Optimal Severance Pay in a Matching Model

Giulio Fella*

Queen Mary, University of London, Mile End Road, London E1 4NS, UK

Abstract

This paper uses an equilibrium matching framework to study jointly the optimal private provision of severance pay 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 privately optimal severance payment is bounded below by the fall in lifetime wealth associated with job loss. Simulations show that, despite contract incompleteness, legislated dismissal costs largely in excess of such private optimum are effectively undone by renegotiation and have only a small allocational effect. 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. Furthermore, in many countries minimum levels of severance payments and other forms of employment protection are enshrined in legislation. The existence of such measures is difficult to understand in the light of standard labour market models in which homogeneous workers maximise 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 internalised and the market equilibrium is constrained efficient. As pointed out by Lazear (1990), employment protection measures have no useful role to play in such environment and there is no reason why a firm which takes aggregate quantities as given should offer them. 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 labour markets.”

This paper studies the optimal private provision of one form of employment protection, severance pay, in an environment in which it plays an economic role as risk-averse workers can only imperfectly insure against idiosyncratic labour income shocks. This optimal contracting problem is cast within Mortensen and Pissarides’s (1994) equilibrium matching model. Using an equilibrium framework, the paper can explore jointly the privately optimal

\footnote{For the US, Bishow and Parsons (2004) document that, over the period 1980-2001, roughly 40 per cent of workers in establishments with more than 100 employees, and 20 per cent in establishments below such threshold, were covered by severance payment 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 severance pay in excess of legislated measures.}

\footnote{See Fella (2005) for a model with heterogeneous workers in which consensual termination restrictions increase firms’ investment in the general training of unskilled workers.}
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 both explicit and (reputation-based) implicit complete contracts and ensures that excessive mandated severance pay is non-neutral. This would not be the case with risk-neutral firms and complete contracting, as the latter would be a substitute for complete insurance markets. Excessive severance pay legislation would also be undone by a simple intertemporal 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.

While feature (i) stacks 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, 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 possibly imperfect and excessive mandated severance pay is a priori non-neutral.

In order to abstract from wealth effects, the paper assumes workers have constant absolute risk aversion (CARA) preferences. It establishes that the optimal severance payment size is bounded below by 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.

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3 Privately negotiated severance payment are also unenforceable through reputation alone in the standard matching framework with anonymity 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.
By yielding a closed-form lower bound 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 the lower bound on optimal severance pay 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, their optimal lower bound. Even for those countries for which this is not the case, the observed deviation from the private optimum is inconsistent with quantitatively important changes in the allocation of labour in the light of the model’s numerical results. Therefore, the model implies a direction of causation from factors which generate high workers’ rents and unemployment duration to high severance pay but rules out the reverse. The same causation also goes from low unemployment benefits to large severance payments, coeteris paribus.

The reason why legislated severance payments above private optima have only small allocational effects is that they just determine the maximum transfer in case of separation. In equilibrium, the firm pays it only if the marginal labour product 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 ensures that separation Pareto dominates continuation of the match. 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 shares of the surplus from a new match.

While the allocation of labour is hardly affected, very large deviations from the private optimum 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 two countries in our dataset are observed deviations large enough to imply an upper bound on the welfare loss equal to a third of a percentage point fall.

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 emphasises the constraint that ex post efficiency imposes on insurance provision by means of simple, explicit contracts.

Recently, Alvarez and Veracierto (2001), Bertola (2004) and Pissarides (2004) have explored the role of employment protection within a fully dynamic framework with risk-averse workers. Alvarez and Veracierto (2001) show that exogenously-imposed severance payments can have large positive effects on employment and welfare in a model with costly frictions and self-insurance. Bertola (2004) shows, within a competitive equilibrium environment, that collectively administered income transfers may improve welfare and efficiency by reducing the consumption fluctuation associated with job mobility. Both papers do not allow for optimal private contracts. This paper shows that allowing for optimal private contracting eliminates any welfare-improving role for legislated employment protection. Yet, Pareto optimal renegotiation implies that the allocational effects and welfare costs of excessive government intervention are small.

Pissarides (2004) 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 (2004) allows for dismissal delays (advance notice). 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 transfers, dismissal delays provide additional (imperfect) insurance against the uncertain length of unemployment spells at a lower cost to the firm than severance pay.

A related literature studies the optimal size and time path of unemployment benefits in search and matching models with risk-averse workers. For tractability, it studies environment in which severance pay has little or no role. Acemoglu and Shimer (1999) show that positive unemployment benefits increase efficiency and welfare relative to *laissez faire* in a directed search model without job loss. The matching models with wage bargaining and hand-to-mouth consumers of Cahuc and Lehmann (2000), Fredriksson and Holmlund (2001) and Coles and Masters (2006) also imply that the optimal size of unemployment benefits is strictly positive.

Finally, Blanchard and Tirole (2008) study the optimal joint design of unemployment insurance and employment protection in a static, partial-equilibrium setup. Because the model is static, it blurs the distinction between severance pay and unemployment benefits and the analysis emphasises the optimal financing of benefits by means of layoff taxes.

Common to all these papers is the result that, in a dynamic context, moral hazard implies that efficient and/or optimal insurance by means of unemployment benefits is imperfect and job loss costly. This paper shows that severance pay complements unemployment insurance and derives a lower bound for the optimal severance payment as a function of unemployment duration and benefits. It shows that costly job loss calls for positive severance pay. The same insight underpinning Acemoglu and Shimer (1999) also implies that severance payments are not a perfect substitute for unemployment benefits either. We show that productive efficiency still requires the latter to be positive.

The paper is structured as follows. Section 2 introduces the economic environment. Section 3 characterizes the renegotiation outcome. Section 4 characterizes the equilibrium contract. Section 5 calibrates the model and derives empirical implications. Section 6 con-
siders a number of extensions and Section 7 concludes. All proofs are in Appendix A.1 with the exception of the proof of Proposition 1 in the main text.

2 Environment

2.1 Workers and firms

Time is continuous and the horizon infinite. The economy is composed by an endogenous number of risk-neutral establishments (or firms) and a unit mass of risk-averse workers with infinite lifetimes. Workers are endowed with an indivisible unit of labour and maximise the present value of utility from consumption

$$E \int_\tau^\infty u(c_s)e^{-\phi(s-\tau)}ds$$

where $E$ is the expectation operator conditional on the information set at time $\tau$ and $\phi > 0$ is the subjective discount rate. The felicity function is assumed to have the CARA form $u(c) = -\exp\{-\alpha c\}$, where $\alpha > 0$ is the coefficient of absolute risk aversion and $c \in \mathbb{R}$.

There are no insurance markets, but agents can self-insure by borrowing and lending at the exogenous, riskless rate $r$. That is, an agent’s dynamic budget identity is $\dot{a} = s = ra + z - c$ where $a$ is the stock of wealth, $s$ the flow of saving and non-capital income $z$ equals respectively the wage and the unemployment benefit for employed and unemployed workers. Furthermore, the no-Ponzi-game condition $\lim_{\tau \to \infty} e^{-r\tau}a_\tau \geq 0$, (a.s.) has to hold. In what follows it is assumed $r = \phi$, which implies workers would choose a flat consumption profile under complete markets.

Firms maximize the expected present value of profits discounted at the market interest rate. Each establishment requires one worker in order to produce. Firms with vacant positions and unemployed workers are brought together by a random matching process according to a constant returns to scale, strictly 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 \( q(\theta) = M(U,V)/V \), for vacant firms, and \( p(\theta) = M(U,V)/U \), for unemployed workers. Keeping an open vacancy entails a flow cost \( m > 0 \).

When a firm and worker meet at some time \( \tau_0 \), they negotiate an initial contract and the worker starts producing a unit flow of output and receives the initial, post-tax, contract wage. At any time \( \tau > \tau_0 \), the job may be hit by a shock at Poisson rate \( \lambda \) and the parties decide, after observing the new productivity realization, whether to continue or end the match and on which terms. Productivity draws are i.i.d. Following a shock the match-specific value of productivity takes a new value \( y \), with \( y \) distributed according to a time-invariant, continuous distribution function \( G(y) \) with support \( Y = [y_l, 1] \).

A worker who becomes unemployed receives a net-of-tax flow of unemployment benefits \( b \) independently from the reason for separation. We assume \( b < 1 \) to ensure a non-degenerate equilibrium with positive employment exists. As in Acemoglu and Shimer (1999), benefits are assumed to be financed by a lump-sum tax \( \nu \) and the unemployment benefit fund is balanced at all times.

### 2.2 Contracts

The paper focuses on simple, realistic employment contracts featuring state-independent wages and termination pay. Namely, it assumes that a long-term, explicit, initial contract \( \sigma = (\sigma) \) specifies only a, post-tax, wage \( w \) in case production takes place and a layoff payment \( F \) from the firm to the worker in case of layoff.

The parties can renegotiate the terms of the current contract \( (\sigma) \) by mutual agreement. Whenever, given the current productivity realization \( y \), the outcome associated with the current contract \( (\sigma) \) is Pareto inefficient, the following procedure governs renegotiation:

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4 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.

5 This is broadly consistent with the form of observed labour contracts. Proposition 2 shows that even such a simple contract delivers full insurance in the benchmark economy.

6 The mechanism is similar to the one in Postel-Vinay and Robin (2002). The main difference is that
1. The worker can make the firm a take-it-or-leave-it offer to either (a) trade at a new contract wage $w'$ or (b) separate with some new severance payment $F'$.

2. If the worker has proposed (a) and the firm accepts, $(w', F)$ becomes the new current contract. Alternatively, if the worker has proposed (b) and the firm accepts, separation takes place with transfer $F'$. If the firm rejects either offer, the current contract remains $(\sigma)$.

3. Given the current ruling contract, each party decides whether to unilaterally end the match to go back to search or not.

4. If the match continues, trade takes place on the terms of the current contract until the next event which triggers renegotiation.

Renegotiation ensures that gains that are not exhausted, due to the incompleteness of the ex ante contract, can be reaped ex post. The mutual consent requirement generates equilibrium wage stickyness despite contract incompleteness, as first pointed out by MacLeod and Malcomson (1993). It implies that the contract is renegotiated infrequently and provides (possibly imperfect) insurance.

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, and the worker is entitled to the contractual layoff payment $F$, 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, and the worker is not entitled to any separation payment, if the worker gives written notice that she no longer intends to continue in employment.

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 is

here the proposer can propose a new price not only for trading but also to separate. The outcome of the mechanism is isomorphic to that of a bargaining game in which the worker is allowed to propose at vanishingly small time intervals. The latter is analyzed in Fella (2007), the working paper version of this paper.

