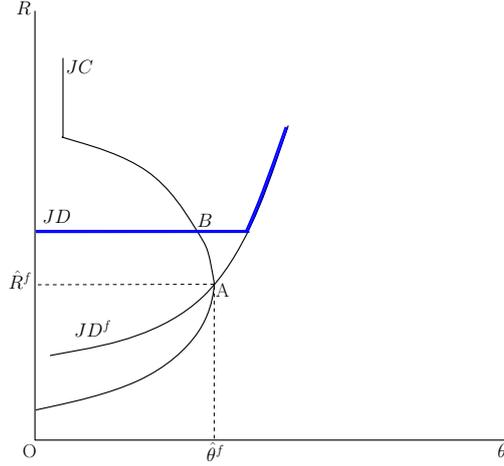


Figure 1: Equilibrium market tightness and reservation productivity - exogenous wage

If the firm shadow cost of labour $\underline{w} - rF$ exceeds the worker's reservation wage $rU(\hat{\theta}^f)$ in the flexible-wage economy, wage rigidity affects the allocation of labour. For given \underline{w} , an increase in F reduces the firm shadow cost of labour and the reservation productivity, shifting the horizontal section of the JD curve downward.

If instead the wage constraint \underline{w} is such that the intersection is below point A the equilibrium is the same as under flexible wages. Shifting the horizontal section of the JD curve further down does not change its intersection with the JC curve.

Remark 1 (Privately eff. separation) *If $\underline{w} \leq r(U(\theta^f) + F)$, the equilibrium allocation is the same as under flexible wages. Any increase in F has no allocational effect.*

Remark 1 is the equilibrium counterpart of Proposition 1. The following corollary then follows straightforwardly from equation (24).

Corollary 1 *If $d(\underline{w} - rF)/dF < 0$, large enough severance payments induce the same equilibrium allocation which obtains in the absence of wage rigidities.*

When \underline{w} is exogenous the condition is trivially satisfied. In general, though, \underline{w} is an endogenous function on F and the condition has to be verified case-by-case. Furthermore, since \underline{w} may also be a function of market tightness θ , the JD^r locus may intersect the JC curve more than ones. Even if the condition is satisfied, there may be an equilibrium with perverse comparative statics. Yet, A will be the unique equilibrium for F large enough.

In Section 4, I establish the extent to which the condition in Corollary 1 is satisfied under two main micro-foundations for wage rigidities and the associated workers' rents: efficiency wages and inefficient union bargaining.

3.2 Socially optimal job destruction

The previous section has established that, to the extent that they reduce the reservation productivity, large enough severance payments increase job creation and employment.

It is well known, though, that matching frictions imply that the decentralised equilibrium is not in general constrained-efficient, even in the absence of wage rigidities; i.e.

when $Z(R) = U$. Efficiency obtains only if Hosios's (1990) condition that workers' bargaining weight β equals the elasticity of the probability of filling a vacancy holds. In such a second-best environment, one cannot conclude that a reduction in job destruction and an increase in employment is associated with an increase in social welfare without solving explicitly the social planner problem. This section solves such a problem.

Given risk-neutrality, the natural social welfare metric is the present value of output, net of vacancy posting costs, discounted at rate r . A constrained-efficient allocation maximises net output subject to the relevant constraints.

Let $(\hat{\theta}^f, \hat{R}^f)$ denote the equilibrium values of market tightness and reservation productivity in the flexible-wage equilibrium associated with point A in Figure 1. One can prove the following result.

Proposition 3 *In a stationary decentralised equilibrium in which the job creation equation (19) is satisfied, a marginal policy change that reduces the equilibrium job destruction rate increases efficiency if $R > \hat{R}^f$ and reduces efficiency if $R < \hat{R}^f$.*

Proof. See Appendix. ■ Proposition 3 is the second main results in the paper. It implies that, even if the social planner cannot choose market tightness - i.e. for any value of β - severance pay improves efficiency, to the extent that it reduces equilibrium job destruction relative to the laissez-faire equilibrium with involuntary layoffs. The result is particularly surprising in the case in which β is smaller than the elasticity of the probability of filling a vacancy and the decentralised equilibrium with flexible wages features inefficiently high job creation and low job destruction (see, for example, p.190 in Pissarides 2000). A priori one could expect that a distortion that increases job destruction - thus also reducing the ex ante joint surplus and job creation - relative to the decentralised flexible wage equilibrium, could be welfare improving in such a case. Proposition 3 rules this out. It implies that privately inefficient separation - $Z(R) \neq U$ - *always* reduces the aggregate net flow of consumable resources, relative to the flexible wage equilibrium, even in a second best world in which the Hosios condition is not satisfied.

