Optimal Severance Pay in a Matching Model

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Abstract

This paper uses an equilibrium matching framework to study jointly the optimal supply of job security and the allocational and welfare consequences of government intervention in excess of private arrangements. Firms insure risk-averse workers by means of simple explicit employment contracts. Contracts can be renegotiated ex post by mutual consent. It is shown that the lower bound on the optimal severance payment equals the fall in lifetime wealth associated with job loss. Simulations show that, despite contract incompleteness, legislated dismissal costs largely in excess of such lower bound are effectively undone by renegotiation and have only a small and negative impact on unemployment and its duration. Welfare falls. Yet, for deviations from *laissez faire* in line with those observed for most OECD countries, the welfare loss is small.

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1 Introduction

Employment contracts often contain explicit severance payments provisions[1]. Furthermore, in many countries minimum levels of severance payments and other forms of job security are enshrined in employment legislation. The existence of such measures is difficult to understand in the light of standard labour market models in which homogeneous[2] workers maximize expected labour income and wages are perfectly flexible.

From a general equilibrium perspective, risk-neutral behaviour requires perfect insurance or complete asset markets. Together with wage flexibility and unconstrained side-payments, perfect insurance implies that any spillover between a worker and her current employer is internalized and the market equilibrium is constrained efficient. There is no reason why a firm which takes aggregate quantities as given should provide job security to fully-insured workers.

Even if the existence of inefficiencies at the aggregate level (e.g. the inefficiencies associated with search externalities first pointed out by Diamond, 1982) called for government intervention, the type of legislated job security measures observed in practice would have no role to play. In nearly all countries mandated job security takes the form of costs which firms have to bear only if a job termination is labelled a layoff and sanctioned by a letter from the firm to the worker to that effect. Fella (1999) has shown that with flexible wages private contracting would undo any allocational effect of such *conditional* provisions, whether pure severance payments or not, as a firm-worker pair can always negotiate away any inefficient restriction by agreeing to label the separation a quit[3].

[1]Pencavel (1991) documents that 39.2 per cent of US unionized workers covered by major collective agreements in 1980 were covered by severance payments clauses. For the UK, the 1990 *Workplace Industrial Relations Survey* reveals that 51 per cent of union companies bargain over the size of non-statutory severance pay for non-manual workers and 42 per cent for manual workers (Millward et al. 1992). Even for Spain, a country usually associated with high level of state-mandated employment protection, Lorences et al. (1995) document that between 8 and 100 per cent of collective agreements in a given sector establish levels of job security in excess of legislated measeures.

[2]See Fella (2004) for a model with heterogeneous workers in which consensual termination restrictions increase firms' investment in the general training of unskilled workers.

[3]In a seminal paper, Lazear (1990) first showed that such result applies to mandatory unconditional severance payments, though not to wasteful, *unconditional,* separation costs.

In brief, it is hard for models based on risk-neutral labour market behaviour to provide a role for job security measures when wages can adjust freely. As argued in Pissarides (2001), this implies that "...much of the debate about employment protection has been conducted within a framework that is not suitable for a proper evaluation of its role in modern labor markets."

This paper, instead, addresses the role and effect of employment protection in an environment in which they play an economic role. It studies optimal severance pay provision when risk averse workers cannot insure against idiosyncratic labour income shocks. It casts this optimal contracting problem within Mortensen and Pissarides (1994) equilibrium matching model. Using an equilibrium framework, the paper can explore jointly the privately optimal size of severance pay and the allocational and welfare effects of a mandated discipline which deviates from it.

The two key features of this exercise are: (i) simple explicit contracts, and (ii) renegotiation by mutual consent.

Feature (i) rules out reputation-based complete implicit contracts and ensures that excessive mandated job security is non-neutral. This would not be the case under complete contracting, as the latter would be equivalent to complete markets. Excessive employment protection legislation would also be undone by a simple contract mandating that workers rebated to firms the excess of the legislated termination pay over its privately optimal level. Since courts are unlikely to enforce contracts aimed at circumventing legislation, though, such an arrangement would be feasible only if supported by a self-enforcing implicit agreement. Yet the arrangement cannot be self-enforcing as a worker about to be fired would have no ex post incentive to honour such an ex ante pledge[4].

While feature (i) stakes the odds in favour of non-neutrality, feature (ii) imposes the natural joint rationality constraint that a firm-worker pair do not leave money on the table if they can avoid it. It allows the parties to potentially circumvent legislation,

[4]Privately negotiated severance payment are also unenforceable through reputation alone in the standard matching framework with anonimity in which a firm coincides with one job and, when a job becomes unprofitable, there are no third parties that can punish a firm that reneges on an implicit contract.

if there are mutual gains from doing so, but only by means of ex post spot side payments. Since such ex post side payments are state-dependent, insurance is imperfect and excessive legislated job security is a priori non-neutral.

The paper establishes a lower bound for the optimal severance payment size. This equals the fall in lifetime wealth associated with job loss. Hence, job security in the form of positive redundancy pay is part of an optimal contract whenever workers enjoy positive rents. Positive workers' rents imply costly mobility and call for insurance against job loss.

By yielding a closed-form solution for the optimal severance pay the model provides a metric against which to assess the extent to which observed legislated measures are excessive. Such a metric is used to construct a series for optimal severance payments for a sample of OECD countries and compare it to the corresponding series for legislated payments. It turns out that for a large proportion of these countries mandated payments do not significantly exceed, and are often significantly lower than, optimal ones. Even for those countries for which this is not the case, the observed deviation from private optima is inconsistent with quantitatively important changes in the allocation of labour in the light of the model's numerical results.

The reason why, despite their *a priori* non-neutrality, legislated firing costs above private optima have *quantitatively* small allocational effects is the following. In the *laissez-faire* equilibrium of the benchmark economy private contracts are never renegotiated. The firm's present value of profits at the reservation productivity is exactly equal to the severance pay. The marginal firm is thus indifferent between continuing and terminating the match paying the worker a transfer equal to minus the present value of profits. A legislated severance payment in excess of the private optimum just determines the *maximum* transfer in case of separation. In equilibrium, the firm pays it only if the productivity shock is so low that the firm cannot credibly threat to continue the match at the contract wage. If the productivity realization is not so negative, yet below its reservation value, the parties agree to label the separation a quit and exchange a lower severance payment which equals the firm's present value of profits at the contract wage and current productivity realization. This is Pareto optimal as it makes the worker strictly better off and leaves the firm indifferent between continuation and separation. As the legislated severance payment is renegotiated when the marginal job is destroyed it has only a minor, general equilibrium, impact on the reservation productivity and the job destruction rate. The wage component of the contract falls to rebalance the parties' respective bargaining. This induces a small fall in the unemployment rate and its duration.

While the allocation of labour is hardly affected, large deviations from private optima may have considerable negative effects on workers' welfare as, by overinsuring against job loss, they increase income fluctuation relative to *laissez-faire.* Yet, for only three countries in our dataset are observed deviations large enough to imply an upper bound on the welfare loss in excess of half a percentage point fall in permanent consumption.

The model is related to a number of papers in the literature. MacLeod and Malcomson (1993) is the closest antecedent to the contracting framework studied in the paper. In a risk neutral framework they show how incomplete contracts of the fixed price and severance payment variety can solve the hold up problem, as they are infrequently renegotiated. Severance payments reduce the probability of renegotiation of the fixed-price component of the contract. This paper applies MacLeod and Malcomson's insight about the infrequent renegotiation of simple, explicit, fixed-price contracts to the optimal private provision of insurance. This contrasts with the implicit contract literature pioneered by Azariadis (1975) and Baily (1974). That literature was mainly concerned with establishing minimal restrictions on contracts or information that could generate a deviation from the first-best, full-insurance outcome and a trade-off between risk sharing and productive efficiency. By assuming that reputational considerations ruled out firm-initiated renegotiation of implicit agreements that literature resolved the trade-off in favour of risk-sharing. Instead, by allowing for renegotiation by mutual consent our paper emphasizes the constraint that ex post efficiency imposes on insurance provision by means of simple, explicit contracts.

Recently, Bertola (2004) and Pissarides (2002) have explored the role of employment protection, as a means of shielding workers from idiosyncratic labour income risk, within a fully dynamic framework. Bertola (2004) shows, within a competitive equilibrium environment, that collectively administered income transfers may improve welfare and efficiency by reducing consumption fluctuation associated with job mobility. Yet, the chosen framework does not allow for explicit optimal private contracts. We show that when optimal private contracts are feasible, there is no welfare-improving role for legislated employment protection. Pissarides (2002) shows that optimal private contracts feature severance pay and, possibly, advance notice. Being partial equilibrium though, his model cannot address the allocational effects of excessive government intervention. On the other hand, contrary to this paper, Pissarides (2002) does allow for the risk associated with the uncertain length of unemployment spells. He shows that, as long as state-provided unemployment insurance is low enough for it not to make it worthwhile for the parties to take advantage of such third-party income transfer, advance notice provides (imperfect) insurance exactly against this kind of risk at a lower cost to the firm than severance pay.

Alvarez and Veracierto (2001) study the unemployment and welfare impact of exogenously imposed severance payments in a model with costly frictions and self-insurance, but do not allow for optimal contracting.

The paper is structured as follows. Section 2 introduces the economic environment. Section 3 derives the equilibrium of the renegotiation game and derives the agents' Bellman equation. Section 4 characterizes the optimal contract. Section 5 calibrates the model and derives its empirical implications. Section 6 considers some extensions and Section 7 concludes.

2 Environment

2.1 Description

Time is continuous and the horizon infinite. The economy is composed by an endogenous number of establishments and a unit mass of risk-averse workers with infinite lifetimes. Workers supply labour inelastically at zero disutility. Their preferences over the unique consumption good are represented by a strictly increasing and strictly concave felicity function u with $u(0) = 0$ and $u'(0) = \infty$. All agents discount the future at the constant subjective discount rate r. To keep the state space manageable, we assume workers have no access to capital markets and just consume their current income stream. On the other hand, establishments are risk neutral. The market interest rate coincides with the subjective discount rate r. Hence, with complete markets workers would choose a flat consumption profile.