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

Finally, unconstrained ex ante contracting requires that the initial contract be ex ante Pareto optimal as of $\tau_0$, the time a match is formed. Any such a contract maximizes the present value of the firm’s expected profits at $\tau_0$ subject to the worker receiving a given level of expected utility. Varying the worker’s lower bound on utility allows to trace the whole contract curve. Alternative (efficient) bargaining solutions are just a device to select different values for the worker’s utility level. Among these, the axiomatic Nash bargaining solution is the most used one in the matching literature. Furthermore, it is straightforward to adapt the proof of Proposition 2.4 in Rudanko (2006) to show that, in the model environment, the random matching equilibrium with Nash bargaining coincides with the competitive search equilibrium if Hosios’s (1990) condition, requiring workers’ Nash bargain share to coincide with the elasticity of the probability of filling a vacancy, is satisfied. For this reason, it is assumed, without loss of generality, that the initial contract is chosen to maximize the axiomatic Nash bargaining maximand with worker’s weight $0 \leq \gamma < 1$.

We allow for the possibility that the government mandates a minimum layoff payment $F_m \geq 0$.

Such a minimum standard imposes a constraint $F \geq F_m$ on the contractual layoff payment $F$, since a contract in breach of existing legislation would not be upheld in court. Although the mandated minimum constraints ex ante contracting, it does not prevent a firm-worker pair from negotiating a lower spot side payment $F'$ upon separation if doing so is Pareto optimal. The parties can achieve this in two equivalent ways. They can label the separation a quit or a voluntary redundancy rather than a layoff, 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 payment $F$ and the ex post Pareto optimal one.

We restrict attention to stationary equilibria and drop time indices in what follows. A

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8The lower bound at zero is consistent with the inalienability of human capital. As it will become clear in Section 4.2 it is never strictly binding in equilibrium.
formal definition of equilibrium is postponed to Section 4 for notational convenience.

3 Contract renegotiation

Given stationary aggregate quantities, the state of an ongoing match is fully described by the vector \((y, \sigma, a)\). We assume that the contract gives the worker at least her outside option, so that renegotiation is never triggered by the worker credibly threatening to quit.\(^9\)

The firm expected payoff from trading, given the current contract \((\sigma)\) and productivity realization \(y\), is denoted by \(J^t(y, \sigma)\). This must satisfy the system of Hamilton-Jacobi-Bellman equations.

\[
(r + \lambda) J^t(y, \sigma) = y - w - \nu + \lambda \int_{y_t}^{1} J^e(y', \sigma) dG
\]

\[
J^e(y, \sigma) = \max \left\{ -F, J^t(y, \sigma) \right\}
\]

Trading yields an instantaneous stream of profits, equal to the difference between the marginal product \(y\) and the pre-tax wage \(w + \nu\). A match draws a new productivity realization \(y'\) at rate \(\lambda\). The associated continuation value, conditional on \(y'\) and the current contract, is \(J^e(y', \sigma)\). Its expectation is the integral over all possible realizations of \(y'\).

Given a productivity realization, trade on the terms of the current contract may or not be optimal. In the latter case, renegotiating the contract may be in the interest of both parties. Equation (3) embodies the renegotiation assumptions. Since renegotiation requires mutual consent, the firm has the option to reject a renegotiation proposal. In such a case the contract is unchanged and, since the worker (weakly) prefers trading to quitting unilaterally, trade takes place at the ruling contract wage \(w\). Therefore, given the current productivity realization \(y\), the worker’s cannot force the firm payoff below \(J^t(y, \sigma)\). Alternatively, the firm can pay the contractual severance payment \(F\) and unilaterally fire the worker. The firm chooses optimally between the two options, and, since renegotiation offers are take-
it-or-leave-it, it receives exactly her best-response payoff. Note, that the firm payoffs are independent of the worker’s wealth since the latter does not enter equations (2) and (3).

The function $J^t(y, \sigma)$ is increasing in the match productivity $y$ and decreasing in the current contract wage $w$. It follows that, given the current contract $(\sigma)$, there exists a reservation value of productivity $\bar{y}(\sigma)$ such that the firm prefers trading at $w$ to firing the worker at cost $F$, if $y \geq \bar{y}(\sigma)$, and vice versa, if $y < \bar{y}(\sigma)$. The firm reservation productivity satisfies $J^t(\bar{y}(\sigma), \sigma) = -F$. Replacing for $J^e(.)$ in equation (2) and using integration by parts to solve for $J^t(.)$ one obtains

$$\bar{y}(\sigma) - w - \nu + rF + \lambda \int_{\bar{y}(\sigma)}^{1} \frac{1 - G(y')}{r + \lambda} dy' = 0. \quad (4)$$

Correspondingly, one can define the firm reservation wage $\bar{w}(y, F)$; i.e. the wage which leaves the firm indifferent between firing the worker at cost $F$ and trading given the match productivity $y$. This is the solution to $J^t(y, \bar{w}(y, F), F) = -F$ or $\bar{y}(\bar{w}(y, F), F) = y$, namely

$$\bar{w}(y, F) = y - \nu + rF + \lambda \int_{y}^{1} \frac{1 - G(y')}{r + \lambda} dy'. \quad (5)$$

The firm reservation productivity and reservation wage determine, interchangeably, a renegotiation trigger.

If $y < \bar{y}(\sigma)$ - equivalently $w > \bar{w}(y, F)$ - the firm can credibly threat to lay the worker off at cost $F$, unless the contract wage is renegotiated down to its reservation wage. The worker can either (i) offer to renegotiate the contract wage down to $w' = \bar{w}(y, F)$, or (ii) accept ending the match with severance payment $F$. Separation takes place whenever the worker prefers the second alternative. If, instead, the match survives the new contract is independent of the previous wage $w$.

Consider instead the case $y \geq \bar{y}(\sigma)$ - equivalently $w \leq \bar{w}(y, F)$. The firm can credibly threat to continue the match under the terms of the current contract. Since the worker cannot force the firm to fire her, she can either (i) trade at the current contract wage $w$, or (ii) offer to separate with a renegotiated severance payment $F' = -J^t(y, \sigma) < F$ equal
to the expected present value of the firm losses from continuing the match at the current contract. The match is optimally terminated whenever the worker is better off under the second alternative. In any case, the worker extracts all the surplus from renegotiation.

It follows that the contractual wage and layoff payment can only be renegotiated down in equilibrium. If the match continues, the transition law for the contract wage is

$$w'(y, \sigma) = \min\{w, \bar{w}(y, F)\}. \quad (6)$$

Similarly, if the match ends, the associated transfer from the firm to the worker equals

$$F'(y, \sigma) = \min\{F, -J'(y, \sigma)\}. \quad (7)$$

Turning to the worker’s optimization problem, let $W^t(\cdot)$ and $W^u(\cdot)$ denote respectively the worker’s value function, conditional on trade taking place under the contract ($\sigma$), and its partial derivative with respect to wealth. Let $W^u(a)$ denote the value function of an unemployed worker with wealth $a$.

The worker’s problem in recursive form can be written as

$$(r + \lambda)W^t(\sigma, a) = \max_{c^t} [u(c^t) + (ra + w - c)W^u] + \lambda \int_{y_t} W^e(y', \sigma, a) \, dG \quad (8)$$

with

$$W^e(y, \sigma, a) = \max_{j \in \{0,1\}} (1 - j)W^u(a + F'(y, \sigma)) + jW^t(w'(y, \sigma), F, a). \quad (9)$$

The square bracket on the right hand side of equation (8) describes the worker’s consumption choice if no shock takes place; she chooses consumption so as to maximize the associated flow of utility plus the utility value of the flow of saving $ra + w - c$. The second term is the expectation, over all possible realizations, of the continuation value in case the job is hit by a shock. The continuation value, conditional on the shock realization $y'$, is $W^e(y', \sigma, a)$. Note that since shocks are i.i.d., $W^t(\sigma, a)$ is independent of the productivity
realization. Finally, equation (9) describes the worker’s optimal choice of proposal after a shock. She can propose either to trade \((j = 1)\), given the equilibrium contract wage in equation (6), or to separate \((j = 0)\), given the equilibrium termination transfer in equation (7).

Strict monotonicity of the felicity function \(u(c)\) implies that the value function \(W(.\)) is strictly increasing in all its arguments. Since \(w'(y, \sigma)\) and \(F'(y, \sigma)\) are respectively weakly increasing and decreasing in \(y\), and either of them strictly so, the job destruction decision in equation (9) has the reservation property. The match is destroyed - \(j = 0\) - if the productivity realization is below some joint reservation productivity \(y^d(\sigma, a)\) and continues otherwise.

The following proposition characterizes the job destruction threshold.

**Proposition 1.** Let \(y^+(F, a)\) and \(y^-(\sigma, a)\) be the solutions to \(W^t(\bar{w}(y^+, F), F, a) = W^u(a + F)\) and \(W^t(\sigma, a) = W^u(a - J^t(y^-, \sigma))\).

1. The job destruction threshold satisfies

\[
y^d(\sigma, a) = \begin{cases} 
y^+(F, a) & \text{if } w \geq \bar{w}(y^+(F, a), F), \\
y^-(\sigma, a) & \text{otherwise}; \end{cases}
\]  

(10)

2. \(y^d(\sigma, a) - \bar{y}(\sigma)\) is decreasing in \(w\) and is zero at \(w = \bar{w}(y^+(F, a), F)\).

Figure 1 conveys the main intuition. The two solid curves plot the firm reservation productivity \(\bar{y}(\sigma)\) and the job destruction threshold \(y^d(\sigma, a)\) as functions of \(w\), given the worker’s wealth \(a\) and the contractual severance payment \(F\). Equation (11) implies \(\bar{y}(\sigma)\) is an increasing and concave function of \(w\). The inverse image of \(y\) along it is the firm reservation wage \(\bar{w}(y, F)\).

To understand Proposition 1, suppose that the contract \((\sigma)\) is such that the firm outside option is binding for the marginal job; i.e. \(w'(y^d, \sigma) = \bar{w}(y^d, F)\) and \(F'(y^d, \sigma) = F\). By definition of marginal job, the worker must also be indifferent between continuing and ending the match. It follows from equation (9) that the marginal productivity realization \(y^d(\sigma, a)\) coincides with the solution \(y^+(F, a)\) to
Trade at \( w' = w \) and is independent of \( w \). The same is true for any wage \( w > \bar{w}(y^+(F, a)) \), as the firm outside option is binding for some \( y > y^+(F, a) \) and the worker strictly prefers trading at \( \bar{w}(y, F) \) to being fired for any productivity realization above \( y^+(F, a) \). Therefore, the job destruction threshold \( y^d(\sigma, a) \) coincides with \( y^+(F, a) \) for any \( w > \bar{w}(y^+(F, a)) \), as shown in Figure 1. Since \( y^+(F, a) \) and the firm reservation productivity \( \bar{y}(\sigma) \) are respectively independent of and increasing in the contract wage, \( y^d(\sigma, a) - \bar{y}(\sigma) \) is decreasing in \( w \) for any \( w > \bar{w}(y^+(F, a), F) \).

Suppose, it is instead, \( w < \bar{w}(y^+(F, a), F) \), or equivalently \( \bar{y}(\sigma) < y^+(F, a) \). The worker prefers being fired to continuing the match at the contract wage - \( W^t(\sigma, a) < W^u(a + F) \) - but, for any \( y > \bar{y}(\sigma) \), the firm strictly prefers the reverse. By continuity of \( J^t(y, \sigma) \), there exists \( y^-(\sigma, a) > \bar{y}(\sigma) \) satisfying \( W^t(\sigma, a) = W^u(a - J^t(y^-, \sigma)) \), such that both the worker and the firm are indifferent between trading at unchanged contract and ending the match with a renegotiated transfer \( F' = -J^t(y^-, \sigma) < F \).