Intuitively, the flexible-wage, decentralised equilibrium pair $(\hat{\theta}^f, \hat{R}^f)$ coincides with point A on the JC curve where market tightness θ is maximised, as a function of the reservation productivity. As the economy moves along the JC curve towards point A , the expected utility of unemployed workers in equation (16) increases with θ . It is well known¹² that the expected utility of the unemployed is maximised at the socially efficient workers' share β . The above result implies that the maximum of the unemployed expected utility and social welfare coincide, also in a second-best world in which β is suboptimal and job creation is decentralised.

4 Endogenous wage rigidity

This section endogenous the lower bound on the wage w using two common micro-foundations for wage rigidity: efficiency wages and inefficient union bargaining.

¹²See, for example, Pissarides (2000) p. 187.

4.1 Efficiency wages

Suppose, that a moral hazard problem requires firms to pay efficiency wages along the lines of Galdón-Sánchez and Güell's (2003) version of Shapiro and Stiglitz (1984). Workers enjoy zero utility from leisure when working, but enjoy marginal utility z if they shirk on the job for their, optimally-chosen, fraction of time. A shirking worker is detected with instantaneous probability q . Therefore, the expected marginal benefit from withdrawing effort until caught shirking is z/q . Suppose, following Galdón-Sánchez and Güell (2003), that courts can only imperfectly distinguish between disciplinary and economic dismissals and that no severance payment is due in case a dismissal is deemed disciplinary.

Let π^d denote the probability that courts wrongly deem a dismissal to be economic, and award severance pay, conditionally on the actual cause being disciplinary. The marginal cost of being cost shirking is $W - U - \pi^d F$, the loss of rent minus the expected payment awarded by courts. Incentive compatibility then requires workers to receive a rent no smaller than $W - U = z/q + \pi^d F$, to induce them to forgo the expected gain from shirking. As long as $\pi^d > 0$, the mandated severance payment F increases the workers' rent since workers receive the payment with probability π^d in the case of dismissal for under-performance.

Similarly, let π^l denote the probability that courts wrongly deem a dismissal to be disciplinary, and fail to award severance pay, conditionally on the actual cause being economic. Therefore, the expected cost to the firm of an economic redundancy is $(1 - \pi^l)F$.

It follows from that the job destruction condition (8) can be written as

$$Z(R) = U + \max\{z/q + \pi^d F - (1 - \pi^l)F, 0\}, \quad (21)$$

or, replacing in (17),

$$\max\left\{0, \frac{z}{q} + (\pi - 1)F\right\} = \frac{h(R, \theta)}{[r + \lambda G(R)]}, \quad (22)$$

where $\pi = \pi^d + \pi^l$ is the sum of the conditional probabilities that courts wrongly adjudicate either type of separation.

The condition $\pi < 1$ is equivalent to $\pi^d < (1 - \pi^l)$ and is satisfied if the probability that courts wrongly award severance payments for a disciplinary dismissal is less than the probability that they correctly award the payment for an economic redundancy. The condition just requires courts to perform better than a coin toss and is most likely to be satisfied.

If $\pi < 1$ severance payments reduce the wedge between the firm shadow cost of labour and the worker's return from unemployment and the following result follows.

Proposition 4 *If the efficiency wage constraint implies involuntary layoffs and $\pi < 1$:*

1. *there exists an equilibrium in which severance payments reduce equilibrium job destruction and increase job creation and efficiency, as long as $F < z/[q(1 - \pi)]$;*
2. *the equilibrium is unique if $r + \lambda G(R)$ is log-concave;*
3. *large enough severance payments induce a unique equilibrium with the same allocation as under flexible wages.*

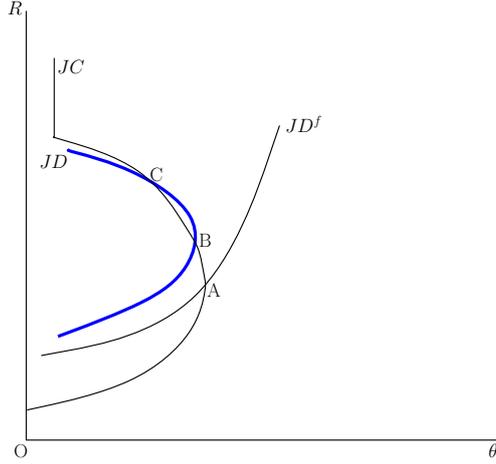


Figure 2: Equilibrium market tightness and reservation productivity - efficiency wages

Proof. See Appendix. ■ Point 3. follows straightforwardly from Result 1. Higher severance pay shifts (and stretches) the rigid wage job destruction curve JD in Figure 2 to the right until it coincides with JD^f .