Each establishment requires one worker in order to produce. Because of search frictions, it takes time for a firm with a vacant position to find a worker. Such frictions are captured by a constant returns to scale, strictly concave, matching technology $m(U, V)$, where U is the number of unemployed workers and V the number of vacancies. Instantaneous matching rates depend only on market tightness $\theta = V/U$. The rates at which searching firms and workers find a match are respectively $q(\theta) = m(U, V)/V$ and $p(\theta) = m(U, V)/U$.

Keeping an open vacancy entails a flow cost c. If a firm and worker meet, they negotiate an initial contract σ. At time t_0, when the contract is signed, the worker receives instantaneous training at positive cost k and starts producing a unit flow of output. At any time $t > t_0$, the job may be hit by a shock with instantaneous probability λ. Following the shock the match-specific value of productivity takes a new value[5] $y \in \left[\underline{y}, 1\right]$, with y distributed according to a continuous cumulative density function $G(y)$. After observing the new productivity realization the parties decide whether to continue or end the match.

A worker who becomes unemployed receives unemployment benefits b independently from the reason for separation.

The paper focuses on simple, realistic employment contracts featuring state-independent wages and termination pay. Namely, we assume that a long-term, initial contract $\sigma = (w_c, F_c)$ only specifies a wage w_c in case production takes place and a layoff pay-

[5]The assumption that new jobs are created at the top of the productivity distribution is without loss of generality. What matters is that a new match has positive surplus.

ment F_c from the firm to the worker in case of layoff[6].

Crucially it is assumed that termination payments can be conditioned on who takes verifiable steps to end the relationship. A separation is deemed a dismissal if and only if the firm gives the worker written notice that it no longer wishes to continue the employment relationship. The end of the relationship is deemed a quit if the worker gives written notice that she no longer intends to continue in employment[7]. That is, neither party can claim the counterpart has unilaterally severed the relationship unless they can produce a written document, signed by the other party, proving their claim. This seems broadly consistent with existing practices in most countries. A separation is consensual if both parties sign a written document stating their agreement to terminate the relationship and exchange any termination payment specified in the document. Until one of these actions is taken the employment relationship is considered in existence.

At any time the parties can renegotiate the terms of the ruling contract (w_c, F_c). This ensures that mutual gains which are not exhausted by the ex ante contract can be reaped ex post. If the initial contract is renegotiated, there are two possibilities. Either the contract wage is renegotiated and the match continues or the parties agree to renegotiate the severance payment and separate.

Workers cannot borrow or lend and fully consume their current income in all periods[8]. This is of no relevance while the worker is employed as she can use the firm as banker. On the other hand, ruling out saving would miss the role of severance payment as a form of insurance against job loss. The solution we adopt is to assume that workers can annuitize their severance payment with a risk-neutral and reliable agency that can perfectly observe, and will stop paying the annuity if a worker does not search or meets

[6]This is broadly consistent with the form of observed labour contracts. Proposition 3 shows that even such a simple contract delivers full insurance in the benchmark economy.

[7]Alternatively, not showing up for work without providing a medical certificate could be interpreted as a signal that the worker has quit.

[8]Allowing for borrowing and lending would make the problem intractable. With decentralized trade, employment contracts and termination decisions would depend on workers' heterogeneous asset holdings.

a firm[9]. In doing so, we are abstracting from the risk associated with the uncertain duration of unemployment spells studied in Pissarides (2002). Section 6.2 relaxes this assumption.

2.2 Steady state

Since attention is restricted to steady state equilibria, time subscripts can be dropped.

The asset value of an unfilled job V_c satisfies the Bellman equation

$$[r + q(\theta)] V_c = -c + q(\theta) (J(1, w_c, F_c) - k), \tag{1}$$

where $J(1, w_c, F_c)$ is the value to the firm of forming a new productive match with initial productivity equal to one and contract (w_c, F_c) gross of the training cost k.

Free entry in the creation of productive units requires $V_c = 0$ and implies that

$$J(1, w_c, F_c) - k = \frac{c}{q(\theta)}. \tag{2}$$

An unemployed worker's expected utility $W_u(F)$ depends on the size of the separation payment F she received upon leaving her last job and satisfies

$$[r + p(\theta)] W_u(F) = u[b + (r + p(\theta)) F] + p(\theta) W(1, w_c, F_c) \tag{3}$$

An unmatched unemployed worker's income flow is the sum of unemployment benefits plus the annuity value of her last severance payment F. With probability $p(\theta)$ an unemployed worker becomes employed at a contract (w_c, F_c) and produces a flow of output 1. $W(1, w_c, F_c)$ is the associated expected utility.

As in Mortensen and Pissarides (1994), the unemployment steady-state flow equilibrium condition is

$$\lambda G(y_d)(1 - u) = p(\theta) u. \tag{4}$$

[9]The assumption captures the insight that, unlike unemployment benefits, severance payments are sunk and their cumulated flow is not endogenous to workers' search and job acceptance decisions.

In order to determine the firm and worker's expected returns from matching, $J(1, w_c, F_c)$ and $W(1, w_c, F_c)$, we need to solve for the optimal contract.

3 Contracts and renegotiation

3.1 Contract renegotiation

After the parties match and a contract is signed at time t_0, the ruling contract is (w_c, F_c) and the parties play the following infinite horizon renegotiation game along the lines of MacLeod and Malcomson (1993). The first offer of renegotiation is made at t_0 and subsequent offers follow at intervals of length Δ. There is a potentially infinite number of bargaining rounds. The following sequence of moves characterizes a bargaining round n if the game has not already ended.

(n.1) The worker chooses either to quit or selects a proposal from two mutually exclusive, continuous, bounded sets $\{w\}$ and $\{F\}$. If the worker quits the game ends and the worker and firm payoffs equal respectively $W_u(0)$ and zero. Alternatively, she proposes to produce at a wage w_n or to separate with a severance payment F_n.

(n.2) The firm can either lay the worker off or accept the proposal or reject it. If it lays off the worker the game ends and the firm has to pay the contracted severance payment. Its payoff is $-F_c$ and the worker's $W_u(F_c)$. If F_n is proposed at n.1 and the firm accepts, the game ends and the firm and worker obtain payoffs $-F_n$ and $W_u(F_n)$. If w_n is proposed at n.1 then the ruling contract for the current period evolves according to the following transition law. $\sigma'_c = [w'_c, F_c]$ with $w'_c = w_n$ if the firm accepts and $w'_c = w_c$, the current contract wage, if the firm rejects. Trade takes place in the current round at the contract wage w'_c.

(n.3) With probability $\lambda\Delta$ a new probability realization is drawn from the set $[\underline{y}, 1]$.

This extensive form is meant to capture the following three aspects. First, the insight of MacLeod and Malcomson (1993) that if trade takes place over time, rather than at a fixed date, simple fixed-price contracts are not necessarily renegotiated. If trade under the terms of the current contract is profitable for both parties, refusing to revise the contract is a credible threat for the party who opposes renegotiation. This is captured by the fact that trade takes place at the ruling wage unless the match ends or the contract is renegotiated[10]. Second, the threat to refuse renegotiation is constrained by either party's option to unilaterally end the match. The threat to end the match, when credible, limits a fixed-price contract ability to provide insurance against productivity fluctuations in case the match continues. Third, the parties can renegotiate existing arrangement when this is Pareto optimal.

The equilibrium concept used is stationary subgame perfect equilibrium (SPE) in pure strategies. That is a subgame perfect equilibrium in which strategies depend only on the current state.

The renegotiation game above is a stochastic bargaining game. Merlo and Wilson (1995) derive a sufficient condition for a stochastic alternating offer bargaining game to have a unique equilibrium. Such condition is violated if agents are risk averse. Removing the alternating offer assumption, by giving the worker all the bargaining power, is sufficient to guarantee uniqueness of a stationary equilibrium[11].

We can now prove the following result.

Proposition 1 *For fixed Δ, the renegotiation game has a unique stationary SPE.*

Proof. See Appendix A.1. ■

In the Appendix we derive equilibrium payoffs in all possible states (y, w_c, F_c). Yet, since the initial choice of w_c and F_c affects the value of the wage at $t > t_0$, not all states can be reached at $t > t_0$. In particular,

[10]It would be straightforward to allow the parties to choose optimally whether to trade or not at the ruling wage in case the match survives. If lockouts are illegal and the ruling contract exceeds the disutility of labour (zero in this case) trade would always take place if the match survives. Lockouts are indeed illegal in a number of countries. Furthemore, if legal lockouts destroyed insurance with positive probability, by allowing the firm to renegotiate the contract, the parties could negotiate a Pareto improving clause ruling them out.

[11]As it turns out, Proposition 3 shows that giving all bargaining power to the worker is without loss of generality in the absence of government intervention as payoffs are always determined by outside options.

Lemma 1 *Under an optimal contract w_c is never below the worker's reservation wage calculated along the equilibrium path.*

Proof. See Appendix A.1. ■

Even if at this stage we do not provide a full characterization of the optimal contract, Lemma 1 allows to simplify the expressions for the Bellman equations that follow. Its intuition is straightforward. If at t_0 w_c were above the worker's reservation wage, the worker would never accept to renegotiate the initial contract to a wage below her reservation wage at some $t > t_0$. Furthermore, an optimal contract cannot feature a wage w_c below the worker's reservation wage at t_0. In a stationary equilibrium, the worker would quit at n.1 if this were the case as in equilibrium the firm would not accept to renegotiate the wage in the current round. This cannot be optimal ex ante given that gains from trade are positive at t_0.

We can now characterize the firm's and worker's value functions in state (y, w_c, F_c) in terms of the respective Bellman equations in the limit as bargaining frictions become negligible.