Finally, since \( W^t \) is increasing in \( w \), the transfer \(-J^t(y^-, \sigma)\) must be increasing in \( w \), for \( W^t(\sigma, a) = W^u(a - J^t(y^-, \sigma)) \) to hold as \( w \) changes. Standard manipulation allows to rewrite (2) as

\[
J^t(y, \sigma) = \frac{y - \bar{y}(\sigma)}{r + \lambda} - F, \tag{11}
\]

which implies that \( y^-(\sigma, a) - \bar{y}(\sigma) \) must be decreasing in \( w \).
Therefore, given \((F, a)\), the two solid curves partition the set of possible \((y, w)\) pairs into the four, mutually exclusive, subsets in Figure 1. In other words, given the contract \((\sigma)\), worker’s wealth \(a\) and the current productivity realization \(y\), only one of the following cases can occur.

1. \(y \geq \max\{\bar{y}(\sigma), y^d(\sigma, a)\}\) and trade takes place at unchanged contract. [Both parties prefer trading at unchanged contract.]

2. \(\bar{y}(\sigma) > y \geq y^d(\sigma, a)\) and trade takes place at a new contract wage \(w' = \bar{w}(y, F)\). [The firm can credibly threat to fire the worker at cost \(F\), and the worker prefers trading at the lower wage to being fired.]

3. \(y^d(\sigma, a) > y \geq \bar{y}(\sigma)\) and separation takes place with a renegotiated severance payment \(F' = -J^t(y, \sigma) < F\). [The firm prefers continuing the match under the terms of the current contract to firing the worker at cost \(F\). Yet, it is Pareto optimal for the parties to end the match with a lower redundancy transfer equal to the present value of the firm loss.]

4. \(y < \min\{\bar{y}(\sigma), y^d(\sigma, a)\}\) and the match ends with the contractual severance payment \(F\). [The firm can credibly threat to fire the worker at cost \(F\) and the worker prefers entering unemployment with a transfer \(F\) to continuing the match at the firm reservation wage.]

Given the triplet \((\sigma, a)\) case 2. and 3. are mutually exclusive. If \(w > \bar{w}(y^+(F, a), F)\), e.g. \(w = w^2\) in Figure 1, case 2. applies. The wage is renegotiated to the appropriate wage along the arc \(AB\) if the productivity realization is between the two curves. The contractual severance payment is never renegotiated. If \(w < \bar{w}(y^+(F, a), F)\), e.g. \(w = w^1\) in Figure 1, case 3. applies. The contract wage is never renegotiated, while the severance payment is renegotiated whenever the productivity realization is between the two curves.

Finally, the contract \((\sigma)\) is never renegotiated and the transfers it establishes ex ante are realized ex post in all states if and only if \(w = \bar{w}(y^+(F, a), a)\) or \(W^t(\sigma, a) = W^u(a + F)\). Since the contract leaves the worker indifferent between employment at the contractual wage
and being fired with the contractual severance payment, it leaves the firm residual claimant to the surplus from either continuation or separation. Therefore, the separation decision maximizes the firm payoff and it is $y^d = \bar{y}$.

Note that the possibility of renegotiating the severance payment applies independently from whether the severance payment $F$ born by the firm is embodied in a private contract or mandated by legislation as renegotiating $F$ involves just exchanging a lower spot payment and labelling the separation either a quit or a voluntary redundancy.

4 Equilibrium contracts

4.1 Contracts and market returns

In order to streamline notation we anticipate here that with CARA preferences the initial contract is independent of workers’ asset stocks.

When match is formed at $\tau_0$, individual rationality requires that the chosen contract satisfies the respective participation constraints. Let $\Sigma(W^u(a)) = \{\sigma : J^e(1, \sigma) \geq 0, \ W^c(1, \sigma, a) \geq W^u(a)\}$ denote the set of all such contracts. Given the scope for risk exchange, though, not all such contracts are Pareto optimal. For any firm payoff $J$, consistent with individual rationality, the (unconstrained) Pareto frontier at $\tau_0$ is

$$\Omega(J, W^u(a)) = \max_{\sigma \in \Sigma(W^u(a))} \{W^c(1, \sigma, a) | J^e(1, \sigma) \geq J\}.$$  \hspace{1cm} (12)

Equation (12) describes the set of payoff pairs the parties can attain at $\tau_0$, when private contracting is unconstrained. A contract that attains the Pareto frontier is Pareto optimal (or efficient) and the set of all such contracts is the contract curve. Let $\bar{J}$ the maximum value that $J^e(1, \sigma)$ attains on this set.

It is assumed that the parties choose a contract $\sigma^*$ by maximizing the axiomatic Nash
bargaining solution, or

\[ \sigma^* = \arg \max_{\sigma \in \Sigma(W^u(a))} N = J^e(1, \sigma)^{1-\gamma} [W^e(1, \sigma, a) - W^u(a)]^{\gamma} \] (13)

\[ F \geq F_m. \]

Since the Nash bargaining solution is Pareto efficient, a solution to problem (13) lies on the contract curve at \( \tau_0 \), as long as the constraint on \( F \) is not binding.

The Nash maximand in (13) is a function on the respective returns \( J^e(1, \sigma), W^e(1, \sigma, a) \) before renegotiation rather than the payoffs \( J^t(1, \sigma), W^t(\sigma) \) from trading at the agreed contract \( \sigma \). Therefore, equation (13) does not impose a priori that trade takes place at the initial contract terms. The next lemma, though, establishes that restricting attention to contracts that are not immediately renegotiated is without loss of generality.

**Lemma 1.** An initial contract \( \sigma \) either satisfies

\[ W^t(\sigma, a) \geq W^u(a), \quad J^t(1, \sigma) \geq -F, \] (14)

or is renegotiated with probability one to some contract \( \sigma' \) satisfying (13) and (14).

If an initial contract \( \sigma \) is renegotiated with certainty immediately after being signed, because it violates a post-contractual participation constraint, then, given rational expectations, it has to be the case that the contract it is renegotiated to also maximizes problem (13). The resulting equilibrium is isomorphic to one in which \( \sigma' \) is initially chosen. Therefore, we can restrict attention to contracts which are not renegotiated until a match is first hit by a shock\(^{10}\) or such that \( W^e(1, \sigma, a) = W^t(\sigma, a) \) and \( J^e(1, \sigma) = J^t(1, \sigma) \).

Lemma 1 allows to write the Hamilton-Jacobi-Bellman equation for an unemployed worker as

\[ rW^u(a) = \max_{c^u} [u(c^u) + (ra + b - c^u)W^u_a] + p(\theta) \max \{W^t(\sigma^*, a) - W^u(a), 0\}. \] (15)

\(^{10}\)Note that problem (13) does not restrict \( F \) to the positive. Therefore, Lemma 1 goes beyond stating that an initial contract satisfies the ex ante participation constraints.

18
While unmatched, a worker’s consumption choice maximizes the total utility from current consumption \( c^u \) and saving, the latter evaluated at the shadow price \( W_a(a) \), the marginal value of assets. A worker meets a firm at rate \( p(\theta) \) and optimally chooses whether to form a match with contract \( \sigma^* \) or not. In the former case, the associated lifetime expected utility is \( W^t(\sigma^*, a) \).

It follows from totally differentiating equations (8) and (15) with respect to wealth, using the first order condition

\[
u'(c) = W_a, \quad i = t, u,
\]

that workers’ optimal consumption choices have to satisfy

\[
-(ra + w - c^t)W_{aa}^t = \lambda \left[ \int_{y^l}^{1} u'(c^t(w', F, a))dG + \int_{y^l}^{y^d} u'(c^u(a + F'))dG - u'(c') \right]
\]

and

\[
-(ra + b - c^u)W_{aa}^u = p(\theta) \left[ u'(c^t(\sigma^*, a)) - u'(c^u) \right],
\]

where, with some slight abuse of notation, we have omitted the argument - the relevant state - from the policy and value functions evaluated at the current state.

The two equations highlight the saving motive in the current environment. Since \( W_{aa}^i < 0, i = t, u \), the flow of saving in the bracket on the left hand side has the same sign as the square bracket on the right hand side.

Given that the rate of time preference equals the market interest rate there is no consumption tilting motive. Equation (17) implies that the saving of an employed worker is driven only by a precautionary motive. Consumption is below current income \( ra + w \) if the expected marginal utility of consumption, conditional on a new productivity draw, exceeds the marginal utility of current income and viceversa if marginal utility is expected to rise. Symmetrically, equation (18) implies that unemployed workers run down their assets to the extent that they expect the marginal utility of consumption to fall upon employment.

\[11\]

This follows from equation (16) and \( u \) being concave and consumption a normal good.
Turning to firms, the asset value of an unfilled job $V_c$ satisfies the Bellman equation

$$rV_c = -m + q(\theta) \max \{J^I(1, \sigma^*) - V_c, 0\} = 0,$$  \hspace{1cm} (19)$$

where the second equality follows from free entry.

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

$$\lambda G\left(y^d(\sigma, a)\right) (1-u) = p(\theta) u. \hspace{1cm} (20)$$

Finally, balancing of the government budget requires the total gross unemployment benefit bill to equal total tax revenues, or

$$\nu = (b + \nu)u. \hspace{1cm} (21)$$

The equilibrium can now be formally defined as follows.

**Definition (Stationary equilibrium).** A stationary equilibrium is a set of policy functions \{\bar{y}, \bar{w}, w^t, F^t, y^d, c^t, c^u\}, value functions \{J^I, J^e, V_c, W^t, W^e, W^u\}, an optimal contract $\sigma^*$, market tightness $\theta$, unemployment rate $u$ and tax $\nu$ such that: i) \{\bar{y}, \bar{w}, w^t, F^t, y^d, c^t, c^u\} satisfy (4)-(7), (10) and (17)-(18); ii) \{J^I, J^e, W^t, W^e\} satisfy (2)-(3) and (8)-(9); iii) $W^u$ satisfies (15); iv) free entry implies $V_c = 0$ or $J^I(1, \sigma^*) = m/q(\theta)$; v) $\sigma^*$ solves (13); vi) $u$ is given by (20); vii) $\nu$ satisfies (21).

The following lemma derives some properties of the equilibrium.

**Lemma 2.** In equilibrium

1. workers’ value functions $W^i$, $i = t, u$ satisfy

$$W^i = \frac{u(c^i)}{r}; \hspace{1cm} (22)$$

2. savings, the initial contracts $\sigma^*$ and the joint reservation productivity $y^d$ are independent of wealth;
3. for any contract $\sigma$, it is $y_d(\sigma) \geq \bar{y}(\sigma)$ if $c'(\sigma, a) \geq c^u(a + F)$.