Point 1. states that there always exists one equilibrium, such as point B, in which severance payments efficiently reduce job destruction also locally. Yet, one cannot exclude that JD has the shape illustrated in Figure 2. The intuition is the following, a higher R increases the expected flow payoff from the marginal job $h(R, \theta)$ but it also reduces the expected job duration $\lambda G(R)$. When the second effect prevails, the present value of the joint payoff on the right hand side of equation (22) is decreasing in R and a fall in the firm shadow cost of labour increases rather than reduces R at given market tightness. This is the case in all equilibria, such as point C in Figure 2, in which the JD curve is negatively-sloped and flatter than the JC curve¹³. Point 2. provides a sufficient condition to rule out such equilibria. If satisfied the JD is everywhere upward sloping. For r small enough, the condition converges to requiring log-concavity of the shock distribution which is a rather common assumption in the search literature.¹⁴

Equation (13) implies that the worker prepays for the increase in the rent $\pi^d F$ through a lower transfer S from the firm upon entry. For π^d small enough, though, Result 4 generalises to the case in which bonding is ruled out and the utility of a newly hired worker is the same of that of an insider - $S = 0$. Saint-Paul (1995) and Fella (2000) obtain the same result without bonding in the case in which $\pi^d = 0$; i.e. severance payments are paid only for economic dismissals. Since severance payments do not increase the rent $W - U$ when $\pi^d = 0$, firms fully capture the increase in the joint surplus associated with lower job destruction. This is no longer true for large enough π^d , though. To see this, notice that if $\pi^d = 1 - \pi^l$, it is $\pi = 1$ and severance payments increase the rent $W - U$, but do not alter the shadow cost of labour $W - F$ and the job destruction condition (22). For given θ , this leaves the total ex ante payoff from a new match $Z(1)$ unchanged but,

¹³The perverse comparative statics applies not only to severance payments but also to the utility of leisure and a higher cost of capital.

¹⁴A function is log-concave if its logarithm is concave. Bagnoli and Bergstrom (2005) discuss extensively the log-concave references and their use in economics. Masters (1999) assumes a log-concave shock distribution to ensure uniqueness of equilibria in a search model with wage posting.

given no bonding, reduces the firm share of it $Z(1) - W$ and so job creation.¹⁵

By continuity there exists some value $\hat{\pi}^d$ strictly between zero and one such that severance payments are welfare improving even in the absence of bonding.

4.2 Unionised wage setting

Fully dynamic theories of inefficient unionised wage setting are hard to come by. In a static setting, privately inefficient job destruction due to inefficient bargaining over wages alone - right to manage - obtains only if the marginal revenue product of labour is decreasing.¹⁶ In the present constant-returns setup bargaining over state-dependent wages would be privately efficient. One way to introduce inefficient unionised wage setting is to assume, following Garibaldi and Violante (2005), that bargaining is over a unique, state-independent wage that applies to all union members.

Bargaining takes place at the sectoral level. There is a large number (possibly a continuum) of sectors with identical productivity distribution $G(y)$. Within each sector the wage is the outcome of right-to-manage bargaining between the workers' and employers' unions. That is bargaining is over the (state-independent) wage alone and then employers choose whether to end or not each specific match.

Both unions represent only their employed members and have a utilitarian objective function. As long as $w \geq r(U + F)$, it follows from Proposition 1 that the equilibrium severance payment always equals F , and the workers' union objective function is

$$\bar{W}(w) = [1 - G(R)]W(w) + G(R)(U + F) = U + F + [1 - G(R)][W(w) - U - F]. \quad (23)$$

Correspondingly, the employers' union objective function is

$$\bar{J}(w) = \int_R^1 J(y, w) - G(R)F = -F + \int_R^1 \frac{y - R}{r + \lambda} dG. \quad (24)$$

Since each sector is atomistic, the parties take the value of market tightness θ as given. Over the range for which $w \geq r(U + F)$, the wage solves the bargaining problem

$$\max_{w, R} N = (\bar{W}(w) - \underline{W})^\beta (\bar{J}(w) - \underline{J})^{1-\beta} \quad (25)$$

$$\text{s.t. } h(R, \theta) - [r + \lambda G(R)] \max\{W(w) - F - U, 0\} = 0. \quad (26)$$

The parties choose w to maximise the Nash product subject to the ex post job destruction condition (26).