Proposition 2 *Under an optimal contract as the interval between offers goes to zero ($\Delta \to 0$), the firm's and worker's value functions at any $t \geq t_0$ converge to*

$$J(y, w_c, F_c) = \max \left\{ -F_c, \frac{y - w_c + \lambda \int_{\underline{y}}^{1} J(y', w_c, F_c)\, dG}{r + \lambda} \right\}, \tag{5}$$

$$W(y, w_c, F_c) = \max \left\{ W_u(-J(y, w_c, F_c)), \frac{u(w) + \lambda \int_{\underline{y}}^{1} W(y', w', F_c)\, dG}{r + \lambda} \right\}, \tag{6}$$

with $w' = \min\{w_c, w(y, F_c)\}$ and

$$w(y, F_c) = y + (r + \lambda) F_c + \lambda \int_{\underline{y}}^{1} J(y', w, F_c)\, dG. \tag{7}$$

Proof. See Appendix A.1. ■

Equation (5) implies that in the unique equilibrium the firm's can either threat to fire the worker or to continue the relationship at the current wage contract w_c. The firm's payoff is the one associated with the credible of the two threats: the one that yields the highest payoff to the firm. Therefore if the match continues w_c is renegotiated if and only if the firm prefers firing the worker than producing at w_c. In such a case w_c is renegotiated down to the firm's reservation wage in equation (7). This is the wage that gives the firm a payoff exactly equal to F_c, what she would obtain by firing the worker. On the other hand, if the match ends, the worker cannot force the firm to unilaterally terminate the match and pay F_c. The firm has no incentive to fire the worker when $J(y, w_c, F_c) \geq -F_c$. In such a case, if separation is jointly optimal the termination payment will be renegotiated down to $-J(y, w_c, F_c)$ which leaves the firm indifferent between terminating and continuing the match at w_c. $W_u(-J(y, w_c, F_c))$ is the corresponding payoff to the worker.

Equations (5)-(7) apply only to an optimal contract as they do not allow for a worker's option to quit. It follows from Lemma 1 that such an option is never exercised under an optimal contract and can be disregarded.

The right hand side of (5) is increasing in y and decreasing in w_c. Hence, for given w_c and F_c there exists a reservation value of productivity $y^*(w_c, F_c)$ such that $J(y, w_c, F_c) = -F_c$ if $y < y^*(w_c, F_c)$ while $J(y, w_c, F_c)$ equals the second term inside the maximum operator in (5) if $y \geq y^*(w_c, F_c)$. Alternatively, for given y and F_c, $w(y, F_c)$ in equation (7) is the firm's reservation wage that leaves the firm indifferent between firing the worker and producing. Therefore it is $y \geq y^*(w_c, F_c)$ if and only if $w_c \leq w(y, F_c)$ and the contract wage is not renegotiated.

It follows that F_c but not w_c is renegotiated under the following conditions.

Corollary 1 *Under an optimal contract, if $y \geq y^*(w_c, F_c)$, as $\Delta \rightarrow 0$:*

1. *if $y \geq y_d$ trade takes place at the ruling wage w_c in the current round;*

2. *if $y < y_d$ the parties agree immediately to separate with a severance payment $F = -J(y, w_c, F_c)$;*

3. y_d satisfies

$$\frac{u(w_c) + \lambda \int_{\underline{y}}^{1} W(y', w_c, F_c)\, dG}{r+\lambda} = W_u(-J(y_d, w_c, F_c)). \tag{8}$$

Conversely w_c is renegotiated down to $w(y, F_c)$ while F_c is not renegotiated if the following Corollary applies.

Corollary 2 *Under an optimal contract if $y < y^*(w_c, F_c)$ as $\Delta \to 0$:*

1. *if $y \geq y_d$ the parties agree immediately to renegotiate w_c to $w(y, F_c)$ and trade in the current round;*

2. *if $y < y_d$ the parties agree immediately to separate with a severance payment F_c;*

3. *y_d satisfies*

$$\frac{u(w(y_d, F_c)) + \lambda \int_{\underline{y}}^{1} W(y', w, F_c)\, dG}{r+\lambda} = W_u(F_c). \tag{9}$$

Corollaries 1 and 2 together imply that, given a contract (w_c, F_c) at time $t \geq t_0$, there are two possibilities. If $y_d > y^*(w_c, F_c)$, the wage component of the contract is never renegotiated as the firm's threat to fire the worker is not credible if continuation is efficient. Conversely, the contracted severance payment F_c will be renegotiated down for $y \in [y^*, y_d)$; i.e. for productivity realizations such that termination is jointly optimal but the firm has no incentive to unilaterally fire the worker at cost F_c. Viceversa if $y_d < y^*(w_c, F_c)$, F_c is never renegotiated. On the other hand, w_c is renegotiated down to $w(y, F_c)$ if $y \in [y_d, y^*)$ as the firm can credibly threat to fire the worker unless she accepts a wage no larger than $w(y, F_c)$. Only, in the knife-edge case $y_d = y^*(w_c, F_c)$ neither w_c nor F_c are ever renegotiated and the ex ante transfers established by the contract are realized ex post in all states.

Corollaries 1 and 2 apply independently from whether the termination cost F_c born by the firm is embodied in a private contract or mandated by legislation. Furthermore, it is often argued, following Lazear (1990), that legislated dismissal payments have different effects depending on whether they involve or not third party payments. As noted in Malcomson (1997) and Fella (1999), though, as long as information is symmetric, Lazear's argument applies only to unconditional separation payments, but not to restrictions which, as it is the case in this model and in practice, are *conditional* on firms initiating separation[12].

3.2 Initial contract

An optimal initial contract maximizes the present value of the firm's expected profits at t_0 subject to the worker receiving a given level of utility. Alternative (efficient) bargaining solutions just select different values for the worker's utility level. Among these, the axiomatic Nash bargaining solution is most used in the matching literature.

We therefore assume without much loss of generality that the initial contract satisfies the axiomatic Nash bargaining solution, or

Assumption 1 *The initial contract solves*

$$\max_{w_c, F_c} N = \left(J\left(1, w_c, F_c\right) - k\right)^{1-\gamma} \left(W\left(1, w_c, F_c\right) - W_u\left(0\right)\right)^{\gamma} \tag{10}$$

$$s.t. \quad \frac{u\left(w_c\right) + \lambda \int_{\underline{y}}^{1} W\left(y', w_c, F_c\right) dG}{r + \lambda} \geq W_u\left(0\right) \tag{11}$$

$$J\left(1, w_c, F_c\right) \geq k \tag{12}$$

Note that the assumption that workers lose their entitlement to the annuity when they meet a firm implies that a worker's threat point is $W_u\left(0\right)$ and not $W_u\left(F\right)$.

Constraint (11) follows from Lemma 1, while (12) is the participation constraint for the firm.

We can now derive the optimal contract.

[12] To see this suppose that, in case the firm sends a layoff letter, it has to pay a firing cost F_c of which only a fraction $F_c' < F_c$ accrues to the worker, while the rest is a deadweight loss. Of course, the firm has an incentive to send a layoff letter only when $-F_c > J\left(y, w_c, F_c\right)$. Yet, even in such a case it is optimal for the parties to avoid the deadweight loss by labelling the separation a quit, rather than a layoff, and negotiating a pure transfer $F_c - \delta$ from the firm to the worker with δ arbitrarily small. With $F_c - \delta$ a pure transfer, the deadweight $F_c - F_c'$ is never incurred and, therefore, has no effect on either separation decision or ex ante payoffs.

4 The optimal contract

The maximization problem in equation (10) is continuous and piecewise differentiable in $\sigma = (w_c, F_c)$ on $[-\infty, \infty]^2$. So at a maximum the first derivative of the maximand N in (10) is either zero or non-increasing (non-decreasing) to the right (left).

The optimal contract (off-corners) has to lie on the contract curve

$$\frac{\partial W(1,.)/\partial F_c}{\partial W(1,.)/\partial w_c} = \frac{\partial J(1,.)/\partial F_c}{\partial J(1,.)/\partial w_c} \tag{13}$$

and satisfy the surplus sharing condition

$$\frac{1-\gamma}{\gamma}\frac{W(1,.) - W_u(0)}{J(1,.) - k} = -\frac{\partial W(1,.)/\partial w_c}{\partial J(1,.)/\partial w_c}. \tag{14}$$

Since the training cost k is positive the firm's participation constraint in equation (12) implies $J(1, w_c, F_c) > -F$ or

Lemma 2 *Under an optimal contract, at t_0 it is $y^*(w_c, F_c) < 1$.*

For the firm's participation constraint to be satisfied, the firm's reservation productivity at t_0 has to be strictly smaller than the initial match productivity. If this were not the case, Corollary 2 would imply $J(1, w_c, F_c) = -F$ which violates constraint (12). It follows from Corollary 1 that w_c is not immediately renegotiated at t_0. Therefore, under an optimal contract, $J(1,.)$ is given by the second expression inside the maximum operator in equation (5) evaluated at $y = 1$. Also, given that gains from trade are positive when a match is formed $W(1,.)$ is given by the second expression inside the maximum operator in (6) evaluated at $y = 1$ and $w' = w_c$. Therefore the partial derivatives of $J(1,.)$ and $W(1,.)$ can be obtained by differentiating (5) and (6) using equation (3). The derivations are relegated to Appendix A.2. Replacing for the partial derivatives (14) can be rewritten as

$$\frac{1-\gamma}{\gamma}\frac{W(1,.)-W_u(0)}{J(1,.)-k}= \tag{15}$$
$$\frac{r+\lambda G(y^*)}{r+\lambda G(\max\{y^*,y_d\})}\left[u'(w_c)+\lambda\int_{\min\{y_d,y^*\}}^{y_d}\frac{u'(b-(r+p)J(y,.))}{r+\lambda G(y^*)}dG\right].$$

If F_c is never renegotiated - $y^* \geq y_d$ - then the ratio of the parties marginal benefits from w_c is just $u'(w_c)$ and (14) reduces to the standard Nash bargaining solution when one agent is risk averse. If instead F_c is renegotiated with positive probability - $y^* < y_d$ - then w_c has an additional benefit for the worker as it increases the severance payment in those states in which F_c is renegotiated. This corresponds to the second term in the square bracket.

Replacing for the partial derivatives in the contract curve (13) and rearranging yields

$$\int_{y_d}^{\max\{y_d,y^*\}}\left[\frac{\partial W(y,w,F_c)}{\partial F_c}-u'(w_c)\right]dG+ \tag{16}$$
$$G(\min\{y_d,y^*\})\left[u'(b+(r+p)F_c)-u'(w_c)\right]=0.$$

Since the firm and worker share the same discount rate and objective probability distribution, one can interpret the optimality condition (16) just in terms of the marginal cost and benefit to the worker of a higher severance payment F_c. The worker's pays for F_c through a lower w_c. This reduces her ex ante utility by $u'(w_c)$. On the other hand, F_c increases a worker's utility in those states in which (a) the match continues and w_c is renegotiated and (b) the match terminates and F_c is not renegotiated. The first set of states is non-empty only if $y^* > y_d$ and the associated positive utility gain to the worker is $\partial W(y,w,F_c)/\partial F_c$. The marginal utility increase in the second set of states is $u'(b+(r+p)F_c)$[13].

