Privately-Optimal Severance Pay

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Abstract

This paper constructs an equilibrium matching model with risk-averse workers and incomplete contracts to study both the optimal private provision of severance pay and the consequences of government mandates in excess of the private optimum. The privately-optimal severance payment is bounded below by the fall in lifetime wealth resulting from job loss. Despite market incompleteness, mandated minimum payments significantly exceeding the private optimum are effectively undone by adjustment of the contractual wage, and have only small allocational and welfare effects.

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1 Introduction

Employment contracts often contain explicit severance-pay provisions.[1] Indeed, in many countries minimum levels of severance pay and other forms of employment protection are enshrined in legislation. This is difficult to understand in the context of standard labor market models in which homogeneous workers maximize expected labor income and wages

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[1]For the US, Bishow and Parsons (2004) document that from 1980–2001, roughly 40 percent of workers in firms with more than 100 employees, plus 20 percent in smaller businesses, were covered by severance-payment clauses. For the UK, the 1990 *Workplace Industrial Relations Survey* reveals that 51 percent of union companies bargained over the size of (non-statutory) severance pay for non-manual workers and 42 percent for manual workers (see Millward, Neil et al. 1992). For Spain—a country usually thought to have high levels of state-mandated employment protection—Lorences et al. (1995) document that from 1978–91, the proportion of collective bargaining agreements establishing severance pay in excess of the legislated minimum varied between 8 and 18 percent in the metal manufacturing sector and between 22 and 100 percent in the construction sector.

are perfectly flexible.[2] As observed by Lazear (1990), employment protection measures have no useful role in such a setting, and there is no reason why a firm taking aggregate quantities as given would offer them. Thus, as Pissarides (2001) concludes, "much of the debate about employment protection has been conducted within a framework that is not suitable for a proper evaluation of its role in modern labor markets."

This paper constructs a model that can be used to study both the optimal private provision of one form of employment protection, namely severance pay, as well as the allocational and welfare consequences of government intervention mandating payments that exceed the private optimum. We accomplish this by extending the matching model of Mortensen and Pissarides (1994) to allow for risk-averse workers, incomplete asset markets, and bargaining over explicit contracts that feature a fixed wage and severance payment.[3] As in the Mortensen-Pissarides setting, workers face multiple sources of risk: Idiosyncratic productivity shocks create both *wage* and *job-loss risk*, while the uncertain duration of an unemployment spell amounts to *re-employment risk*.

The paper's main results can be summarized as follows. First, privately-optimal severance payments insure against job-loss risk. They are positive whenever market wages exceed workers' reservation wages, so that job loss is costly, and their size is bounded below by the fall in permanent income associated with job loss. By establishing a closed-form lower bound for the privately-optimal payment, the model provides a standard against which to assess whether observed legislation in this area is excessive. We construct a series for our lower bound in a sample of OECD countries and compare it to the corresponding series for legislated payments. In a large fraction of these countries, we find that mandated payments do not significantly exceed—and are often substantially below—the relevant lower bound.

Second, the allocational and welfare consequences of deviations from the private optimum in line with those observed in most OECD countries are quantitatively small. The model implies that factors increasing workers' rents or unemployment duration—such as high workers' bargaining power, high costs of posting vacancies, or low matching efficiency—raise the permanent-income drop associated with job loss and call for higher severance pay. For the same reason, privately-optimal severance pay is negatively related to the unemployment-benefit replacement rate. On the other hand, the model rules out reverse causation from mandated severance payments to meaningful increases in workers' rents and unemployment duration.

Intuitively, mandated severance-pay minima overinsure workers against job loss and induce a fall in the contractual wage to reestablish ex-ante profitability. These two effects increase income fluctuations and the cost to firms of providing a given level of utility to new hires. Fixing the utility level, mandated minima thus reduce job creation relative to laissez-faire. With wages lower and severance payments higher, job destruction also falls. This partial-equilibrium insight carries over to general equilibrium, with the extra effect that

[2] See Fella (2005) for a model with heterogeneous workers in which consensual termination restrictions increase firms' investment in the general training of unskilled workers.

[3] Privately-negotiated severance transfers 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.

the welfare of workers may fall as they absorb part of the higher labor cost.

Quantitatively, the effects of mandated severance payments are generally small. This is because the contract wage falls so as to rebalance the parties' shares of the surplus from a new match.

The key feature of our model is incompleteness of contracts, with only the fixed wage and severance payment specified. This rules out time- or state-dependent contractual terms, thus eliminating the possibility of renegotiating any mandated payment by means of an ex-ante contract at the time of hiring. Mandates are therefore a priori non-neutral. With risk-neutral firms, broadening the space of contracts would increase their ability to substitute for complete insurance markets, and hence make mandates more neutral. For example, severance-pay legislation could be undone by a simple contract mandating that workers rebate to firms the excess of legislated termination pay over its privately-optimal level. Since courts are unlikely to enforce contractual terms aimed at circumventing legislation, such an arrangement would be effective only if it were self-enforcing. This cannot be the case, since a worker about to be fired would have no ex-post incentive to honor his ex-ante pledge.