The threat points \underline{W} and \underline{J} are respectively the worker's and firm no-trade, fallback utilities. Through the appropriate choice of threat points the Nash maximand (25) can encompass most strategic and axiomatic bargaining solutions. It can also accommodate the monopoly union model as a special case when $\beta = 1$.

Let $R(\theta)$ denote the solution to problem (25) as a function of θ and $R^f(\theta)$ the flexible-wage, reservation productivity as a function of θ . The following result holds.

¹⁵This is the case considered in Galdón-Sánchez and Güell (2003) who show that, without bonding, severance payments reduce employment for *any* value of $\pi^d > 0$.

¹⁶See Booth (1995) p. 53 and references therein. A decreasing marginal revenue product implies that, under right-to-manage, an infra-marginal (e.g. average) worker bargains for higher wages relative to the marginal worker.

Proposition 5 Suppose $\beta < 1$, and either $\partial \underline{W}/\partial F < 1$ or $\partial \underline{J}/\partial F > -1$. For given θ , a higher severance payment F reduces the reservation productivity $R(\theta)$ as long as $R(\theta) > R^f(\theta)$.

Proof. See Appendix. ■

The result is best understood by remembering from Section 2.2.2 that, as long as $w > r(U + F)$, it is $W(w) = W^r(w) > U + F$ which implies that the value of the curly bracket in equation (26) is $W(w) - F - U$. Replacing for $\bar{W}(w)$ using equation (23) and the job destruction constraint (26) yields

$$\max_R N = \left(U + F + \frac{[1 - G(R)]h(R, \theta)}{r + \lambda G(R)} - \underline{W} \right)^\beta \left(-F + \int_R^1 \frac{y - R}{r + \lambda} dG - \underline{J} \right)^{1-\beta} \quad (27)$$

It follows from equation (27) that a higher F reduces the worker's payoff and increases the firm one at given R . As long as $\partial \underline{W}/\partial F < 1$ or $\partial \underline{J}/\partial F > -1$, this redistribution results in a higher worker's and lower firm surplus at given R , relative to the respective threat points. The Nash solution calls for the wage to partly offset this redistribution so that the shadow cost of labour and R fall at an internal maximum. Therefore, R falls with F .

It is instructive to compare Proposition 5 with the following result.

Proposition 6 For given θ the reservation productivity $R(\theta)$ is independent of the severance payment F if either

1. $\underline{W} = U + F$ and $\underline{J} = -F$; or
2. $\beta = 1$.

In case 1 the severance payment drops out of the Nash maximand in equation (27). Case 2 corresponds to the monopoly-union model analysed in Garibaldi and Violante (2005). Since the optimal R maximises the first bracket in (27), F does not enter the first order condition. In both cases, severance payments just raise the worker's payoff one-for-one and are neutral even if separation is inefficient.

The two cases covered by Proposition 6, while appealing for their analytical convenience, are restrictive. In general, unions do not set wages unilaterally but bargain them with firms or employer's representatives, as argued for example in Booth (1995). Furthermore, while the threat points in part 2 of the result are standard in the matching literature, they can be justified on the basis of convenience only if they do not constrain the equilibrium outcome in a qualitatively important way. This is not the case here.

As first pointed out by Binmore, Rubinstein and Wolinsky (1986), whenever there is ambiguity about the appropriate threat points in bargaining one should get guidance by modelling the bargaining process strategically. They show that, when this is done, threat points are usually different from outside options. Outside options are the payoffs that the parties obtain by *irreversibly* breaking the match to trade outside. Since an agent's threat to abandon the match is not credible unless her outside payoff exceeds what she would receive under bilateral monopoly, outside options only provide a constraint for the bargaining outcome - inequality (16). The appropriate threat points are instead the

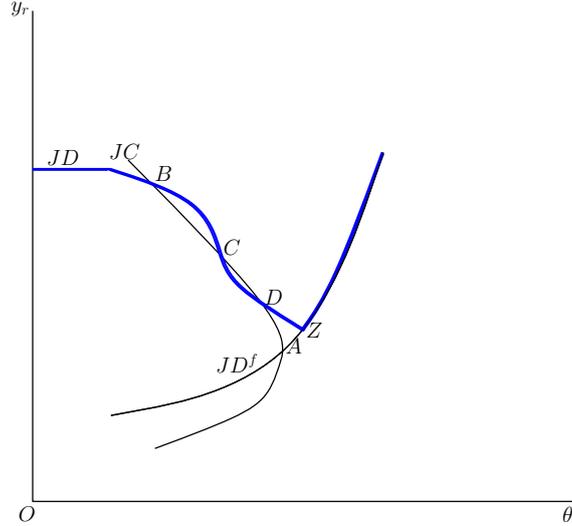


Figure 3: Equilibrium market tightness and reservation productivity - unionised wage setting