We are now in a position to prove the main result of the paper.

[13]To be precise F_c affects costs and benefits also in those states in which separation takes place and the severance pay is renegotiated. Yet, it turns out that in such states the marginal cost and benefit are the same and cancel out.

Proposition 3 *The unique optimal contract features* $w_c = b + (r + p) F_c$ *and is never renegotiated.*

Proof. See Appendix A.1. ■

Proposition 3 characterizes the optimal severance payment size. Given that unemployed workers have access to perfect annuity markets, they are fully insured against the uncertain duration of an unemployment spell and severance payments are a perfect substitute for unemployment insurance. Their optimal size equals the expected loss in lifetime income associated with transiting through unemployment. This equals the expected present value of the income loss $w_c - b$ over the expected length of an unemployment spell.

Also, the optimal contract is never renegotiated and features full insurance. This is actually a knife-edge result, given the simple explicit contracts the parties have at their disposal. The reason is that neither party can commit not to terminate the relationship or renegotiate the contract if optimal. Hence, for given w_c, the severance payment has to perform two conflicting roles. First, it has to ensure that the firm does not renegotiate the contract wage down. This would destroy insurance in those states in which the match survives. Secondly, F_c cannot be so large that it is renegotiated down in case of separation. This would make the income of job losers fluctuate with productivity. In fact, though, w_c is not given so that the parties have exactly two instruments to achieve the two objectives. They can trade off, at a constant level of utility for the worker, a higher (lower) F_c for a lower (higher) w_c until both parties ex post incentives to renegotiate are eliminated. Therefore, even such a simple contracts is able to provide perfect insurance in this benchmark case.

The optimal severance payment in Proposition 3 is always strictly positive if $w_c > b$ or, equivalently, workers have positive bargaining power. In fact,

Corollary 3 *The unique optimal contract features* $F_c = 0$ *if and only if* $\gamma \to 0$.

If employed workers enjoy no rents over their unemployed counterparts, their participation constraint is binding, unemployment entails no utility cost and a contract that results in a wage equal to workers' income from unemployment is optimal and requires no severance payment. Such a contract features $w_c = b$. When separation is optimal the firm fires the worker at zero cost and the worker suffers no income loss.

Instead, if workers have positive bargaining power employed workers enjoy positive rents and insurance requires such rents to be spread evenly across states and time.

Clearly, mandated employment protection matters only in so far as it exceeds privately optimal levels. In such a case the following proposition applies.

Proposition 4 *If F_c is exogenously set at a level $F_c > (w_c - b) / (r + p)$, the unique optimal contract features $y_d > y^*$.*

Proof. See Appendix A.1. ■

Proposition 4 implies that if somebody, e.g. the government, imposes on the parties a severance payment in excess of the optimal one then the parties adjust (reduce) wages in such a way that Corollary 1 applies for $y \geq y_d$ and $y \in (y^*, y_d)$. The wage component of the contract w_c is never renegotiated, while the parties agree to renegotiate the mandated severance payment down to $-J(y, w_c, F_c) > 0$ for $y \in (y^*, y_d)$.

Excessive mandated intervention, overinsures job losers and calls for a fall in wages to reestablish ex ante share. Yet, the ability of the government to impose higher than *laissez-faire* job security is limited by renegotiation.

5 Implications

5.1 Actual versus optimal severance pay

Proposition 3 summarizes the main message of the paper: when labour reallocation is a time-consuming process, severance payments are a necessary part of an optimal insurance contract whenever employed workers enjoy rents over their unemployed counterparts.

A key prediction of the model is the functional relationship between the optimal severance pay on the one hand and wages, benefits and unemployment duration on the other. Severance payments are usually expressed as a function of the last wage. For this reason it is useful to define the variable $f_c = F_c/w_c$ which measures the severance payment in units of per-period wage. The fact that in reality unemployment benefits b are a function ρw_c of the last wage imply that in the *laissez-faire* equilibrium of Proposition 3 it is

$$f_c = (1 - \rho) / (r + p(\theta)), \tag{17}$$

where ρ is the replacement rate.

In what follows we will refer to f_c as *the* optimal severance payment. Equation (17) implies that the optimal severance payment is fully determined by just three variables, the unemployment benefit replacement rate, the interest rate and unemployment duration. This implies that the optimal severance payment is an increasing function of all exogenous factors which increase equilibrium unemployment duration such as training and search costs, workers' bargaining power and frictions in the matching process.

In expressing the optimal severance pay as a function of observable quantities, equation (17) provides an operational metric which can usefully inform the debate on whether observed legislated job security measures are excessive.

To this effect, we choose an annual interest rate of 4 per cent and use data on unemployment duration and benefit replacement rates [14] for seventeen OECD countries to construct an optimal severance series on the basis of equation (17). The data with details of their sources are reported in Table 4 in Appendix A.3. For comparison, we have also constructed series for actual legislated dismissal payments and notice periods for blue and white collar workers assuming a representative worker with job tenure equal to the average completed job tenure derived from the worker-flow data in Nickell, Nunziata, Ochel and Quintini (2002). The resulting four series are reported in Table 4 in Appendix A.3. Since in a number of countries notice periods constitute the main bulk of dismissal costs for firms, our series for observed legislated severance payments add up dismissal payments and notice periods. The result are two series for

[14] The optimal severance payment should be a function of unemployment duration in the counterfactual *laissez-faire* equilibrium which is unobservable. Yet, as argued in Section 5.2, the distinction is not quantitatively important.

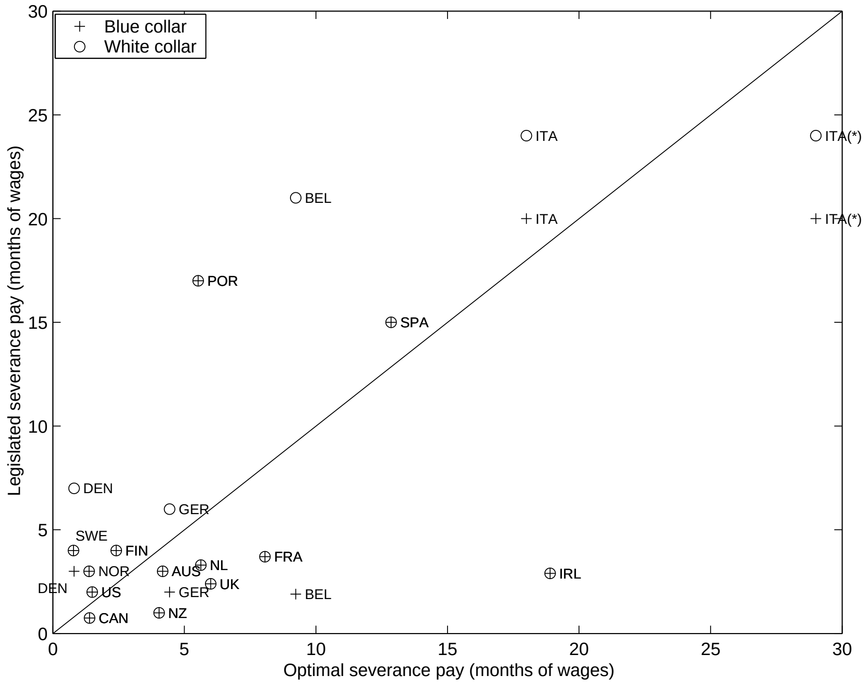

Figure 1: Optimal and actual severance payments

legislated severance payments for white and blue collar workers.

Figure 1 plots the model's optimal severance payment on the horizontal axis against the two series for legislated severance payment for a worker of average tenure. Two things should be kept in mind in interpreting Figure 1. First, as long as firms' risk neutrality is a good approximation to reality, the optimal severance payment in our model is just a lower bound for the size of the optimal payment, for reasons discussed in Section 6. On the other hand, our series for legislated payments are likely to constitute an upper bound for actual legislated dismissal payment to the extent that the actual cost to firms of notice requirements falls short of total wage payments over the legislated notice period in so far as workers find a new job before the expiration of their notice. Hence, if legislated severance payments were in line with optimal private arrangements one should observe most data points to lie on or above the forty-five degree line.

The figure highlights that, for a number of countries, legislated payments are significantly below the level consistent with optimal insurance. In particular, legislated severance payments for all workers in Ireland and for blue collar workers in Belgium are significantly below their optimal level. Given the high duration of unemployment in these two countries over the sample period, legislated payments underinsure workers. The same is also true for France and New Zealand. Spain and Italy, two countries which are normally deemed to have extreme levels of employment protection, turn out to have legislated payments which exceed their optimal lower bound by respectively seventeen and at most thirty-three per cent. This is not so surprising in the light of an average unemployment duration in excess of thirty months for Italy and forty months for Spain. The two starred observations for Italy refer to the period before 1991, the year in which the replacement rate was raised from three to forty per cent. It makes clear the extent to which despite the very high levels of dismissal costs Italian workers were underinsured before the reform.

Portugal presents an interesting case. Its level of severance payments is not only high in absolute terms, but nearly three times its optimal lower bound. With effectively the same replacement rate but an unemployment duration roughly on third of the Spanish one, its optimal severance payment should also be roughly one third. Yet, observed legislated payment in Portugal are higher than in Spain. Also severance payments for white collar workers in Belgium and for all workers in Norway are roughly twice their privately optimal lower bound. This applies to Sweden and Denmark to an even greater extent. Firing costs are five times their optimal lower bound in Sweden and equal 3.7 (blue collar) and 8.6 (white collar) times their lower bound in Denmark. It is worth keeping in mind, though, that for these last four cases notice periods constitute the bulk of the legislated severance payment reported in the figure[15]. Hence, the actual cost to firms and transfer to workers may actually be lower.

The above discussion makes clear that if one judges legislated employment protection measures by how much insurance against the cost of job loss they imply then, with the possible exception of Portugal, there is little support for the view that Mediterranean countries, or indeed most OECD countries, feature levels of employment protec-

[15] See the table in section A.3.

tions significantly in excess of privately optimal levels. There is an important caveat, though. Since series for optimal severance payments is constructed using *observed* unemployment duration the above comparison does not allow for the widely-debated possibility that the positive relationship between legislated employment protection measures and unemployment duration reflects the reverse causation going from high mandated job security to low job creation. This imply that countries with high levels of mandated job security would have high optimal severance payments based on *observed* unemployment duration. We tackle this possibility in the next subsection.