Point 2 states that, even in the presence of bargaining, the CARA restriction implies that the wealth distribution does not affect the equilibrium allocation. With saving independent of wealth, it follows from the dynamic budget identity $c = ra + z - s$ that wealth enters the consumption function only through the additively separable term $ra$ and, from equation (22) and exponential felicity, that $W^t(\sigma, a) = -u(ra)W(t, 0)$ and $W^u(a) = -u(ra)W^u(0)$. Therefore, workers’ wealth does not affect the maximand of the Nash product in (13) and the separation rule (10).

Point 3 follows from point 2 in Proposition 1 and equation (22) which implies that, with CARA preferences, $W^t(\sigma, a) \geq W^u(a + F)$ is equivalent to $c'(\sigma, a) \geq c^u(a + F)$.

Finally, the following remark confirms that the assumption that an employed worker’s outside option does not affect renegotiation is verified in equilibrium.

**Remark 1.** In equilibrium, the worker’s outside option is never strictly binding.

The payoff of a worker employed at contract $\sigma$ is always no smaller than $\min\{W^t(\sigma, a), W^u(a + F)\}$, as the worker’s threat to hold out is constrained only by the firm ability to lay her off. It follows from Lemma 1 and $F_m \geq 0$ that, when the contract is signed at $\tau_0$, it is $\min\{W^t(\sigma, a), W^u(a + F)\} \geq W^u(a)$. Since CARA preferences imply $W^i(\cdot, a) = -u(ra)W^i(\cdot, 0), i = t, u$, the stock of wealth does not affect the sign of the inequality and the worker’s outside option is never strictly binding.

### 4.2 Non-binding mandated severance pay

We are now in a position to characterise the optimal contract when $F_m = 0$. As it turns out, such a bound imposes no constraint on private contracting. Trivially, the results in this section apply as long as, in equilibrium, the mandated minimum $F_m$ is below its privately optimal counterpart.

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12 If this were not the case, the relevant state space would include the wealth distribution.

13 This is in general not the case for other types of preferences. See, e.g., footnote 24.
Proposition 2. Suppose $F_m = 0$. Given $s^u$, the unique equilibrium contract $\sigma^* = (w^*, F^*)$ has $rF^* = w^* - b + s^u \geq 0$ and fully insures workers. $F^* = 0$ if and only if $\gamma = 0$.

Since equation (22) implies that the value function is proportional to the marginal utility of consumption, equalizing consumption of a worker employed at wage $w$ and consumption of a job loser receiving $F$ implies, from Proposition 1 that the contract is never renegotiated; i.e. $y^d = \bar{y}$. The optimal contract achieves this by equating the total income $ra + w^*$ of an employed worker to consumption $c^u = r(a + F^*) + b - s^u$ of a job loser, or equivalently by setting $w^* = rF^* + b - s^u$. Equation (17) then implies that it is optimal for an employed worker to consume current income and accumulate no assets until the job is destroyed. On the other hand, equation (18) implies that an unemployed worker runs down assets to smooth consumption over an unemployment spell as long as consumption increases upon reemployment. From equation (22), this is the case if $\gamma > 0$ and employed workers enjoy rents over the unemployed.

Since with CARA utility $s^u$ is independent of wealth, it is effectively given to a firm-worker pair and unaffected by the contractual severance payment. Therefore the result applies whatever worker’s bargaining power as $w^*$ and $F^*$ move proportionally to keep $w^* = rF^* + b - s^u$ while, at the same time, ensuring the appropriate division of the surplus from a new match. It follows from equation (1) that the job destruction threshold satisfies

$$\bar{y}(w^*, F^*) - b + s^u - \nu + \lambda \int_{\bar{y}(w^*, F^*)}^1 \frac{1 - G(y')}{y' + \lambda} dy' = 0.$$  

(23)

and is independent of the contract. The term $b - s^u$ plays the same role as the permanent income from unemployment in the standard Mortensen and Pissarides (1994) model with risk-neutral workers. Like the unemployed’s permanent income in the risk-neutral setup, $s^u$ is a function of the ex ante worker’s rent and of market tightness. Therefore, in equilibrium, the job destruction rate does depend on workers’ bargaining power.

As discussed in Section 6.2, the full insurance result is actually knife-edged and specific to CARA preferences. Outside such a case, imperfect self-insurance implies that the value function of an unemployed does not satisfy (22). Therefore, the optimal contract cannot at
the same time equalize an employed worker’s consumption across all states and ensure no renegotiation.

The second part of Proposition 2 is the more important and general one. Insurance against job loss requires a positive severance payment whenever employed workers enjoy rents over their unemployed counterparts. Given workers’ risk aversion and imperfect capital markets, optimal risk exchange requires the rent to be spread across states of nature, that is both $w^* > b$ and $F^* > 0$. The following corollary provides a lower bound for the optimal severance payment.

**Corollary 1.** If $\gamma > 0$, the laissez-faire-equilibrium severance payment $F^*$ exceeds $F = (w^* - b)/(p(\theta) + r)$.

The optimal size of severance pay is bounded below by $F$, the expected loss in lifetime income associated with transiting through unemployment. This equals the expected present value of the income loss $w^* - b$ over the expected length of an unemployment spell.

The intuition is the following. Proposition 2 implies that, under an optimal contract, consumption does not fall upon entering unemployment. Since the duration of unemployment is uncertain, the variability of future consumption for a job loser is higher than for her employed counterpart. The existence of a precautionary saving motive implies that the expected consumption profile of a job loser is more upward sloping - present consumption is further below permanent income - than that of her employed counterpart. Therefore, for consumption not to fall upon losing one’s job, the permanent income of a job loser has to exceed that of an employed worker.

### 4.3 Binding mandated severance pay

This section derives the response of the optimal contract to the introduction of a legislated severance payment marginally in excess of its privately optimal level.

The following preliminary result establishes the effect of an exogenous change in the contractual severance payment on the probability that the contract is renegotiated at given contract wage.
Lemma 3. The thresholds $\bar{y}(\sigma)$, $y^-(\sigma)$ and $y^+(F)$ are respectively strictly decreasing, increasing and constant as a function of $F$.

The implications of the lemma are best seen with the help of Figure 1. An increase in $F$ reduces the firm’s reservation productivity $\bar{y}$ and weakly increases the job destruction threshold $y^d$. In terms of Figure 1 both $\bar{y}(.)$ locus and the downward sloping part of $y^d(.)$ curve shift to the right (dotted curves). Their horizontal intersection moves from B to B’, while their vertical intersection remains unchanged. Therefore, at constant contract wage, a higher contractual severance payment increases the probability that such payment is renegotiated and reduces the probability that the contract wage is. The following result follows.

Proposition 3. For given $s^u$, if $F_m$ is marginally above the laissez-faire equilibrium value $F^*$, the equilibrium contract features $y^d > \bar{y}$ and a wage below its laissez-faire equilibrium counterpart.

Proposition 3 implies that if somebody, e.g. the government, imposes on the parties a severance payment in excess of the unconstrained privately optimal one then the parties adjust (reduce) wages in such a way that the wage component of the contract is never renegotiated, while, ex post, the mandated severance payment is renegotiated down to $F' = -J^t(y, \sigma)$ for $y \in (\bar{y}, y^d)$. Excessive mandated intervention, overinsures job losers and calls for a fall in wages to reestablish ex ante shares. Contrary to Lazear (1990), with risk averse workers and incomplete contracts, government intervention increases consumption fluctuation relative to laissez-faire and is non-neutral. On the other hand, its allocational effect is dampened by spot renegotiation of the government mandated payment.

The quantitative general equilibrium implications of such intervention in terms of allocation and welfare can only be obtained numerically.
5 Quantitative implications

5.1 Actual versus optimal severance pay

Corollary 1 summarises 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 lower bound $F$ on 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 $f = F/w$ which measures the severance payment in units of per-period wage. The fact that in reality unemployment benefits $b$ are a function $\rho w$ of the last wage imply that in laissez-faire equilibrium it is

$$f = (1 - \rho) / (r + p(\theta)),$$

(24)

where $\rho$ is the replacement rate.

Equation (24) implies that, as a share of wages, the lower bound on 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 $f$ 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 lower bound on optimal severance pay as a function of observable quantities, equation (24) 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 for seventeen OECD countries to construct a series for $f$. The data with details of their sources are reported in Table 5 in Appendix 14

\footnote{The lower bound $f$ should be a function of unemployment duration in the counterfactual laissez-faire equilibrium which is unobservable. Yet, as shown in Section 5.2, the distinction is not quantitatively important.}
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 5 in Appendix A.2. 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 legislated severance payments for white and blue collar workers.

Figure 2 plots the lower bound \( f \) on the horizontal axis against the two series for legislated severance payment for a worker of average tenure. In interpreting Figure 1 it is worth keeping in mind, that not only is \( f \) a lower bound, but our series for legislated payments 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 mandated 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 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 one and at most six months. 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. They make clear the extent to which despite the very high levels of dismissal costs Italian workers were underinsured before the reform.

Portugal presents the most extreme case. The mandated level of severance payments exceeds its optimal lower bound by slightly more than eleven months. With effectively the same replacement rate but an unemployment duration roughly one 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 exceed their optimal lower bound by eleven months. It is worth keeping in mind, though, that in the latter case, as for countries such as Denmark and Sweden, notice periods constitute the bulk of the legislated severance payment reported in the figure.\textsuperscript{15} Hence, the actual cost to firms and transfer to workers is likely to 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 protections significantly in

\textsuperscript{15}See the table in section A.2
excess of privately optimal levels. There is an important caveat, though. Since our series for optimal severance payments has been 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. We tackle this possibility in the next subsection.

5.2 Quantitative impact of excessive mandated job security.

We have been able to characterise 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, given the model complexity, can only be answered numerically.

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

We choose a Cobb-Douglas matching function $m(U, V) = AU^\eta V^{1-\eta}$, where $A$ indexes the efficiency of the matching process. The productivity distribution is assumed uniform on $[y_l, 1]$. With benefits equal to $b = \rho w$ where $\rho$ is the replacement ratio, the model has ten parameters: $\{r, y_l, \rho, \alpha, \eta, \lambda, \gamma, f_c, m, A\}$.