parties' expected payoff in case of perpetual disagreement¹⁷. Depending on whether the parties search or not while bargaining these are either the expected returns to search as in Wolinsky (1987) or the present value of income flows while no trade takes place as in Coles and Hildreth (2000) and Hall and Milgrom (2008). In the latter case, they are obviously independent of severance payments. If instead the parties searched while bargaining, because of search frictions they would find a new partner with probability strictly less than one in finite time. With positive discounting, even if the firm were obliged to pay the severance payment whichever party left bargaining for a new match, F would increase the worker's and decrease the firm threat point less than one-for-one.

Finally, the following proposition partially characterises the reservation productivity $R(\theta)$ as a function of θ .

Proposition 7 *The reservation productivity satisfies either $R(\theta) = R^f(\theta)$ for any $\theta \geq 0$ or there exists a unique $\theta_1 > 0$ such that $R(\theta) > R^f(\theta)$ for $\theta < \theta_1$ and $R(\theta) = R^f(\theta)$ otherwise.*

Proof. See Appendix. ■

The proposition states that if the rigid-wage JD curve lies above its flexible-wage counterpart for low enough θ , it eventually intersects the flexible-wage JD^f curve and coincides with it to the right of such intersection. For given θ the reservation productivity is inefficiently high to the left of the intersection. Figure 3 draws the JC and JD curves in the case in which the latter lies above its flexible-wage counterpart JD^f at the flexible-price equilibrium point A . The job destruction locus JD is given by the thicker curve and the portion of the JD^f locus to the right of point Z .

¹⁷Furthermore, since workers are not entitled to severance payments if they unilaterally abandon the match, even in an axiomatic bargaining framework it is unclear why the severance payment F should enter their threat point.

Since one cannot rule out that the job creation and job destruction curves both slope down over the relevant range multiple equilibria are again a possibility. The intuition for this is apparent from the Nash maximand (27). A given value of W can be achieved with either a high U (high θ) and low rents (low R) or low U and high rents. If the loss of joint surplus associated with workers' rents and inefficient separation is large enough, the optimal fall in the rent in response to a relatively small increase in U may be large and the JD^{fw} locus be sufficiently steep.

It follows from Proposition 6 that severance payments shifts down the job destruction curve over the range where it lies above its flexible wage counterpart. If the equilibrium is unique the JD curve cuts the JC locus from below. Provided wage rigidity is binding at equilibrium - $\hat{R} > \hat{R}^f$ - job destruction falls and job creation and efficiency increase. If there are multiple equilibria at least one of these (e.g. point C in Figure 3) behaves perversely. Severance payments increase job destruction, thus reducing job creation and efficiency. Proposition 7, though, implies that for large enough F , though, the JD curve in Figure 3 lies everywhere below JC to the right of point A. Therefore, the unique equilibrium coincides with the constrained-efficient equilibrium under flexible wages corresponding to point A.

5 Summary and discussion

Firms and workers have an incentive to negotiate around privately inefficient employment protection legislation. This paper characterises the implications of mandated severance pay in the presence of matching frictions and wage rigidities when renegotiation, by means of spot side payments upon termination, is feasible.

Severance payments have real effects as long as wage rigidity implies privately inefficient separation under employment at will. If this is the case, severance payments increase job creation and efficiency as long as they reduce job destruction. While their marginal impact on job destruction is ambiguous if multiple equilibria are possible, large enough severance payments always reduce job destruction relative to employment at will. Their maximum relevant size is bounded and their marginal effect is zero when their size exceeds the one which induces the same allocation that prevails under flexible wages. In the latter case, Pareto optimal renegotiation by means of spot payments upon separation implies that any increase in severance pay is neutral.

The ability to negotiate around privately inefficient employment protection measures is crucial for the results in the paper.