5.2 Quantitative impact of excessive mandated job security.

We have been able to characterize the features of an optimal contract and obtain insight into the rationale for the existence of severance payments in an effectively partial equilibrium set up. Yet, the question of the allocational and welfare impact of excessive mandated job security is of an equilibrium nature and can only be answered numerically.

To this effect we calibrate our model economy to the Portuguese one. As noted in Subsection 5.1 Portugal is characterized by legislated dismissal costs dramatically in excess of the optimal lower bound predicted by the model. Furthermore, it is also one of the countries where the main bulk of dismissal costs is the severance pay. Therefore, it appears a natural benchmark to investigate the consequences of excessive government intervention.

We choose a constant relative risk aversion utility function $u(c) = c^{1-\sigma}/(1-\sigma)$ and Cobb-Douglas matching function $m(U,V) = U^{\alpha}V^{1-\alpha}$. The productivity distribution is assumed uniform on $\left[\underline{y},1\right]$. With benefits equal to $b = \rho w_c$ where ρ is the replacement ratio and $\bar{w}$ the average wage, the model has ten parameters: $\left\{r, c, k, \underline{y}, \rho, \sigma, \alpha, \lambda, \gamma, f_c\right\}$.

All flow variables are per quarter. The interest rate is $r = 0.01$. Following Millard and Mortensen (1997), the cost of creating a vacancy c and the training cost k are set to $c = 0.33$ and $k = .275$. The lower support of the distribution is set to $\underline{y} = 0.32$ to obtain a coefficient of variation for output shocks of 0.3 as in Blanchard and Portugal

Table 1: Calibration statistics

Variables	Portugal	Model
Unemployment rate	6.5%	6.4%
Avg. unemployment duration (months)	17	17

$r = .01$, $\gamma = .97$, $\rho = .65$, $f_c = 17$, $c = .33$, $k = .275$, $\lambda = .013$

G(.) is uniform on [.32,1]

Matching function is Cobb-Douglas with $\alpha = 0.5$

$u(.)$is CRRA with risk-aversion coefficient $\sigma = 0.9$

(2000). The Portuguese benefit replacement rate is $\rho = 0.65$. The ratio between the legislated severance pay and the quarterly wage is $f_c = 5.7$ which corresponds to its value of seventeen months in Table 4. The chosen value for the coefficient of relative risk aversion is $\sigma = 0.9$ which is close to the value of $\sigma = 1$[16] in Hopenhayn and Rogerson (1993) and Alvarez and Veracierto (2001). The elasticity of the matching function α is set to 0.5 consistently with the evidence in Petrongolo and Pissarides (2001). The remaining two parameters λ and γ are chosen to match an average unemployment duration of 17 months and an unemployment rate of 6.5 per cent. The chosen value for unemployment duration comes from the OECD unemployment duration database[17] (see Blanchard and Portugal (2000), figure 4). Table 1 summarizes the calibration procedure[18].

We can now tackle the question of the employment and welfare costs of mandated employment protection. Table 2 summarizes our findings. It shows the allocational and welfare impact of imposing a severance payment in excess of its privately optimal value of 5.7 months in the calibrated economy.

[16] With benefit proportional to wages and $\gamma < 1$, the optimal contract wage converges to zero as σ goes to 1 from the left. The worker's threat point is not even defined if $\sigma \geq 1$. The accuracy of the numerical simulation worsens dramatically for $\sigma > 0.9$.

[17] Bover, García-Perea and Portugal (2000) calculate a slightly higher value of 20 months for the period 1992-1997 using the Portuguese Labour Force Survey. Despite using the same worker outflow data in their empirical part, Blanchard and Portugal (2000) assume a much lower value of 9 months in their calibration.

[18] The value - $\gamma = 0.97$ - of the bargaining power parameter may appear very high if compared to calibrated values in the range 0.3-0.6 under risk neutrality (see, for example, Millard and Mortensen, 1997). The reason is twofold. First, compared to the risk neutral case, risk aversion reduces the worker's effective bargaining power. Second, in our calibration the worker's utility from leisure is zero while it exceeds one quarter of maximum output in Millard and Mortensen (1997).

	Laissez-faire	Mandated	
Months of wages	5.7	17	50
Unemployment duration	100	96.8	89.1
Job destruction	100	99.9	100.2
Unemployment rate	100	96.9	90.8
Net output	100	100.2	100.6
Welfare (employed)	100	99.1	94.5
Welfare (unemployed, $f_c = 0$)	100	99	94.4
Welfare (average job loser)	100	101.7	100

Table 2: Mandated severance payments (endogenous unemployment benefits).

Clearly legislated severance payments below private optima are not binding and have no effect. Instead, rows three to nine in Table 2 report the percentage changes in labour allocation, output net of training and vacancy posting costs, and workers' welfare[19] associated with severance pay equal to 5.7 months, its *laissez faire* optimum, and respectively seventeen and fifty months. Seventeen months is the legislated value in Portugal which we have used in our calibration. Fifty months corresponds to a ratio of 8.6 between legislated severance pay and its optimal value. This is the highest value in our dataset which is observed for white collar workers in Denmark.

The effect of legislated severance payment widely in excess of private optima on job destruction is negligible and ambiguous. As the legislated severance payment is renegotiated, separation is hardly affected. Unemployment duration and the unemployment rate fall by roughly three per cent when severance payments equal three times their *laissez-faire* value and eleven per cent when they are 8.6 times as large. This fall in unemployment duration may appear surprising at first sight. Even if wages fall in response, government intervention by increasing income uncertainty should increase the cost to the firm of providing a given level of utility and reduce, rather than increase, job creation. This turns out not to be the case as, at given benefit replacement rate, the reduction in wages reduces steady state unemployment benefits and workers' threat

[19]The values of all equilibrium variables of interest have been normalized to 100 in the decentralized equilibrium. Workers' welfare is measured in terms of the percentage of permanent consumption in the *laissez faire* equilibrium which would give worker the same level of utility as in the equilibrium with government intervention. Profits do not feature in the welfare calculation as they are exhausted by training and vacancy posting costs.

	Laissez-faire	Mandated	
Months of wages	5.7	17	50
Unemployment duration	100	101.2	103.5
Job destruction	100	100.1	100.8
Unemployment rate	100	101.2	104.2
Net output	100	99.9	99.7
Welfare (employed)	100	99.2	94.9
Welfare (unemployed, $f_c = 0$)	100	99.2	95.1
Welfare (average job loser)	100	101.9	100.8

Table 3: Mandated severance payments (exogenous unemployment benefits).

point in bargaining thus increasing firms' return to job creation. This can be easily seen by simulating the model keeping unemployment benefits constant at their initial value in *laissez-faire* equilibrium. The results are reported in Table 3.

Job destruction is still virtually unaffected while, as expected, job creation and the unemployment rate increase though their absolute change is even smaller when benefits are exogenous. As a consequence also the absolute change in net output is smaller[20].

This result that even with incomplete markets, if firms and workers can write optimal contracts, however simple, legislated dismissal costs have very small effects constitutes one important insight of this paper. It implies that even in the absence of complete markets there is no causal relationship from legislated dismissal costs to high unemployment rates and duration. On the contrary, our findings imply that the causation goes the other way round, from factors, such as high workers' bargaining power or high matching frictions, that result in high unemployment duration to optimal severance payments. Also, the optimal severance payment is larger, the lower the amount of insurance provided by the state through unemployment benefits[21].

Turning to welfare, the impact of excessive government intervention are qualitatively similar independently from whether benefits are endogenous or exogenous. As legislated payments increase, the average job loser's welfare first increases and then decreases as the increase in income variance more than offsets the increase in the expected

[20]The sign of change in net output is the opposite of the sign of the change in job duration as our parameterization implies job creation is inefficiently low in laissez faire.

[21]It can never be optimal for unemployment benefits to provide perfect insurance, given that, unlike severance pay, they induce moral hazard in search.

severance pay. On the other hand, welfare falls for employed workers and, potential, new entrants into the labour market who have not received severance pay. The fall in welfare is nearly one per cent for the case in which mandated payments equal three times their privately optimal value and a very large five per cent when they equal 8.6 times the private optimum.

It is worth noting that the fact that efficiency, as measured by net output, and the welfare of unemployed workers move in opposite direction in Table 2 implies that the distortion stemming from overinsurance more than offsets the reduction in search externalities. Also it needs to be emphasized that the comparisons involve alternative steady states. So, while employed workers would be better off in the steady state of the *laissez faire* economy, they would lose if at a point in time excessive legislated job security were scrapped. Since contract wages are not renegotiated up as long as they remain above reservation wages in the post-reform equilibrium, employed workers would suffer a negative windfall given that their contract wages were fixed in the past at a lower level reflecting higher expected layoff payments. This is consistent with the fact that employed workers are often very opposed to reduction in mandated job security.

It also has to be pointed out that the size of the welfare losses derived reflects two extreme deviations from *laissez-faire.* For most countries in our dataset the difference between optimal and legislated severance payments is substantially lower. This is clearly seen in Figure 2 which plots the unemployed welfare loss against the ratio between the legislated and optimal severance pay in our dataset together with the cumulative sample density[22]. For 47 per cent of our data points legislated measures are no larger than their optimal lower bound. For 82 per cent of observations, that is all countries other than Portugal, Sweden and Denmark, the ratio between legislated and optimal payments is no larger than 2.3. The associated upper bound on the welfare loss is lower than half a percentage point.

It is obviously of interest to know how sensitive the result is to changes in the

[22]Observations for white and blue collars are treated as separate data points.