All flow variables are per quarter. The interest rate is $r = \phi = 0.01$. The lower support of the distribution is set to $y_l = 0.32$ to obtain a coefficient of variation for output shocks of 0.3 as in Blanchard and Portugal (2000). The Portuguese benefit replacement rate is $\rho = 0.65$. The ratio between the legislated severance pay and the net quarterly wage is set to 5.7 which corresponds to its value of 17 months in Table 5.16. The chosen value for

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16The government budget constraint (21) implies that the tax born by the worker equals the total benefit bill net of taxes divided by the size of the employment pool. Therefore, it is legitimate to equate the net
Table 1: Summary of calibration

<table>
<thead>
<tr>
<th></th>
<th>Portugal</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate (%)</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Avg. unemployment duration (months)</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

Parameters

\[ G(y) \text{ uniform on } [y_l, 1], \quad m(U, V) = AU^\eta V^{1-\eta}, \quad u(c) = -\exp(-\alpha c). \]

\[ r = .01, \quad \gamma = \eta = .5, \quad \rho = .65, \quad f_c = 17, \quad m = .33, \quad \lambda = .014, \quad y_l = .32, \quad A = 0.18, \quad \alpha = 1.7. \]

the coefficient of absolute risk aversion is \( \alpha = 1.7 \) which implies a coefficient of relative risk aversion of \( \sigma = \alpha c^u(0) = 1.5 \) for an unemployed worker with zero wealth. A value of 1.5 is in the middle of the range of available estimates for the coefficient of relative risk aversion. Results are reported also for \( \alpha = 3.5 \) which corresponds to \( \sigma = 3 \). The elasticity of the matching function \( \alpha \) is set to 0.5 consistently with the evidence in Petrongolo and Pissarides (2001). The chosen value for the coefficient of workers’ bargaining power \( \gamma \) is also 0.5. As noted in Section 4.1 this implies that the bargaining equilibrium coincides with the competitive search one. If workers are risk neutrals, it also implies that the decentralised equilibrium is efficient in the absence of unemployment benefits.

The cost of posting a vacancy \( m \) is set to 0.33 following Millard and Mortensen (1997). The remaining two parameters \( \lambda \) and \( A \) are set to 0.014 and 0.18 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 summarises the calibration procedure.

We can now tackle the question of the employment and welfare costs of mandated employment protection. Table 2 summaries our findings for the benchmark case in which the coefficient of relative risk aversion equals 1.5 and for the more extreme one in which it equals wage in the model with the wage net of payroll taxes in the data.

3. It shows the allocational and welfare impact of imposing mandated severance payments of respectively 17 and 30 months, against a privately optimal value of 6 months in the calibrated economy. 17 months is the legislated value in Portugal used in our calibration. 30 months is an upper bound obtained by adding the size of the largest mandated severance payments in our dataset - 24 months - to the privately optimal value.

Clearly legislated severance payments below private optima are not binding and have no effect. Instead, rows three to ten in Table 2 report the labour allocation, wages and the percentage change, relative to laissez-faire, in the present value of net output, and workers’ welfare associated with the three levels of severance pay considered.

The effect of legislated severance payment widely in excess of private optima on job destruction is negligible, as the legislated severance payment is renegotiated. As for the job finding rate, with \( \sigma = 1.5 \), it increases by 0.4 and 0.7 percentage points when severance payments exceed their laissez-faire value by respectively 11 and 24 months. The corresponding fall in the unemployment rate is 0.2 and 0.5 of a percent. The fall in unemployment duration

\[\text{Table 2: Mandated severance payments (in months of net wages)}\]

<table>
<thead>
<tr>
<th>Severance pay</th>
<th>( \sigma = 1.5 )</th>
<th>( \sigma = 3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laissez-faire 6</td>
<td>Mandated 17 17</td>
</tr>
<tr>
<td>Job finding rate (%)</td>
<td>17.4</td>
<td>17.8 17.7</td>
</tr>
<tr>
<td>Job destruction (%)</td>
<td>1.2</td>
<td>1.2 1.2 1.2</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>6.7</td>
<td>6.5 6.6</td>
</tr>
<tr>
<td>Gross wage ( \times 100 )</td>
<td>93.3</td>
<td>89.4 85.9</td>
</tr>
<tr>
<td>Net wage ( \times 100 )</td>
<td>89.0</td>
<td>85.4 82.1</td>
</tr>
<tr>
<td>Net output</td>
<td>100.0</td>
<td>100.2 100.3</td>
</tr>
<tr>
<td>Welfare (employed)</td>
<td>100.0</td>
<td>100.0 99.8</td>
</tr>
<tr>
<td>Welfare (unemployed)</td>
<td>100.0</td>
<td>99.9 99.6</td>
</tr>
<tr>
<td>Welfare (avg. job loser)</td>
<td>100.0</td>
<td>103.4 106.2</td>
</tr>
</tbody>
</table>

\[18\] This is five per cent larger than 5.7 months, the value of the optimal lower bound \( f \) in our calibration.

\[19\] The values of quantities with no meaningful unit of measurement have been normalised to 100 in the decentralised equilibrium. The present value of output is the shadow value of an unemployed worker which, as in Acemoglu and Shimer (1999), is maximised at a social optimum in the risk-neutral case. 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.
is due to a fall in the gross (producer) wage $w + \nu$ equal to 4 and 12 percent respectively.

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. A second, offsetting, effect is at play, though. At given benefit replacement rate, the reduction in wages reduces steady state unemployment benefits and workers’ threat point in bargaining thus increasing firms’ return to job creation. If the benefit replacement rate is sufficiently high the second effect prevails.

Net (consumer) wages fall slightly less than gross wages due to the fall in the payroll tax stemming from the fall in unemployment.

The fall in wages, unemployment duration and the unemployment rate is smaller in the case in which $\sigma = 3$. Higher risk aversion implies that workers’ are less willing to trade off a wage cut for overinsurance in case of job loss.

Independently from the degree of risk aversion, the increase in unemployment duration increases net output in our calibration, as unemployment benefits are inefficiently high and, job creation inefficiently low, in the calibrated economy. While the sign of the change in net output is specific to the choice of calibration parameters, though, its absolute value is not. In general, the change is very small, reflecting the marginal nature of the change in the allocation.

Turning to welfare, as legislated payments increase, the average job loser’s welfare increases significantly as the increase in the expected severance pay more than offsets the increased consumption variability. On the other hand, welfare falls for employed workers and unemployed job seekers. The fall in welfare is no larger than respectively one tenth ($\sigma = 1.5$) and one third ($\sigma = 3$) of one per cent for the case in which mandated payments equal 17 months of wages. If $\sigma = 3$ though, the maximum welfare loss is nearly one per cent when mandated payments equal 30 months.

It is instructive to conduct the same experiment starting from the constrained efficient equilibrium in which, as in Acemoglu and Shimer (1999), the social planner chooses one
Table 3: Mandated severance payments (in months of net wages): efficient benefits

<table>
<thead>
<tr>
<th></th>
<th>$\sigma = 1.5, \rho = 0.05$</th>
<th>$\sigma = 3, \rho = 0.1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severance pay</td>
<td>Laissez-faire Mandated</td>
<td>Laissez-faire Mandated</td>
</tr>
<tr>
<td>Job finding rate (%)</td>
<td>9.8 21 34</td>
<td>9.6 21 34</td>
</tr>
<tr>
<td>Job destruction (%)</td>
<td>1.1 1.1 1.1</td>
<td>1.2 1.1 1.1</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>3.8 3.8 3.9</td>
<td>3.8 3.9 3.9</td>
</tr>
<tr>
<td>Gross wage × 100</td>
<td>89.4 86.2 83.3</td>
<td>89.5 86.3 83.4</td>
</tr>
<tr>
<td>Net wage × 100</td>
<td>89.2 86.0 83.1</td>
<td>89.1 85.9 83.0</td>
</tr>
<tr>
<td>Net output†</td>
<td>101.9 101.9 101.9</td>
<td>101.9 101.9 101.9</td>
</tr>
<tr>
<td>Welfare (employed)†</td>
<td>100.3 100.2 100.0</td>
<td>100.2 100.1 99.6</td>
</tr>
<tr>
<td>Welfare (unemployed)†</td>
<td>99.0 98.9 98.6</td>
<td>99.0 98.8 98.3</td>
</tr>
<tr>
<td>Welfare (avg. job loser)†</td>
<td>100.3 103.4 106.1</td>
<td>100.2 103.3 105.8</td>
</tr>
</tbody>
</table>

† Relative to the corresponding value in laissez-faire equilibrium with $\rho = 0.65$ in Table 2.

instrument, the replacement rate, to maximise net output. The results of such experiment are reported in Table 3. Net output and welfare are reported as proportion of their corresponding value in the laissez-faire equilibrium in Table 2.

The first interesting result is that, as far as efficiency is concerned, severance payments are no perfect substitute for unemployment benefits. The efficient replacement rate is respectively 0.05 and 0.1 depending on the risk aversion coefficient. The intuition is the same as in Acemoglu and Shimer (1999) and is clearest in the present CARA setup where given the absence of wealth effects, severance pay have no partial equilibrium effect on the bargaining outcome. Decreasing marginal utility implies that wages increase a worker’s surplus by less than they reduce a firm’s one. Therefore, if Hosios’s (1990) condition is satisfied, the firm’s share of surplus is inefficiently high in the absence of benefits. This result applies as long as workers marginal utility of consumption is decreasing.

Unlike in Acemoglu and Shimer’s (1999) benchmark model, the equilibrium considered is only constrained efficient as one instrument is insufficient to hit both active margins - job creation and job destruction. In practice, though, the allocation turns out to coincide with the efficient allocation of the model with risk-neutral workers to at least the third decimal digit.

The optimal replacement rate is roughly half than in Table 1 in Acemoglu and Shimer (1999) as their calibration features an average unemployment duration of 6.5 years against 17 months here.
Second, the optimal severance payment size is decreasing in the replacement rate. It is now roughly 10 months of wages against 6 months in Table 2. The larger income fall, relative to the calibrated benchmark economy, is less than offset by the general equilibrium fall in unemployment duration.

Third, increasing severance payments by the same amount as in Table 2—respectively 11 and 24 months—above their privately optimal value still has hardly any allocational effect, although the sign of the change in the duration of unemployment and its level is now reversed relative to Table 2. Given the small replacement rate, the fall in wages has now a smaller effect on the worker’s threat point relative to the previous case. Therefore the higher cost of providing a given level of utility to the worker is less than offset by the fall in her bargaining power. Job creation falls as a consequence, but the absolute value of the change is still negligible. The associated reduction in net output is less than second order (lower than a thousandth of a per cent) with respect to the change in unemployment while the fall in welfare is roughly the same as in Table 2.

Conversely, the efficiency cost of raising the replacement rate from its efficient level to 0.65 is large. Net output in the laissez-faire equilibrium with efficient benefits is 1.9% higher than in the corresponding equilibrium when $\rho = 0.65$. As for welfare, the increase in the replacement rate redistributes from employed, whose net wage falls due to the increase in the unemployment pool and the payroll tax, to unemployed workers.

Summing up, the robust insight of the paper is that, if firms and workers can write optimal contracts, however simple, legislated dismissal costs have very small allocational effects. The result implies that even in the absence of complete markets there is no causal relationship from legislated dismissal costs to high unemployment rates and duration and low job destruction. 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.
It is worth emphasising 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 measures 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 at a lower level in the past, 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*. Figure 2 shows that for all but two countries in our dataset the difference between the lower bound \( f \) and legislated severance payments is 5 months or less, rather than 11 months.

It is obviously of interest to know how sensitive the results are to changes in the key parameters. It turns out that, for a given difference between optimal and mandated severance pay, the result is remarkably robust to alternative parameterisations being driven by the optimal nature of contracts rather than any other features.\(^{22}\)

### 6 Extensions and discussion

This paper has relied on a number of simplifying assumptions to derive a closed form lower bound for the optimal severance pay wage ratio as a function of observable quantities. In what follows we discuss how relaxing such assumptions alters the main conclusions. The broad message can be anticipated here. The lower bound we have derived is remarkably robust. Also, provided wages are flexible and separation jointly optimal, the welfare losses derived in Section 5.2 are an upper bound on the corresponding losses under less restrictive assumptions.