There is considerable evidence that negotiation of Pareto-optimal transfers upon separation is more than a theoretical construct. One example is the frequency with which one reads or hears about voluntary redundancy packages or early retirement incentives offered by downsizing firms.¹⁸ By revealed preference, these must be jointly optimal if workers accept them. Furthermore, if contracting firms make the effort to negotiate such packages the associated cost must be smaller than the (possibly shadow) cost of

¹⁸For example, Allied Irish Banks has recently negotiated a voluntary redundancy deal providing for a one-off payment of EUR17,000, the payment of a service-related lump sum of up to one year's salary and a EUR10,000 grant for children in full-time education to employees above the age of 50. ("Redundancy Scheme Set to cost AIB Euro26m," *The Irish Times*, 27 March 2007)

unilaterally laying workers off. Also, in Germany firms cannot legally carry out mass redundancies (i.e., the mandated layoff cost is infinite) unless they agree with workers' representatives on a social plan covering layoff procedures and compensation packages. For Italy, a country usually associated with extreme levels of employment protection, IDS (2000) reports that employers often negotiate incentive payments to induce employees to take voluntary redundancy and sign agreements waiving their right to take legal action.¹⁹ Finally, Toharia and Ojeda (1999) document that it is common for Spanish firms to agree with workers to label economic dismissals as disciplinary ones to economise on advance notice and procedural costs. Over the 1987–97 period, between 60 and 70 per cent of all layoffs took this form and involved bargaining over the size of termination payments.

Efficient renegotiation also requires efficient bargaining. In the standard symmetric-information, risk-neutral framework, Merlo and Wilson (1995) have shown that the equilibrium of bilateral bargaining games is efficient under quite general circumstance.²⁰

Finally, our assumption that full bonding is unrestricted is extreme but useful to separate the effect of severance payments from that of entry wage inflexibility. Bertola (1990) and more recently Garibaldi and Violante (2005) have emphasised that constraints on entry wages may imply that pure severance payments reduce job creation. Yet, if minimum wage constraints imply positive rents for new hires the same must be true for the marginal insider worker. We have shown that if this is the case, severance payments increase ex post efficiency in such framework. The appropriate policy response to reestablish ex ante efficiency is to increase the flexibility of entry wages, or subsidise job creation, rather than removing legislated severance payments. While this paper does not entail any role for government intervention, as with full bonding it is ex ante optimal to incorporate severance payments in private contracts, a reform that removed existing severance payments would constitute a windfall loss for workers in existing jobs, and a windfall gain for their employers, and would result in inefficiently excessive destruction of existing jobs.

A Appendix

A.1 Proofs

Proof of Proposition 1. Since the firm can fire the worker at cost F , it is $Q(y, w) \leq F$.

1. Suppose $w \geq r(U + F)$. Assume by contradiction that the mandated payment F is renegotiated, that is $Q(y, w) < F$, for some $y < R$. Since renegotiation is consensual, it has to be $W(w) - U \leq Q(y, w)$ which implies that the square bracket in (2) is always non-negative and $W(w) \geq U + F$. It follows that $\Omega(y, w)$ is either empty or contains only the point F ; a contradiction. Therefore, all separations are layoffs – $Q(y, w) = F$ for all $y \leq R$ – and $W(w) = W^r(w)$. It ensues that R satisfies $Z(R) = W^r(w) + V - F \geq U + V$, where the last inequality holds as an equality iff $w = r(U + F)$.

¹⁹The same source reports a total cost for individual redundancy of 10–12 months of wages for a worker paid around 2 million ITL a month.

²⁰An exception are repeated-game models, like Haller and Holden (1990) and Fernandez and Glazer (1991), in which an agent ability to “burn money” implies the existence of inefficient equilibria with delay. Some authors, e.g. MacLeod and Malcomson (1995), argue that such equilibria are not very reasonable as both parties would be better off by playing one of the efficient equilibria.

2. Suppose $w < r(U + F)$. Since $Q(y, w) \leq F$, it follows from (2) that $W(w) < U + F$. For all $y > R$, with $Z(R) = U + V$, the match continues, as $J(y, w) = Z(y) - W(w) > V - F$ and $\Omega(y, w)$ is empty. For $y \leq R$, $\Omega(y, w)$ is not empty and ending the match with a payment $Q(y, w) \in \Omega(y, w)$ is jointly optimal. The mandated severance payment is renegotiated downward for all $y \leq R$ and such that $J(y, w) > V - F$. ■

Proof of Proposition 3. Suppose the social planner can optimally choose the reservation productivity R but is otherwise constrained by the evolution of unemployment described by

$$\dot{u} = \lambda G(R)(1 - u) - p(\theta)u, \quad (\text{A.1})$$

and the decentralised job creation condition (19). The social maximand is the aggregate net flow of consumable resources $Y + uz - c\theta u$. Aggregate output Y satisfies the differential equation

$$\dot{Y} = p(\theta)u + \lambda(1 - u) \int_R^1 y dG - \lambda Y. \quad (\text{A.2})$$