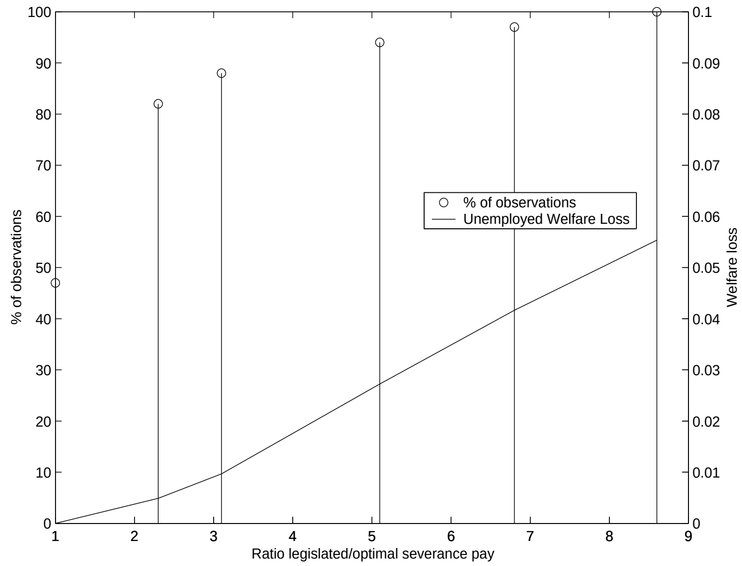

Figure 2: Welfare loss versus legislated/optimal severance pay ratio.

key parameters. It turns out that for all tried parameterization the allocational and welfare effects of mandated severance payments are a feature of the ratio between mandated and *laissez faire* payments and not of their absolute level. The result is remarkably robust to alternative parameterizations being driven by the optimal nature of contracts rather than any other features[23]. Only the size of the workers' welfare changes is sensitive to the degree of risk aversion.

6 Extensions

This paper has relied on a number of simplifying assumptions to derive a closed form solution for the optimal severance pay wage ratio in terms of observable quantities. In what follows we discuss how relaxing such assumptions alters the main conclusions. The general message can be anticipated here. Not surprisingly, given the simplicity of the contract considered, the perfect insurance result of Proposition 3 does not survive. More importantly, the optimal severance payment is never below the value derived in

[23]Calibrating the model to the US economy produces very similar results. They are available upon requests.

Proposition 3. Also the efficiency and welfare losses derived in Section 5.2 are an upper bound on the corresponding losses under less restrictive assumptions.

6.1 Leisure and quits

In the above analysis, the optimal contract is never renegotiated in the *laissez faire* equilibrium. This result is actually knife-edge and relies on the expected utilities of the marginal worker and the marginal job loser being the same under a contract which provides full insurance against the match productivity risk. This is not true in general, though.

Consider, for example, the case in which the utility of leisure is positive. If the utility function is separable in consumption and leisure the contract curve is still given by equation (16). Assume Proposition 3 still holds and the contract is never renegotiated. Employed and laid off workers have the same income in all states. Yet, employed workers have lower utility since they enjoy less leisure. At the full insurance contract, therefore, workers would be willing to be laid off at a level of the severance payment marginally below the full insurance one. Therefore, the contractual severance payment must be renegotiated down with positive probability and insurance is imperfect. Yet, since $y^* < y_d$, the optimal severance payment still satisfies $w_c = b + (r + p) F_c$, as can be seen from equation (16).

Similarly, suppose employed workers quit to unemployment for exogenous reasons with instantaneous probability δ. Quitters are not entitled to severance payments and their expected utility is $W_u(0)$. It can be easily shown that the contract curve is still given by equation (16). Under a contract which fully insured workers against the match productivity risk, employed workers would have lower expected utility as they would face the additional risking of having to enter unemployment for exogenous, and uninsurable, reasons. Again, the contractual severance payment satisfies $w_c = b + (r + p) F_c$ and is renegotiated down with positive probability.

Furthermore, the fact that a fraction of entries into unemployment do not involve the payment of severance payments implies that the allocational and welfare effects of excessive legislation are lower that in an economy with the same unemployment inflow but no quits. Since the simulations in Section 5.2 identify all unemployment inflows with layoffs they overstate expected termination transfers and the efficiency and welfare costs associated with excessive mandated job security.

6.2 Self-insurance and finite benefit duration

The simplicity of the expression for the optimal severance payment in (17) hinges on the two assumptions that benefits have infinite duration and that severance payments can be fully annuitized. Therefore, the model abstracts from unemployment risk: the risk associated with the uncertain length of an unemployment spell and the associated risk of losing benefits before finding a new job. With no unemployment risk, self insurance through borrowing and lending would make little difference as the worker can use the current employer as a banker and insurer against job loss.

Self insurance becomes important in the presence of unemployment risk. To see how this alters the main result consider the following simple, partial equilibrium, two-period model. Now workers can borrow and lend at rate r equal to their subjective discount rate. Assume, without loss of generality, that $r = 0$ and workers have no initial wealth. At the beginning of the first period a newly matched firm-worker pair sign a contract (w_c, F_c) before knowing the productivity realization. After signing a contract they draw a permanent productivity shock y. The possible outcomes are the same as in the main text. If the parties stay together they produce for two periods. If they separate the worker receives unemployment benefit b in the current period. In the second period she finds a job paying some wage $\bar{w} > b$ with some positive probability p and remains unemployment and receives b with the complementary probability.

Conditional on the productivity realization the counterparts of the Bellman equations (5) and (6) are $J(y, w_c, F_c) = \max\{-F_c, 2(y - w_c)\}$ and $W(y, w_c, F_c) = \max\{2u(w'), W_u(-J(y, w_c, F_c))\}$ with $w' = \min\{w_c, w(y, F_c)\}$ and $w(y, F_c) = y +$

$F_c/2$. The expected utility of entering unemployment with a severance payment F is

$$W_u(F) = \max_{c_u} u(c_u) + pu(F - c_u + \bar{w}) + (1-p)\,u(F - c_u + b)\,. \tag{18}$$

An optimal contract maximizes a worker's expected utility $E[W(y, w_c, F_c)]$ subject to $E[J(y, w_c, F_c)] \geq \bar{J}$, where E is the unconditional expectation operator and $\bar{J}$ is some given value for expected profits.

The following result obtains.

Proposition 5 *In the presence of unemployment risk, if $u''' \geq 0$ the optimal severance pay F_c is strictly larger than the present value of a job loser's expected income loss relative to continuing in employment at the contract wage w_c.*

Proof. See Appendix A.1. ■

If the unemployment risk cannot be diversified and prudence is non-negative, the optimal severance payment exceeds the fall in lifetime wealth associated with losing one's job relative to being employed *at the contract wage w_c*. This is obvious if w_c is never renegotiated. For a worker to accept to end the relationship her expected utility from unemployment cannot be lower than the expected utility of being employed at w_c. Since unemployment is riskier than employment, this requires a job loser's lifetime wealth to be strictly higher. The result is less trivial if w_c is renegotiated with positive probability since then the only restriction imposed by voluntary separation is that a job loser must be as well off as the marginal worker who is employed at a wage $w(y, F_c) < w_c$.

Proposition 5 implies that the optimal severance payment in Proposition 3 is indeed a lower bound for the optimal severance pay. This is even more so as the model neither allows for the possibility that workers lose entitlement to benefits before finding a new job or for the kind wage of losses in new occupations documented for example by Topel (1990). Both these aspects would further increase the fall in lifetime wealth associated with job loss.

The possibility of borrowing and lending also reduces the welfare loss associated with excessive government intervention, relative to its value in Tables 2 and 3, as workers can now smooth consumption relative to income.

6.3 Alternating offer bargaining

The assumption that workers have got all the bargaining power in the renegotiation game implies that workers capture all the surplus from separation. If instead firms capture a positive share of the surplus from separation, the agreed severance payment when F_c is renegotiated is lower for given w_c and y. Hence, the redistribution associated with excessive job security is smaller. This further reinforces the conclusion that the welfare loss derived in Section 5.2 is a lower bound.

7 Conclusion

This paper characterizes firms' optimal provision of insurance by means of simple employment contracts when risk averse workers cannot access financial markets and searching for a job is a costly activity. It establishes that positive severance payments are part of an optimal contract whenever employed workers enjoy positive rents. More importantly, the paper derives a lower bound on the optimal severance payment as a function of observable quantities. Such bound equals the fall in lifetime wealth associated with job loss and is therefore decreasing in unemployment benefit replacement rates and increasing in unemployment duration.

The existence of rents to employed workers and the persistence of income losses associated with worker displacement are well documented. Topel (1990) finds wage losses of the order of 10-20 per cent for displaced workers in the US. Cohen, Lefranc and Saint-Paul (1997) document that such losses are even larger in France. Rosolia and Saint-Paul (1998) also find large wage losses for displaced workers in Spain.

The paper makes no attempt to explain if and why severance payments should be enshrined in legislation rather than in written private, explicit contracts. In fact, firms have the same incentives to evade both legislated and privately contracted severance payments and courts face the same informational asymmetries in enforcing both types of measures. Nevertheless, if the assumption is made that observed legislated measures reflect the degree to which private arrangements call for them the model predicts that there should be a direct relationship, *coeteris paribus*, between job security measures and the expected income loss associated with transiting through unemployment.

Indirect evidence consistent with the above assumption comes from Boeri, Borsch-Supan and Tabellini (2001) who find a negative correlation between an index of employment protection and a measure of benefit coverage. More direct evidence can be obtained by regressing observed legislated dismissal costs against the expected income cost of job loss. Estimating such relationship for blue and white collar workers separately yields[24]

$$f^{BC} = \underset{(1.90)}{1.84} + \underset{(0.23)}{0.55} f^*, \qquad \bar{R}^2 = 0.23 \qquad s.e. = 5.20$$

and

$$f^{WC} = \underset{(2.34)}{2.74} + \underset{(0.28)}{0.70} f^*, \qquad \bar{R}^2 = 0.24 \qquad s.e. = 6.39.$$

There is a positive and statistically significant relationship between the series for the optimal severance pay f^* and those for legislated dismissal costs for blue and white collar workers f^{BC} and f^{WC} in Table 4.

In principle, such positive correlation may reflect the reverse causation from high legislated job security to high unemployment duration which has been most emphasized in the literature on employment protection. Numerical simulations of our model, though, indicate that such reverse causation is unwarranted despite the lack of perfect insurance. Optimal private contracting undoes excessive legislated job security to a great extent. Legislated payments dramatically in excess of privately optimal ones have negligible effects on job destruction and a small negative effect on the unemployment rate and its duration. Excessive mandated job security though overinsures workers and increases income fluctuation thus reducing welfare. The upper bound on such welfare

[24]Standard errors in parenthesis.

loss can be potentially large. On the other hand, deviations between legislated and optimal severance pay equal to those observed for the bulk of OECD countries in our sample imply only marginal welfare losses.