\(^{22}\)Calibrating the model to the US economy produces very similar results. They are available upon request.
6.1 Wage rigidity and no renegotiation

To better understand the near-neutrality result derived in the paper it may be useful to disentangle the relative role played by wage flexibility and ex post renegotiation of mandated severance payment.

Consider first the case in which the contract wage is rigid, but the severance payment is renegotiated. Equation (11), together with (4), implies that, for given \( w \), the contractual or mandated severance payment \( F \) fully determines the firm’s return from job creation \( J(1, \sigma^*) \) and, through equation (19), market tightness. An increase in \( F \), at given \( w \), reduces job creation. Importantly, since (19), (4) and (31) do not depend on workers’ preferences, the result applies to any matching model in which wages are exogenous.

The last column in Table 4 reports the allocation and welfare associated with increasing \( F \) while keeping \( w \) constant at its level in the laissez-faire benchmark in Section 5.2 in the case in which the coefficient of relative risk aversion equals 1.5. Increasing \( F \) to 17 months effectively exhausts any return to job creation and no equilibrium exists for higher values of the mandated severance payment. Job creation collapses to a fifth of its original value as the wage is prevented from reestablishing profitability of new jobs. Given constant returns in production, mandated severance payments have a large negative impact on the ex ante value of a job. Job destruction fall by 20 per cent as the increase in duration makes workers less willing to enter unemployment. All welfare measures also collapse. It follows that the flexibility of the average wage in response to policy parameters is crucial not only for mandated severance pay to have negligible welfare costs, but, much more generally, for the ability of calibrated matching models to generate reasonable changes in allocation and welfare in response to observed cross-country variation in policies.

Let us now turn to the opposite case in which the wage is endogenous, but the excessive mandated severance payment is not renegotiated. In such a case \( y^d \) no longer satisfies equation (34), but instead coincides with the firm’s reservation productivity \( \bar{y} \) even outside laissez faire. The wage, instead, still maximizes the Nash product in (13).

\footnote{I am grateful to an anonymous referee and Ioana Marinescu for suggesting to explore respectively the rigid-wage and no-renegotiation cases.}
Table 4: Mandated severance payments (months of wages): $\sigma = 1.5$.

<table>
<thead>
<tr>
<th></th>
<th>Laissez-faire</th>
<th>Mandated Exog. $F$</th>
<th>Mandated Exog. $w$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severance pay</td>
<td>6</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>Job finding rate (%)</td>
<td>17.4</td>
<td>17.7</td>
<td>17.8</td>
</tr>
<tr>
<td>Job destruction (%)</td>
<td>1.2</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>6.7</td>
<td>5.7</td>
<td>4.8</td>
</tr>
<tr>
<td>Gross wage $\times 100$</td>
<td>93.3</td>
<td>89.5</td>
<td>86.0</td>
</tr>
<tr>
<td>Net wage $\times 100$</td>
<td>89.0</td>
<td>85.9</td>
<td>83.2</td>
</tr>
<tr>
<td>Net output</td>
<td>100.0</td>
<td>100.1</td>
<td>100.2</td>
</tr>
<tr>
<td>Welfare (employed)</td>
<td>100.0</td>
<td>100.3</td>
<td>99.8</td>
</tr>
<tr>
<td>Welfare (unemployed, $f_c = 0$)</td>
<td>100.0</td>
<td>100.2</td>
<td>99.6</td>
</tr>
<tr>
<td>Welfare (average job loser)</td>
<td>100.0</td>
<td>103.9</td>
<td>107.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Columns 3 and 4 in Table 4 report the allocational and welfare changes when severance pay is increased relative to its *laissez-faire* value. The separation rate falls significantly as there is now (jointly) suboptimal labour hoarding. The producer wage, though, is effectively unchanged relative to Table 2. In fact, it falls marginally with higher severance pay as, given the increase in job duration, a given wage cut implies a bigger fall in a worker’s permanent income and welfare. It follows that job creation is hardly affected and the unemployment rate falls significantly.

Net output still increases with the fall in unemployment, though marginally less than in the case in which separation is Pareto optimal. More surprising is the marginal increase in welfare for unemployed and employed workers when $F$ is increased to 17 months of wages. The increase is fully accounted for by the fall in the lump sum tax, a positive externality, stemming from the lower unemployment level. Were it not for the tax reduction, consumption and welfare would actually fall. When $F$ equals 30 months of wages though, the welfare loss is comparable to the corresponding one in Table 2 with the fall in taxes still accounting for the difference. Basically, the larger fall in taxes offsets the welfare cost associated with the private inefficiency of separation.

While less crucial than wage flexibility, the ability of the parties to negotiate Pareto optimal side payments is an important ingredient of the near-neutrality result, though it
hardly matters for welfare.

There are numerous examples suggesting that negotiation of Pareto optimal transfers upon separation is more than a theoretical construct. One such instance is the frequency with which one reads or hears about voluntary redundancy packages and/or early retirement incentives offered by downsizing firms. By revealed preferences, these must be jointly optimal (if workers accept them) and if contracting firms make the effort to negotiate such packages the associated cost must be smaller than the, possibly shadow, cost of 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 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 proceedings. 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. Between 60 and 70 per cent of all dismissals, over the 1987-97 period, took this form and involved bargaining over the size of termination payments.

6.2 Imperfect insurance

In the above analysis, the optimal contract is never renegotiated in the laissez-faire equilibrium and insurance against match productivity shocks is perfect. As noted in Section 4, 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 unchanged. Furthermore, it is easily shown that Proposition 2 still applies with the only difference that $W^u > u(c^u)/r$ if the utility of leisure is positive. The lifetime utility of being employed at the optimal contract is smaller than that of entering unemployment receiving the contracted severance

\[\text{The same source reports a total cost for individual redundancy of 10-12 months of wages for a worker paid around 2 million ITL a month.}\]
payment $F$. Therefore, the latter must be renegotiated down with positive probability - $y^d > \bar{y}$ - and insurance is imperfect.

The same result is likely to apply if $\gamma > 0$ and workers have constant relative risk aversion (CRRA) preferences, as argued in the following section.

### 6.3 Alternative preferences

CARA preferences have been assumed throughout the paper. If workers enjoy positive rents - $\gamma > 0$ - the assumption is crucial for analytical tractability but probably not essential for the main result in the paper. A previous version, featuring hand-to-mouth consumers with CRRA preferences (but allowing for annuitization of severance payments), obtained quantitatively similar results with only fractionally larger welfare costs. Moreover, Shimer and Werning (2007a) show, albeit in a somewhat different, partial equilibrium, search environment, that, quantitatively, CARA preferences provide a good approximation to CRRA preferences if workers have access to liquidity.

An analytical characterization of the optimal contract in the CRRA case is not feasible, in general. Some partial results can be obtained, though, under the simplifying assumption that workers cannot quit at will.\footnote{Under CRRA preferences, one cannot rule out the possibility that the worker’s outside option becomes binding as wealth changes. If workers can quit at will, one cannot characterize the value functions without jointly solving at least for the sign of the functional relationship between workers’ reservation wages and wealth. Footnote 12 in Shimer and Werning (2007b) discusses the same issue. Acemoglu and Shimer (2000) have to resort to numerical simulation to deal with it, despite a simpler environment that the one in this paper.} Provided the optimal $w$ and $F$ are non-decreasing in wealth\footnote{With CRRA preferences, this holds in all cases that have been explored in the literature. It holds strictly in a static bargaining model and in the one-period competitive search model studied in Acemoglu and Shimer (1999). The same is true in the dynamic, calibrated matching model studied in Krusell, Mukoyama and Şahin (2008). Huang and White (2007) prove a number of results on the effect of workers’ wealth on bargaining outcomes. In none of the cases they study, including the riskless borrowing and lending case, does wealth reduce workers’ bargaining power under CRRA preferences.}, it can be shown that under CRRA preferences it is $y^d > \bar{y}$: the contractual severance payment, but not the wage, is renegotiated with positive probability even in laissez-faire equilibrium. Furthermore, the optimal contract requires that consumption for a job loser receiving the contractual severance payment is no smaller than consumption for an employed worker with...
the same wealth.\footnote{Proofs are available upon request.} A formal proof that the permanent income of the former exceeds that of the latter is not available. Yet, the intuition behind Corollary 3 that, given that the contract provides insurance, the future consumption of an employed worker is less variable than that of a job loser suggests that the contractual severance payment does exceed the fall in lifetime wealth associated with job loss.

### 6.4 Non-stationary benefits

With CARA preferences, allowing for the, realistic, possibility that workers entitlement to benefits falls over an unemployment spell or for the kind wage of losses in new occupations documented for example by Topel (1990) and Farber (2003) would leave unchanged the functional forms for the value functions and the first order condition for an optimal contract.\footnote{Cohen, Lefranc and Saint-Paul (1997) and Rosolia and Saint-Paul (1998) document even larger losses respectively for France and Spain.} Proposition 2 and Corollary 1 would still apply. The fall in lifetime wealth associated with job loss would be larger though. The associated lower bound on the optimal severance payment would also be larger than in expression 24, if, as in our dataset, $\rho$ denotes the replacement rate upon job loss rather than its average value over an unemployment spell and benefits fall over time.

In fact, our argument that the privately optimal size of severance pay is strictly positive just relies on the average replacement rate being smaller than one. Not only is the latter the case in practice. The moral hazard associated with the conditional nature of benefits implies that the maximum, let alone the average, replacement rate along a socially optimal path is below one even when consumers cannot borrow or lend and the optimal time profile of benefits is non-stationary, as in Fredriksson and Holmlund (2001) and Coles and Masters (2006).\footnote{Where the average replacement rate is defined as the constant rate whose expected present value over an unemployment spell coincides with the present value of the path of actual replacement rates.}
6.5 Alternative bargaining protocols

The assumption that workers have 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 $F$ is renegotiated is lower for given $w$ 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 upper bound.

One may also wonder to which extent the chosen bargaining protocol, which makes the offer to renegotiate the wage or the severance payment mutually exclusive, affects the solution. One natural alternative would be for the worker to propose to renegotiate the whole contract ($\sigma$), when offering to continue the match. The outcome would be different, though, only if in equilibrium the initial contract were renegotiated for $y > y^d$. The paper has shown that this is not the case with CARA preferences. Furthermore, we have argued in sections 6.2 and 6.3 that the same is true under a number of alternative assumptions, including possibly CRRA preferences.