Denote by μ_{jc} the Lagrange multipliers associated with (19) and by γ_u and γ_Y the current-value costate variables associated respectively with the differential equation for unemployment (A.1) and for output (A.2). If one denotes by H the current value Hamiltonian, the Maximum Principle states that first order necessary conditions for a maximum are

$$\frac{\partial H}{\partial \theta} = -cu + (\gamma_Y - \gamma_u)p'(\theta)u - \frac{\mu_{jc}}{1 - \beta} \left[\frac{q'(\theta)c}{q(\theta)^2} - \frac{\beta c}{r + \lambda G(R)} \right] = 0, \quad (\text{A.3})$$

$$\frac{\partial H}{\partial R} = (1 - u)(\gamma_u - \gamma_Y R) + \mu_{jc} \frac{h(R, \theta)}{[r + \lambda G(R)]^2} = 0, \quad (\text{A.4})$$

$$\frac{\partial H}{\partial Y} = 1 - \lambda \gamma_Y = r\gamma_Y - \dot{\gamma}_Y, \quad (\text{A.5})$$

$$\frac{\partial H}{\partial u} = z - c\theta + \gamma_Y \left(p(\theta) - \lambda \int_R^1 y dG \right) - \gamma_u \left(p(\theta) - \lambda \int_R^1 y dG \right) = r\gamma_u - \dot{\gamma}_u, \quad (\text{A.6})$$

where $h(R, \theta)$ is given by (18) in the main text.

Imposing steady state, solving for the two costate variables and substituting in equation (A.4) yields, after some manipulation and making use of (19),

$$\frac{\partial H}{\partial R} = -\frac{h(R, \theta)}{r + \lambda G(R)} \left[1 - u - \frac{\mu_{jc}}{r + \lambda G(R)} \right]. \quad (\text{A.7})$$

Solving for μ_{jc} using (A.3) and the steady state values of the costate variables and replacing in (A.7) yields

$$\frac{\partial H}{\partial R} = -\frac{h(R, \theta)(1 - u)}{r + \lambda G(R)} \frac{r\eta + \beta[\theta q(\theta) + \lambda G(R)]}{\eta[r + \lambda G(R)] + \beta\theta q(\theta)}, \quad (\text{A.8})$$

with $\eta = -q'(\theta)\theta/q(\theta) > 0$. It follows that $\text{sgn } \partial H/\partial R = -\text{sgn } h(R, \theta) = -\text{sgn}[Z(R) - U]$, where the last equality follows from equation (17) in the main text. ■

Proof of Proposition 4.

1. A non-degenerate equilibrium with positive employment exists by assumption. Hence, the JD locus characterised by (22) intersects the JC locus in Figure 1 at least once. Equation (22) implies JD lies everywhere to the left of JD^f and does not admit turning points as a function of θ . It follows that the slope of JD has to be larger than that of JC at its vertically lowest intersection with it. If $\pi < 1$, an increase in F shifts JD down and so any intersection such that JD is steeper than JC .
2. If $r + \lambda G(R)$ is log concave the slope of JD is increasing thus ruling out it can bend backward. Therefore it intersects JC only once.
3. A large enough F drives $W - U - F$ to zero. ■

Proof of Proposition 5. If $R(\theta) > R^f(\theta)$, the FOC for problem (27) is

$$\frac{\partial N}{\partial R} = \frac{\beta}{\bar{W}(w) - \underline{W}} \left[\frac{-g(R)(r + \lambda)h(R, \theta)}{[r + \lambda G(R)]^2} + \frac{1 - G(R)}{r + \lambda} \right] - \frac{1 - \beta}{\bar{J}(w) - \underline{J}} \frac{1 - G(R)}{r + \lambda} = 0. \quad (\text{A.9})$$

The result can be proved by monotone comparative statics. The assumption, together with (27), implies that $\bar{W}(w) - \underline{W}$ and $\bar{J}(w) - \underline{J}$ are respectively weakly increasing and decreasing in F with at least one being strictly so. Therefore, $\partial^2 N / \partial R \partial F < 0$ at an optimum. Since $\partial N / \partial R$ is strictly increasing in $-F$ it follows from Corollary 1 in Edlin and Shannon (1998) that the solution to (A.9) is strictly increasing in $-F$; i.e. strictly decreasing in F . ■

Lemma 1 $R(\theta) = R^f(\theta)$ for some θ_1 implies $R(\theta) = R^f(\theta)$ for any $\theta > \theta_1$.