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A Appendix

A.1 Proofs

The proof of the uniqueness of stationary SPE payoffs is a straightforward adaptation of results in Merlo and Wilson (1995).

Be $S = \left[\underline{y}, 1\right] \times R^2$ a Borel subset of a complete metric space. We call $s = \{y, w_c, F_c\} \in S$ a state. Let H denote the space of bounded measurable functions on S taking values in R. A stationary SPE payoff is a pair of functions $W, J \in H$.

Define W and J as

$$W(s) = \max_{i,j \in \{0,1\}} (1-i) W_u(0) + i \left\{ (1-j) \max_F W_u(F) + j \left[\max_w u(w) \Delta + \beta E_{|s} W(s') \right] \right\} \tag{19}$$

$$\text{s.t.} \; -(1-j) F + j \left[(y-w) \Delta + \beta E_{|s} J(s') \right] = \max \left\{ -F_c, (y-w_c) \Delta + \beta E_{|s} J(s') \right\}, \tag{20}$$

$$J(s) = i \left\{ -(1-j) F + j \left[(y-w) \Delta + \beta E_{|s} J(s') \right] \right\}, \tag{21}$$

where $\beta = 1 - r\Delta$ is the discount factor and $E_{|s}$ is the expectation operator conditional on the state s.

W is the value function associated with the following maximization problem. If the worker proposes at n.1, viz. $i = 1$, she offers an agreement on the Pareto frontier which maximizes her payoff subject to the constraint that the firm's payoff cannot fall below the higher between the payoff associated with firing the worker at F_c and with producing at wage w_c. If the highest such feasible payoff to the worker falls below the return to unemployment $W_u(0)$, the worker quits in which case the firms payoff equals zero.

Equations (19)-(21) define an operator T which maps a pair of functions $(W, J) \in H$ into a new pair of functions in H.

Proposition 6 *A pair of functions* W, $J \in H$ *is a stationary SPE if and only if* $(W, J) = T(W, J)$.

Proof. *Sufficiency.* Suppose W, J is an stationary SPE payoff. Fix $s \in S$. Consider a firm's SPE response at n.2 to some feasible proposal yielding a payoff v for the firm. If v is strictly larger than the right hand side of (20) the firm accepts. If v is strictly smaller than the right hand side of (20) the firm rejects if $-F_c < (y - w_c)\Delta + \beta E_{|s} J(s')$ and fires the worker if $-F_c \geq (y - w_c)\Delta + \beta E_{|s} J(s')$[25]. Therefore, by making an unacceptable proposal at n.1 the worker can guarantee herself $W_u(F_c)$ if $-F_c \geq (y - w_c)\Delta + \beta E_{|s} J(s')$ and $u(w_c)\Delta + \beta E_{|s} W(s')$if $-F_c < (y - w_c)\Delta + \beta E_{|s} J(s')$. The worker can obtain the same payoff by proposing respectively a severance payment F_c and a wage w_c. Given the restrictions on the firm's strategy, optimality requires that if the worker makes an acceptable proposal at n.1 she proposes an agreement on the Pareto frontier that gives the firm a payoff equal to the right hand side of (20). It follows that, if the worker does not quit, $W(s)$ satisfies the optimization problem associated with the curly bracket in (19). Optimality requires the worker to quit (propose) if the best agreement for the worker which satisfies constraint (20) yields a payoff to the worker strictly below (above) $W_u(0)$. In either case the firm's payoff satisfies (21). If the worker is indifferent between quitting and making an optimal proposal, the firm must also be indifferent since otherwise the worker could marginally reduce her offer and the firm would still accept. Hence, it is $(W, J) = T(W, J)$.

Necessity. If a fixed point of (19)-(21) exists it can be supported as a stationary SPE by the following strategies. Be $j^*(s)$ the worker's optimal choice in state s conditional on not quitting and $w^*(s)$, $F^*(s)$ the optimal proposals conditional on not quitting and proposing to produce and separate respectively. In what follows we drop the dependence on s.

n.1 The worker quits if $W_u(0) < (1 - j^*) W_u(F^*) + j^* \left[u(w^*)\Delta + \beta E_{|s} W(s')\right]$, proposes to separate - $j^*(s) = 0$ - if $W_u(F^*) > \left\{u(w^*)\Delta + \beta E_{|s} W(s'), W_u\{0\}\right\}$, proposes a wage w^* - $j^*(s) = 0$ - if $u(w^*)\Delta + \beta E_{|s} W(s') \geq \max\{W_u(F^*), W_u(0)\}$.

n.2 If the worker proposes some wage w the firm accepts if $w \leq w^*$ with w^* satisfying

[25] Alternatively, the firm rejects if $-F_c \leq (y - w_c)\Delta + \beta_\Delta E_{|s} J(s')$ and fires the worker if $-F_c > (y - w_c)\Delta + \beta_\Delta E_{|s} J(s')$.

$(y - w^*)\,\Delta + \beta E_{|(w^*,.)} J(s') = \max\left\{-F_c, (y - w_c)\,\Delta + \beta E_{|s} J(s')\right\}$. If $w > w^*$, the firm rejects if $-F_c < (y - w_c)\,\Delta + \beta E_{|s} J(s')$ and fires the worker if $-F_c \geq (y - w_c)\,\Delta + \beta E_{|s} J(s')$. If the worker proposes to separate with some payment F the firm accepts if $F \leq F^*$ with $-F^* = \max\left\{-F_c, (y - w_c)\,\Delta + \beta E_{|s} J(s')\right\}$. If $F > F^*$, the firm rejects if $-F_c < (y - w_c)\,\Delta + \beta E_{|s} J(s')$ and fires the worker if $-F_c \geq (y - w_c)\,\Delta + \beta E_{|s} J(s')$.

■

Proof of Proposition 1. It needs to be shown that the mapping T is a contraction mapping. (20) and (21) imply the firm's value function satisfies

$$J(s) = i \max\left\{-F_c, (y - w_c)\,\Delta + \beta E_{|s} J(s')\right\}. \tag{22}$$

Equation (22) defines a mapping T' from H onto itself. By definition the Pareto frontier is strictly decreasing in payoff space. Therefore, there is a unique mapping from the firm's to the worker's payoff in all states in which the worker proposes. The mapping is also trivially unique in those states in which the worker quits. Therefore, it is sufficient to show that given two functions J_1, $J_2 \in H$ the mapping T' shrinks the distance $\|J_1 - J_2\|_\infty$, where $\|.\|_\infty$ is a norm on R satisfying $\|J\|_\infty = \sup_{s \in S} |J(s)|$.

Given $\beta < 1$, it follows that there exists $\delta < 1$ such that $\beta \left|E_{|s}(J_1 - J_2)\right| < \delta \|J_1 - J_2\|_\infty$. So,

$$|T'(J_1)(s) - T'(J_2)(s)| \leq \beta \left|E_{|s}(J_1 - J_2)\right|, \tag{23}$$

for any $s \in S$, is a sufficient condition for T' to be a contraction mapping.

Fix a state s. We need to consider three cases. All others can be obtained by permutation.

1. $T'(J_1)(s) - T'(J_2)(s) = 0$. Trivially satisfied.

2. $T'(J_1)(s) = (y - w_c)\,\Delta + \beta E_{|s} J_1(s')$, $T'(J_2)(s) = -F_c$. This implies $0 \leq T'(J_1)(s) - T'(J_2)(s)$ by definition of T'. Since, $T'(J_2)(s) \geq (y - w_c)\,\Delta +$

$\beta E_{|s} J_2(s')$, it follows that $0 \leq T'(J_1)(s) - T'(J_2)(s) \leq \beta \left| E_{|s}(J_1 - J_2) \right|$.

3. $T'(J_1)(s) = 0$ with $i_1(s) = 0$ and $T'(J_2)(s) \neq 0$. $i_1(s) = 0$ implies $(y - w_c)\Delta + \beta E_{|s} J_1(s') > 0$ since otherwise the worker could propose a payoff to the firm $x \leq 0$ and achieve a payoff no smaller than $W_u(0)$. Also, it has to be $T'(J_2)(s) < 0$. Since the Pareto frontier and the state are the same both under J_1 and J_2 and the worker's payoff under J_1 is equal to $W_u(0)$ the worker cannot, under J_2, obtain a payoff at least equal to $W_u(0)$ with the firm obtaining a strictly positive payoff. Therefore it is $0 \leq T'(J_1)(s) - T'(J_2)(s) \leq (y - w_c)\Delta + \beta E_{|s} J_1(s') - T'(J_2)(s) \leq \beta \left| E_{|s}(J_1 - J_2) \right|$.

■

Proof of Lemma 1. It needs to be shown that under an optimal contract it is always $u(w_c)\Delta + \beta E_{|s} W(s') \geq W_u(0)$. Suppose not. Be $t = t_0$. Constraint (20) implies that the wage can only be renegotiated down at n.2. At n.1 optimality then requires the worker either to quit or to propose to end the relationship. In either case the match ends with probability one at t_0 despite gains from trade being positive. Hence, the contract cannot be optimal. If $u(w_c)\Delta + \beta E_{|s} W(s') \geq W_u(0)$ at $t = t_0$, the same must apply at $t > t_0$ as (19) implies that the worker proposes at n.1 in equilibrium only if this yields a payoff no smaller than $W_u(0)$. ■

Proof of Proposition 2. It follows from Lemma 1 that under an optimal contract $i(s) = 1$ in (19)-(21) $\forall s$. Replacing for $E_{|s}(J(s')) = (1 - \lambda\Delta) J(s) + \lambda\Delta \int J(y', w_c, F_c)\, dG$ in (19) and taking the limit for $\Delta \to 0$ yields (5). Furthermore, if $j = 1$ the w the maximizes the worker's payoff is $w = \min\{w_c, w_\Delta(y, F_c)\}$ where $w_\Delta(y, F_c)$ satisfies $[y - w_\Delta(y, F_c)]\Delta + \beta E_{|s} J(s') = -F_c$. Replacing for $E_{|s}(J(s'))$ noticing that it is $J(s) = -F_c$ and taking the limit for $\Delta \to 0$ yields (7). Replacing for the optimal w and $E_{|s}(W(s')) = (1 - \lambda\Delta) W(s) + \lambda\Delta \int W(y', w_c, F_c)\, dG$ in (19) and taking the limit yields (6). ■

Proof of Proposition 3. If a full insurance contract exists, it is unique, given the assumptions on preferences, and trivially optimal. We now show that a contract featuring $w_c = b + (r+p) F_c$ provides full insurance.