7 Conclusion

This paper characterises firms’ optimal provision of insurance by means of simple employment contracts when asset markets are incomplete 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 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. One possible explanation for excessive government intervention, along the lines of Saint-Paul (2002), is that it reflects the ability of a majority of employed insiders to extract a one-off welfare gain at the expense of the present and future generations of unemployed. Nevertheless, if the assumption is made that observed legislated measures reflect, to some extent, 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 $f$. Estimating such relationship for blue and white collar workers separately yields:

$$f^{BC} = 1.84 + 0.55 f, \quad R^2 = 0.23 \quad s.e. = 5.20$$

and

$$f^{WC} = 2.74 + 0.70 f, \quad R^2 = 0.24 \quad s.e. = 6.39.$$  

There is a positive and statistically significant relationship between the series for $f^*$ and those for legislated dismissal costs for blue and white collar workers $f^{BC}$ and $f^{WC}$ in Table 5.

In principle, such positive correlation may reflect the reverse causation from high legislated job security to high unemployment duration which has been most emphasised 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. Furthermore, optimal private contracting undoes the effects of excessive mandate job security to a

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30 The outcome is self-sustaining as new generations of insiders, whose contract wage was determined on the basis of the excessive mandated severance pay, would suffer a windfall be hurt by a subsequent reform which reduced the latter.

31 Standard errors in parenthesis.
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A Appendix

A.1 Proofs

Proof of Proposition 1. See main text.

Proof of Lemma 1. Suppose it is $W^t(\sigma, a) < W^u(a)$. Let $\tau_0$ the time the contract is signed. Given the assumption of positive gains from forming a new match, for $\sigma$ to be efficient the worker cannot quit at $\tau_0$. Workers’ rationality then requires $\sigma$ to be renegotiated at $\tau_0$ to some $\sigma'$ such that $W^t(\sigma', a) \geq W^u(a)$. This implies $W^e(1, \sigma, a) = W^t(\sigma', a) \geq W^u(a)$. Therefore, $\sigma$ cannot be efficient unless $\sigma'$ maximizes programme (13). The same argument applies to the case in which $J^t(1, \sigma) < -F$.

Proof of Lemma 2. We characterize the value functions under the assumption that the optimal ex ante contract $\sigma^*$ is independent of the worker’s wealth level. We later verify that the assumption is indeed satisfied.

1. Let $i = t, u$. Under the assumption that $d\sigma^*/da = 0$, the worker’s sequence problem implies the standard Euler equation $u'(c_{\tau_0}) = E_{\tau_0} u'(c_{\tau_1})$ for any time $\tau_1 > \tau_0$. Since CARA preferences imply that $u'(c) = -\alpha u(c)$, it follows that $u(c_{\tau_0}) = E_{\tau_0} u(c_{\tau_1})$ for all $\tau_1 > \tau_0$. Equation (11) can be written as $W^i_{\tau_0} = u(c^i_{\tau_0}) \int_{\tau_0}^{\infty} e^{-r(\tau-\tau_0)} d\tau = u(c^i_{\tau_0})/r$. Stationarity allows to drop the time subscript.

2. Partially differentiating (22) with respect to $a$ and using (16) yields $\partial c^i / \partial a = r$. Differentiating the dynamic budget identities $s^u(a) = ra+b-c^u(a)$ and $s^t(\sigma, a) = ra+w-c^t(\sigma, a)$ with respect to $a$ implies $\partial s^i / \partial a = 0$.

It remains to verify that $\sigma^*(a)$ and $y^d(\sigma, a)$ are independent of wealth. Since saving is independent of wealth, the dynamic budget identity implies that consumption depends on wealth only through the additively separable term $ra$. Given exponential felicity and (22), it is $W^t(\sigma, a) = -u(ra)W^t(\sigma, 0)$ and $W^u(a) = -u(ra)W^u(0)$. From Lemma 1 the worker’s surplus in the Nash maximand (13) is $W^t(\sigma, a) - W^u(a)$. Since the surplus is multiplicatively separable in wealth, the latter does not enter the first order condition.
for $\sigma$. For the same reason, the sign of $W^t(w', F, a) - W^u(a + F')$ and, from (10), $y^d$ are independent of $a$.

3. It follows from point 2 in Proposition 1 that for any $(F, a)$ pair it is $y_d(\sigma, a) \gtrless \bar{y}(\sigma)$ depending on whether $w$ satisfies $W^t(\sigma, a) \gtrless W^u(a + F)$. From (16), $W^t(\sigma, a) \gtrless W^u(a + F)$ is equivalent to $c'(\sigma, a) \gtrless c^u(a + F)$.

Lemma 4. For any $y \geq y_d$, it is $dW^t(\bar{w}(y, F), F, a)/dF = W^t_a(\bar{w}(y, F), F, a)$.

Proof. The lemma follows straightforwardly if $W^t(\bar{w}(y, F), F, a) = W^t(\bar{w}(y, 0), 0, a + F)$, which we now prove. If $w = \bar{w}(y, F)$, the contract wage and the worker’s payoff are unchanged for any $y' \geq y$ while the firm receives its outside payoff $-F$ for any $y' < y$. Equivalently, $w' = \bar{w}(y', F)$ and $F' = F$ for any $y' \leq y$. After collecting terms in $W^t(\bar{w}(y, F), F, a)$, equation (25) implies

$$W^t(\bar{w}(y, F), F, a) = \max_{c_t} \frac{u(c_t) + (ra + \bar{w}(y, F) - c_t)W^t_a + \lambda[\int_{y_d}^{y} W^t(\bar{w}(y', F), F, a) dG + G(y^d)W^u(a + F)]}{r + \lambda G(y)}.$$  

(25)

It follows from (3) that $\bar{w}(y, F) = \bar{w}(y, 0) + rF$. Replacing on the right hand side of (25) verifies that $a$ and $F$ enter additively. □

Lemma 5. The partial derivatives of the value functions $J^t(y, \sigma), W^t(\sigma, a)$ with respect to the contract terms are

$$J^t_w = -\frac{1}{r + \lambda G(\bar{y})}, \quad J^t_F = -\frac{\lambda G(\bar{y})}{r + \lambda G(\bar{y})},$$  

(26)

$$W^t_w = \frac{u'(c') + W^t_{aw} s^t - \lambda \int_{y_d}^{\max\{y^d, \bar{y}\}} u'(c^u(a + F'))F^t_w dG}{r + \lambda G(\max\{y^d, \bar{y}\})},$$  

(27)

$$W^t_F = \frac{W^t_{aF} s^t + \lambda \left[ \int_{y_d}^{\max\{y^d, \bar{y}\}} u'(c'(w', F, a))dG + \int_{y_d}^{y^d} u'(c^u(a + F'))F^t_F dG \right]}{r + \lambda G(\max\{y^d, \bar{y}\})}.$$  

(28)

48
Proof. The symbols $\bar{y}, y^d, w', F', J', c', s^t$ are shorthand for $\bar{y}(\sigma), y^d(\sigma, a), w'(y, \sigma), F'(y', \sigma), W^t(\sigma, a), J^t(y, \sigma), c'(\sigma, a)$ and $s^t(\sigma, a)$.

Equation (26) follows from partially differentiating (11) using (4).

Consider next (27) and (28). Proposition 1 and points 1 to 4 on page 16 imply that the integral on the right hand side of equation (8), can be written as

$$\int_{y_l}^{1} W^e(y', \sigma, a) dG = \int_{\max\{y_d, \bar{y}\}}^{1} W^t(\sigma, a) dG + \int_{y_d}^{\max\{y_d, \bar{y}\}} W^u(a + F') dG. \tag{29}$$

The contract is not renegotiated if $y \geq \max\{y_d, \bar{y}\}$, the wage is renegotiated down to $w' = \bar{w}(y', F)$ if $\max\{y_d, \bar{y}\} > y \geq y_d$ while separation takes place with a transfer $F'$ if $y_d > y$. In taking derivatives of (29) with respect to the contract, the indirect effect through changes in $\bar{y}$ and $y_d$ can be disregarded. The optimality of renegotiation - $w' = w$ when $y = \bar{y} > y_d$ - and of separation - $W^t(w', F, a) = W^u(a + F')$ when $y = y_d$ - imply that the envelope theorem applies.

The denominator of (27) and (28) obtains by collecting terms containing the partial derivatives of $W^t(\sigma, a)$ on both sides of (8) and rearranging.

The terms on the numerator outside the integral are the partial derivatives of the first two addenda on the right hand side of (8) and follow from the first order condition (16). The last two terms are those associated with the derivatives of the last two addenda on the right hand side of (29). To understand the derivative of the second addendum note that, since $w' = \bar{w}(y', F)$ for $\max\{y_d, \bar{y}\} > y' \geq y_d$, it is $\partial W^t(w', F, a)/\partial w = 0$ while $dW^t(w', F, a)/dF = W^t_a(w', F, a)$ from Lemma 4. Finally, the envelope condition (16) implies $W^t_i = u'(c^i), i = t, u$. \hfill \Box

Lemma 6. For any $s^u$ and $\sigma$ it is $-W^t_F/W^t_w \geq -J^t_F/J^t_w$ if $w \geq rF + b - s^u$, or equivalently $\bar{y}(\sigma) \geq y_d(\sigma)$.

Proof. We first derive the respective marginal rates of substitution. Lemma 2 and the CARA felicity function $u(c) = -\exp\{-\alpha c\}$ imply that $W^t_a = r\alpha W^t$. Therefore, the cross partial
derivatives in (27)–(28) satisfy $W_{a_j}^t = -r\alpha W_j^t$ for $j = w, F$ and, rearranging, they result in a common denominator $r + \lambda G(\max\{y_d, \bar{y}\}) + r\alpha s^t$ on the right hand sides of (27) and (28). It follows that it is

$$-\frac{W_F^t}{W_w^t} = -\frac{\lambda \left[ \int_{y_d}^{\max\{y_d, \bar{y}\}} u'(c^t(w', F, a)) dG + \int_{\bar{y}}^{y_d} u'(c^u(a + F')) F'_w dG \right]}{u'(c^t) + \lambda \int_{\bar{y}}^{\max\{y_d, \bar{y}\}} u'(c^u(a + F')) F'_w dG}.$$  (30)

From (26), the firm counterpart is $-J_F^t/J_w^t = -\lambda G(\bar{y})$.

Suppose $\bar{y} \geq y_d$ or, from point 3 in Lemma 2 $c'(\sigma) \geq c^u(a + F)$. The denominator of (30) is $u'(c^t)$ while the numerator is the integral of the marginal utilities of consumption for $y' < \bar{y}$. From point 2 on page 16 it is $w' < w$ and $F' = F$ for $y' < \bar{y}$, which implies $-W_F^t/W_w^t \leq -\lambda G(\bar{y})$, with equality if and only if $\bar{y}(\sigma) = y_d(\sigma)$.

Consider instead the case $\bar{y} < y_d$ or $c'(\sigma) < c^u(a + F)$. From point 3 on page 16 this implies $F' = -J'(y', \sigma)$ for $\bar{y} > y' \geq y_d$ and $F' = F$ for $y' < \bar{y}$. Simple algebra yields $-W_F^t/W_w^t > -\lambda G(\bar{y})$.