Proof. Rewrite the partial derivative in (A.9) as

$$\frac{\partial N}{\partial R} = \frac{\beta}{\bar{W}(w) - \underline{W}} \left[\frac{-g(R)(r + \lambda)h(R, \theta)}{[r + \lambda G(R)]^2} + \frac{1 - G(R)}{r + \lambda} \left(1 - \frac{1 - \beta}{\beta} \frac{\bar{W}(w) - \underline{W}}{\bar{J}(w) - \underline{J}} \right) \right]. \quad (\text{A.10})$$

Since $\bar{W}(w) - \underline{W} > 0$ at an optimum, the sign of $\partial N / \partial R$ is the same as the sign of the square bracket in (A.10). For given θ , the square bracket is largest at $R = R^f(\theta)$, as $G(R)$ and $J(w)$ are respectively increasing and decreasing in R and $\underline{W}(w)$ is lowest when $h(R, \theta) = 0$. Hence, if (A.10) is negative at $R^f(\theta_1)$ for $\theta = \theta_1$ it is negative for any $R > R^f(\theta_1)$. It follows that the optimal reservation productivity satisfies $R(\theta_1) = R^f(\theta_1)$ and $w \leq r(U + F)$. Finally, since U is increasing in θ , (A.10) is declining in θ along $R^f(\theta)$ and it is $R(\theta) = R^f(\theta)$ for any $\theta > \theta_1$. ■

Proof of Proposition 7. It follows from the proof of Lemma 1 that if $\partial N/\partial R \leq 0$ at $\theta = 0$ it is $R(\theta) = R^f(\theta)$ for all θ . Suppose, instead, that $\partial N/\partial R > 0$ at $\theta = 0$ and therefore $R(0) > R^f(0)$. The square bracket in (A.10) evaluated along $R^f(\theta)$ is strictly decreasing in θ . It follows that there exists some θ_1 for which $R(\theta_1) = R^f(\theta_1)$. Lemma 1 implies that the same holds for all $\theta > \theta_1$. ■

A.2 Bargaining over separation

This section derives one efficient bargaining solution to determine the renegotiated severance payment $Q(y, w)$ in Section 3 and shows that, in general, higher mandated severance pay increases a worker's payoff from an ongoing match $W(w)$.

Remember from Section 2.2.2 that the set of Pareto-improving and individually-rational separation transfers

$$\Omega(y, w) = \{W(w) - U, \min\{V - J(y, w), F\}\} \quad (\text{A.11})$$

is non-empty – and mandated severance pay is renegotiated down with positive probability – only if $W(w) - U < F$, that is if case 2. in Proposition 1 applies. We assume this in what follows.

Suppose that bargaining over separation consists of a take-it-or-leave-it offer of a separation transfer. If the offer is rejected trade takes place at the the current wage contract. Let β denote the probability that the worker is the proposer, the firm proposing with the complementary probability.

Since $W(w) - U < F$, when proposing the firm offers the worker reservation severance payment $W(w) - U$ that the worker accepts. Similarly, when proposing, the worker offers the firm reservation severance payment $\min\{V - J(y, w), F\}$ that the firm accepts. Since the two proposals are made respectively with probability β and $1 - \beta$, it follows that the parties would be willing to agree on the expected severance payment

$$Q(y, w) = (1 - \beta)(W(w) - U) + \beta \min\{V - J(y, w), F\}. \quad (\text{A.12})$$

Noticing that $J(y, w) = Z(y) - W(w)$, equation (A.12) can be rewritten as²¹

$$Q(y, w) = W(w) - U + \beta \min\{U + V - Z(y), F - W(w) + U\}. \quad (\text{A.13})$$

Note that, as stated in Proposition 1, the worker is better off separating – $Q(y, w) > W(w) - U$ – if and only if separation maximises joint wealth; i.e. if $y < R$ where $Z(R) = U + V$. The same is true for the firm. Also the mandated payment F is renegotiated down with positive probability for $\underline{R} < y < R$, where \underline{R} is the firm firing threshold satisfying $Z(\underline{R}) - W(w) = V - F$.

²¹As shown by Fella (2005) the alternative – but qualitatively similar – efficient solution $Q(y, w) = \min\{W(w) - U + \beta(U + V - Z(y)), F\}$ obtains if the parties bargain over the separation payment according to the alternating offer bargaining game of MacLeod and Malcomson (1993). The equilibrium severance payment shares the surplus from separation $U + V - Z(y)$ as long as the latter is positive and the firm outside option $V - F$ is not binding.

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