Step 1. *$w_c = b + (r+p) F_c$ implies $y^* \leq y_d$.*

Suppose to the contrary it is $y^* > y_d$. Corollary 2 implies y_d satisfies equation (9). It follows that the left hand side of (9) equals $u(w(y_d, F_c))/r$ as $W(y', w, F_c) = W_u(F_c)$ $\forall y'$ as the wage is never renegotiated for any $y' \geq y_d$ and the worker's utility equals $W_u(F_c)$, for any $y' < y_d$. By definition, $y^* > y_d$ implies $w(y_d, F_c) < w_c = b + (r+p) F_c$. But then (3) implies $W_u(F_c) > u(w(y_d, F_c))/r$ as an unemployed worker receives a strictly higher income and expects an increase in utility $p(W(1, w_c, F_c) - U(F_c)) > 0$. A contradiction.

Step 2. *$w_c = b + (r+p) F_c$ implies $y^* = y_d$.*

Suppose to the contrary it is $y^* < y_d$. Corollary 1 implies y_d satisfies equation (8). It follows that $W_u(-J(y_d, w_c, F_c)) = u(b - (r+p) J(y_d, w_c, F_c))/r$. As the wage is never renegotiated it is $W(1, w_c, F_c) = W(y_d, w_c, F_c)$ which equals $W_u(-J(y_d, w_c, F_c))$ by (8). By definition, $y^* < y_d$ implies $b - (r+p) J(y_d, w_c, F_c) < w_c = b + (r+p) F_c$. Since renegotiation has the reservation property, the expected utility of the marginal worker $W(y_d, w_c, F_c)$ satisfies

$$[r + \lambda G(y_d)] W(y_d, w_c, F_c) = u(w_c) + \lambda \left[\int_{y^*}^{y_d} W_u(-J(y, w_c, F_c)) \, dG + G(y^*) U(F_c) \right]. \tag{24}$$

As $J(y, w_c, F_c)$ is decreasing in y, the square bracket in (24) is strictly positive larger than $W(y_d, w_c, F_c)$. This implies $W(y_d, w_c, F_c) > u(b - (r+p) J(y_d, w_c, F_c))/r$. A contradiction. ■

Proof of Corollary 3. In the limit as $\gamma \to 0$ it is $W(1, w_c, F_c) = W_u(0)$ which, by (3) evaluated at $F = 0$, implies $W_u(0) = u(b)/r$. By setting $F_c = 0$ the optimal contract in Proposition 3 features full insurance and satisfies $W(1, w_c, F_c) = W_u(0)$. If $\gamma > 0$, the Nash bargaining solution implies $W(1, w_c, F_c) > W_u(0)$ and the optimal contract must ensure a constant income flow strictly in excess of b. Hence, the optimal F_c is strictly positive. ■

Proof of Proposition 4. Assume it is $y_d \leq y^*$. The same argument used in Step 1 in the proof of Proposition 3 implies a contradiction. ■

Proof of Proposition 5. Given that renegotiation has the reservation property there are two possible cases to consider.

CASE 1. $y^* \leq y_d$.

In such a case w_c is never renegotiated. Be $c_u(.)$ the policy function of a job loser. The contract curve is given by

$$\int_{y_d}^{\bar{y}} \left[u'(w_c) - u'(c_u(F_c))\right] dG + \int_{y^*}^{y_d} \left[u'(c_u(-J(y_d, w_c, F_c))) - u'(c_u(F_c))\right] dG = 0 \quad (25)$$

with y_d satisfying the counterpart of (8)

$$2u(w_c) = W_u(-J(y_d, w_c, F_c)). \quad (26)$$

Since an unemployed worker is exposed to risk while an employed worker is not, for (26) to be satisfied the severance payment $-J(y_d, w_c, F_c)$ accruing to the marginal job loser must give her a lifetime wealth strictly larger than the lifetime wealth of her employed counterpart. This requires $-J(y_d, w_c, F_c)$, hence F_c, to exceed a job loser's lifetime wealth loss relative to continuing employment at w_c.

CASE 2. $y^* > y_d$.

In such case w_c but not F_c is renegotiated with positive probability. The contract curve is given by

$$\int_{y_d}^{y^*} \left[u'(w(y, F_c)) - u'(w_c)\right] dG + \int_{\underline{y}}^{y_d} \left[u'(c_u(F)) - u'(w_c)\right] dG = 0 \quad (27)$$

with y_d satisfying the counterpart of (9)

$$2u(w(y_d, F_c)) = W_u(F_c). \quad (28)$$

Since $w_c > w(y, F_c)$ for $y \in [y_d, y^*)$, the optimality condition (27) requires $c_u(F_c) > w_c$. Since current consumption is no larger than permanent income if $u''' \geq 0$, this requires the permanent income of a job loser to exceed that of a worker employed at w_c. ■

A.2 Derivatives of ex ante payoffs.

Lemma 2 implies that under an optimal contract $J(1,.)$ is given by the second expression inside the maximum operator in equation (5) evaluated at $y = 1$. Since renegotiation has the reservation property, differentiating (5) with respect to w_c and F_c yields

$$\frac{\partial J(y,.)}{\partial w_c} = -\frac{1}{r + \lambda G(y^*)} \tag{29}$$

and

$$\frac{\partial J(y,.)}{\partial F_c} = -\frac{\lambda G(y^*)}{r + \lambda G(y^*)}, \tag{30}$$

for any $y > y^*$. Also, given that gains from trade are positive when a match is formed $W(1,.)$ is given by the second expression inside the maximum operator in (6) evaluated at $y = 1$ and $w' = w_c$. Differentiating (6) using equation (3) yields

$$\frac{\partial W(1,.)}{\partial w_c} = \frac{1}{r + \lambda G(\max\{y^*, y_d\})} \times \tag{31}$$

$$\left[u'(w_c) - \lambda \int_{\min\{y_d, y^*\}}^{y_d} u'(b - (r+p)J(y,.)) \frac{\partial J(y,.)}{\partial w_c} dG \right] \tag{32}$$

and

$$\frac{\partial W(1,.)}{\partial F_c} = \frac{\lambda}{r + \lambda G(\max\{y^*, y_d\})} \left[\int_{y_d}^{\max\{y^*, y_d\}} \frac{\partial W(y,.)}{\partial F_c} dG - \right. \tag{33}$$

$$\left. \int_{\min\{y_d, y^*\}}^{y_d} u'(b - (r+p)J(y,.)) \frac{\partial J(y,.)}{\partial F_c} dG + G(\min\{y^*, y_d\}) u'(b + (r+p)F_c) \right] \tag{34}$$

A.3 Data and variables used in section 5.1

This section contains the data used to construct Figure 1 in section 5.1. The data for the monthly exit rate from unemployment $p(\theta)$ are from the OECD unemployment duration database. The benefit replacement rates ρ are from Nickell (1997) with the exception of the Italian replacement rate which has been updated on the basis of information in Office of Policy (2002). The average completed job tenure ACJT is from the dataset in Nickell et al. (2002). It is an average over each country's sample period.

The notice periods and severance payments in columns 5 to 8 are obtained by applying the appropriate formulas for legislated notice and severance pay to a tenure equal to the average completed job tenure in column 4. The relevant formulas for the European countries come from Grubb and Wells (1993), with the exception of those for Austria, Finland, Norway, Sweden which are derived from IRS (Industrial Relations Service) (1989). The size of the legislated severance pay for Italy is the sum of the damages workers are entitled to if their dismissal is deemed unfair (5 months) plus the amount they are entitled to if they give up their right to reinstatement (15 months). Our value is consistent with the estimates in Ichino (1996). The formula in Grubb and Wells (1993) wrongly treats as severance pay the *Trattamento di fine rapporto,* a form of forced saving workers are entitled to whatever the reason for termination[26], including voluntary quit and summary dismissal. The data for Portugal and New Zealand come respectively from European Foundation (2002) and CCH New Zealand Ltd (2002). The data for legislation in Australia, Canada and the United States are from Bertola, Boeri and Cazes (1999).

[26]On this see Brandolini and Torrini (2002).

Table 4: Legislated severance pay for blue and white collar workers.

Country	$p(\theta)$ (monthly)	ρ (%)	ACJT (yrs)	f_c	Notice BC (months)	Sev. pay BC (months)	Notice WC (months)	Sev. pay WC (months)
Australia	0.15	36	7.6	4.2	1	2	1	2
Belgium	0.04	60	24.4	9.2	1.9	-	21[a]	-
Canada	0.29	59	3.5	1.4	0.5	0.25	0.5	0.25
Denmark	0.12	90	11.9	0.8	3	-	6	1
Finland	0.15	63	10.4	2.4	4	-	4	-
France	0.05	57	21.1	8	2	1.7	2	1.7
Germany	0.13	63	26.5	4.4	2[b]	-	6[b]	-
Ireland	0.03	37	11.4	19	1.5	1.4	1.5	1.4
Italy	0.03	40 (3)	41.2	18 (29)	0.5	20	4	20
Netherlands	0.05	70	15.3	5.6	3.3	-	3.3	-
Norway	0.25	65	11.6	1.4	3	-	3	-
New Zealand	0.17	30	6.8	4	1	-	1	-
Portugal	0.06	65	14.9	5.7	2	15	2	15
Spain	0.02	70	26.8	12.9	3	12	3	12
Sweden	0.25	80	10.6	0.8	4[b]	-	4[b]	-
UK	0.1	38	4.5	6	1.2	1.2	1.2	1.2
USA	0.33	50	3.1	1.5	2[c]	-	2[c]	-

[a] 0.86 times lenghth of service in years. This is an approximation of the Claeys formula in Grubb and Wells (1993).

[b] For Germany and Sweden the formulas are a function of both age and length of services. We assumed employment started at age 20.

[c] It applies only to large scale redundancies covered by the Worker Advanced Retraining Notification Act.