It remains to prove that $w \geq rF + b - s^u$ if $\bar{y} \geq y_d$ or, equivalently, $c'(\sigma) \geq c^u(a + F)$. From the dynamic budget identity the latter is equivalent to $w - s^t \geq b + rF - s^u$. Noting that (17) implies $s^t \geq 0$ if $c'(\sigma) \geq c^u(a + F)$, makes clear that a fortiori it is $w \geq rF + b - s^u$. □

**Lemma 7.** For any $s^u$ and $J \in [0, J]$, the unique optimal contract is the pair $\sigma^* = (b + rF^* - s^u, F^*)$ solving $J'(1, \sigma^*) = J$. The Pareto frontier is strictly decreasing and strictly concave everywhere, and continuously differentiable on $(0, J)$.

**Proof.** From Lemma 1 and the definition of Pareto optimality the optimal contract maximizes the Lagrangean $L = W^t(\sigma, a) + \mu_1(J'(1, \sigma) - J) + \mu_2(W^t(\sigma, a) - W^u(a))$. The first order conditions for $w$ and $F$ yield $-W_F^t/W_w^t = -J_F^t/J_w^t$ which, together with $J'(1, \sigma) = J$, is necessary for an extremum. From Lemma 2 the pair $\sigma^*$ solving $J'(1, \sigma^*) = J$ is one such extremum. Since, the programming problem is not concave the two conditions are not sufficient for a global maximum. Yet, it follows from Lemma 5 that moving along the constraint $J'(1, \sigma) = J$ towards its intersection with the $w = b + rF - s^u$ line, increases the worker’s expected utility. Therefore, the two conditions select the unique local and global
Replacing for $w$ in (3), one obtains

$$
\bar{y}(\sigma) - b + s^u - \nu + \lambda \int_{\bar{y}(\sigma)}^{1} \frac{1 - G(y')}{r + \lambda} dy' = 0
$$

(31)

which implies that, under the optimal contract, $\bar{y}$, hence $y^d$, are independent of the contract in the current match. Since $s^u$ is a function of aggregate variables alone, it follows from (11) that the firm payoff $J^t(1, w^*(F), F)$ is linearly decreasing in $F$. Also, $\bar{y} = y_d$ and $c^f(w^*(F), F, a) = c^u(a + F)$ together with (22) imply $W^t(w^*(F), F, a) = W^u(a + F)$. Hence, $W^t(\sigma, a)$ is strictly increasing and strictly concave in $F$, as $W_{aa}^u < 0$. Therefore, the maximized value of $W^t$ is strictly decreasing and concave in $J$. Differentiability follows from (16) and the differentiability of the consumption function.

**Proof of Proposition 2.** We first show that $F_m = 0$ does not constraint the set of payoffs as $F \geq 0$ on the contract curve. From Lemma 7, the Pareto optimal $F^*(J)$ is strictly decreasing in $J$, hence minimum at $\bar{J}$. By definition, the image of $\bar{J}$ along the Pareto frontier is $W^u(a)$. From the proof of Lemma 7 the supporting efficient contract implies $c^r(\sigma, a) = c^u(a)$ and implies $F^*(\bar{J}) = 0$.

It is easily shown that the Nash solution selects a payoff pair that maximize the maximand in (13) subject to the Pareto frontier. Since the maximand is strictly quasi-concave, and the Pareto frontier strictly concave, in $W^t, J^t$, the Nash solution selects a unique payoff pair on the frontier and, from Lemma 7, a unique contract.

If $\gamma = 0$, it follows from Lemma 1 and (13) that the contract has to satisfy $W^t(\sigma^*, a) = W^u(a)$ and Lemma 7 implies $w = b$ and $F = 0$ is trivially efficient and maximizes (13). If $\gamma > 0$, maximization of (13) requires $W^t(\sigma^*, a) = W^u(a + F^*) > W^u(a)$, hence $F^* > 0$.

**Proof of Corollary 1.** Proposition 2 implies $c^r(\sigma^*, a) = c^u(a + F^*)$. If $\gamma > 0$, it is $F^* > 0$ and from (22) $c^r(\sigma^*, a) > c^u(a)$. It follows from (18) that $s^u < 0$ and, from $w^* = b + rF^* - s^u$, that $w^* > b$. It remains to prove that $F^* > (w^* - b)/(p(\theta) + r)$ or, using $w^* = b + rF^* - s^u$, $s^u > -p(\theta)(w^* - b)/(p(\theta) + r)$. From Proposition 2 it is $d\sigma^*/da = 0$ and given the value
functions (22) equation (18) can be rewritten as

\[ s^u = \frac{p(\theta)}{r \alpha} \left[ e^{-\alpha (w^* - b + s^u)} - 1 \right]. \]  

(32)

The left and right hand side of (32) are respectively increasing and decreasing in \( s^u \). It is therefore sufficient to prove that that the left hand side is smaller than the right hand side at \( s^u = -p(\theta)(w^* - b)/(p(\theta) + r) \). Substituting in (32) and rearranging gives

\[ 1 - \frac{r\alpha (w^* - b)}{p(\theta) + r} \leq e^{-\frac{r\alpha (w^* - b)}{p(\theta) + r}}, \]  

(33)

with holds as a strict inequality given \( w^* > b \).

**Proof of Lemma 3.** That \( \bar{y}(\sigma) \) is decreasing in \( F \) follows immediately from (4).

Turning to \( y^+(F, a) \), part 2 of Proposition 2 implies that \( y^- \) and \( y^+ \) are independent of \( a \). Proposition 1 then implies that \( y^+ = \bar{y}(w^+(F), F) \) with \( w^+(F) \) solving \( W^t(w^+(F), F, a) = W^u(a + F) \). From the proof of Lemma 6 this implies \( \bar{y}(w^+(F), F) \) satisfies (31) and is independent of \( F \).

Finally, we prove that \( y^-(\sigma) \) is strictly increasing in \( F \). Since \( y^- \) solves \( W^t(\sigma, a) = W^u(a - J^t(y^-, \sigma)) \), equation (22) implies \( y^- \) satisfies \( c^t(\sigma, a) = c^u(a - J^t(y^-, \sigma)) \) or, using the budget identity, \( w - s^t(\sigma) = -rJ^t(y^-, \sigma) + b - s^u \). Differentiating with respect to \( F \) using (11), yields

\[ s^F_t = \frac{\lambda}{r \alpha} \left[ \int_{\bar{y}}^{y^-} A(y', \sigma, s^t) dG + G(\bar{y}) B(\sigma, s^t) - G(y^-) \right], \]  

(34)

with \( A(y', \sigma, s^t) = \exp -\alpha \{ -rJ^t(y', \sigma) + b - s^u + w - s^t \} \), \( B(\sigma, s^t) = \exp -\alpha \{ rF + b - s^u + w - s^t \} \) and \( y^- = y^d \) by assumption. Applying the implicit function theorem to (34) yields

\[ \frac{\partial s^t}{\partial F} = -\frac{r\lambda G(\bar{y})}{r + \lambda G(\bar{y})} \frac{rB + \lambda(A + G\bar{y})B}{r + \lambda(A + G\bar{y})B}. \]  

(35)
Since \(-J'(y^-, \sigma) > F\) it is \(B < 1\) which completes the proof.

**Proof of Proposition 3.** Since \(y^d = y^-\) at the private optimum, it follows from Lemma 3 that the movement from \(F^*\) to \(F^m\) increases \(y^d\) and reduces \(\bar{y}\) at constant \(w^*\). As long as \(w^*\) does not increase in response to government intervention, Proposition 1 implies that \(y^d - \bar{y}\) becomes positive which is what needs to be proved. It just needs to be shown that \(w^*\) falls in response to government intervention.

The first order condition

\[
N_w = -\frac{1 - \gamma}{[r + \lambda G(\bar{y})]J'(1, \sigma_m)} + \frac{\gamma W'_w(\sigma_m)}{W'(\sigma_m) - W^u(a)} = 0 \quad (36)
\]

is satisfied independently from government intervention. We first prove that \(N_{wF} < 0\) at an optimum. Since \(N_w = 0\) the sign of \(N_{wF}\) is the same as that of the partial derivative of \([r + \lambda G(\bar{y})]N_w\). Since \(J'\) and \(W'\) are respectively decreasing and increasing in \(F\), it follows from \((36)\) that a sufficient condition for such derivative to be negative is that the partial derivative of \(H = [r + \lambda G(\bar{y})]W'_w\) with respect to \(F\) exists and is negative. Visual inspection of \((27)\) cannot rule out that \(W'_{wF}\) is discontinuous at those values of \((\sigma, a)\) such that \(y^d = \bar{y}\). Therefore, we have to deal with both the right and left derivative. Consider first the derivative for \(y^d \downarrow \bar{y}\). Keeping in mind that \(s^t = y^d - \bar{y} = 0\) at the private optimum, we can write, dropping obviously zero terms,

\[
H_F = \frac{\lambda g(\bar{y})(y^d_F - \bar{y}_F)u'(c^t)}{r + \lambda G(\bar{y})} + u''(c^t)c^t_F (1 - c^t_w) - \frac{\lambda g(\bar{y})(y^d_F - \bar{y}_F)u'(c^u)}{r + \lambda G(\bar{y})} =
\]

\[
= u''(c^t)c^t_F (1 - c^t_w) < 0 \quad (37)
\]

where the last inequality follows from both present \((c^t_F > 0)\) and future consumption being normal goods and \(w\) exceeding permanent labour income \((c^t_w < 1)\).

It is straightforward to verify that \(H_F\) satisfies \((37)\) also for \(y^d \uparrow \bar{y}\). Therefore, \(H_F\) and \(N_{wF}\) are continuous everywhere. Similar algebra reveals that \(N_{ww}\) is also continuous and negative at the optimum which, from the implicit function theorem, implies that \(w\) falls in
response to the increase in $F$.

\section{Data and variables used in Section 5.1}

This section contains the data used to construct Figure 2 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 $\rho$ 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\footnote{On this see Brandolini and Torrini (2002).}, including voluntary quit and summary dismissal. The data for Portugal and New Zealand come respectively from 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).
Table 5: Legislated severance pay for blue and white collar workers.

<table>
<thead>
<tr>
<th>Country</th>
<th>$p(\theta)$</th>
<th>$\rho$</th>
<th>ACJT</th>
<th>$f_c$</th>
<th>Notice BC</th>
<th>Sev. pay BC</th>
<th>Notice WC</th>
<th>Sev. pay WC</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>(monthly)</td>
<td>(%)</td>
<td>(yrs)</td>
<td>(months)</td>
<td>(months)</td>
<td>(months)</td>
<td>(months)</td>
<td>(months)</td>
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<td>2</td>
<td>1</td>
<td>2</td>
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<td>24.4</td>
<td>9.2</td>
<td>1.9</td>
<td>-</td>
<td>21$^a$</td>
<td>-</td>
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<tr>
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<td>1.4</td>
<td>0.5</td>
<td>0.25</td>
<td>0.5</td>
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<td>-</td>
<td>6</td>
<td>1</td>
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<td>-</td>
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<td>1.4</td>
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<td>-</td>
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<td>2$^c$</td>
<td>-</td>
<td>2$^c$</td>
<td>-</td>
</tr>
</tbody>
</table>

$^a$0.86 times length of service in years. This is an approximation of the Claey's 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.