In any event, despite the incompleteness of contracts we find that the wage adjustment is sufficient to ensure near-neutrality of mandates.

This paper is related to several others in the literature. In contrast to Lazear (1990), we develop microfoundations for the non-neutrality of legislated employment protection measures based on risk-averse workers and incomplete contracts, rather than wasteful firing taxes.[4] Alvarez and Veracierto (2001) and Bertola (2004) find that mandated severance payments can improve welfare and efficiency in dynamic models with search frictions and risk-averse workers, although neither paper allows for optimal private contracts. Finally, Pissarides (2004) shows in a partial equilibrium setting that optimal private contracts feature severance pay and (possibly) advance notice.[5]

The remainder of the paper is structured as follows. Section 2 describes the economic environment, while Section 3 studies the value functions, policy functions, and other key components of the model. Section 4 characterizes its equilibrium and derives several analytical results. Section 5 calibrates the model and assesses its quantitative implications. Section 6 discusses our assumptions and offers some concluding comments. All proofs are in Appendix A.1.

2 Model

Time is continuous and the horizon infinite. The economy contains a unit mass of workers, each with an indivisible unit of labor, together with an endogenous mass of (active or inactive)

[4] Garibaldi and Violante (2005) and Fella (2007) argue that firing taxes are unlikely to be important quantitatively.

[5] A related literature, initiated by Shavell and Weiss (1979), studies the optimal size and time path of unemployment benefits in search and matching models with risk-averse workers. Acemoglu and Shimer (1999) show that unemployment benefits increase welfare and efficiency (relative to laissez-faire) in a directed search model without job loss. Blanchard and Tirole (2008) investigate the optimal financing of benefits by means of layoff taxes.

firms that each require one worker to produce. Workers are risk averse, firms are risk neutral, and both have an infinite horizon.

Firms maximize the expected present value of profits discounted at the exogenous, riskfree rate $r > 0$. At a given time t_0, a worker maximizes the objective function

$$\mathcal{U}_{t_0} := \mathbb{E}_{t_0} \int_{t_0}^{\infty} e^{-\phi[t-t_0]} U(c_t) dt, \tag{1}$$

where $\mathbb{E}_{t_0}$ is the expectation operator, $\phi > 0$ is the subjective discount rate, U is the felicity function, and c_t is consumption at time t. While there are no insurance markets, the worker can self-insure by borrowing and lending at the rate r. Denoting the stock of assets by a_t, its rate of change (i.e., savings) by s_t, and income by i_t, the maximization of $\mathcal{U}_{t_0}$ is thus subject to the dynamic budget identity $s_t = ra_t + i_t - c_t$.[6] To eliminate wealth effects we adopt the CARA specification

$$U(c) = -e^{-\alpha c} \tag{2}$$

for felicity, where $\alpha > 0$. Moreover, we set $\phi = r$, so that under complete markets each worker would choose a flat consumption profile.

Unemployed workers and inactive firms meet via a random matching process governed by a strictly concave function M. More precisely, if u represents the mass of unemployed workers and v the mass of vacancies, $M(u, v)$ is the flow of new matches. Defining market tightness $\theta := v/u$ and assuming that the matching technology is strictly increasing and exhibits constant returns, we have the contact rates $M(u, v)/u = M(1, \theta) =: p(\theta)$ for unemployed workers and $M(u, v)/v = M(1/\theta, 1) =: q(\theta)$ for vacancies. Firms can open vacancies freely, but each entails a flow cost of $m > 0$.

When worker and firm meet, the newly-formed match has productivity $y = 1$. This variable is then subject to Poisson shocks at rate $\lambda > 0$, with the new values i.i.d. according to a continuous distribution G with support $[y_l, 1]$.[7] Unemployed workers receive a flow $b < 1$ of benefits financed, as in Acemoglu and Shimer (1999), by an endogenous, lump-sum tax τ. The benefit program runs a balanced budget at all times.

When a new match is formed the parties negotiate a long-term contract $\sigma = \langle w, F \rangle$, where w is the wage and F the severance payment in the event of a layoff. Featuring simple, state-independent terms, this type of agreement is broadly consistent with observed labor contracts.[8] We assume that the chosen σ is ex-ante (i.e., for $y = 1$) efficient, and more specifically—in line with the matching literature—that this contract arises from the

[6] The worker's consumption plan must also satisfy the no-Ponzi-game condition $\lim_{t\to\infty} e^{-rt} a_t \geq 0$ almost surely.

[7] The assumption that new matches are maximally productive is without loss of generality. What matters is that they have positive surplus.

[8] Proposition 3 will show that even our very simple contracts can deliver full insurance when severance payments are unconstrained. Provided actual contracts are no less flexible, our findings will yield an upper bound on the welfare and efficiency costs of government intervention relative to laissez-faire. (Section 6.1 discusses the implications of broadening the space of contracts.)

Nash bargaining solution with weight $\gamma \in [0, 1)$ on the worker's gain.[9] We also impose the constraint $F \geq F_m$ on the determination of σ, where $F_m \geq 0$ is a parameter. Here $F_m = 0$ simply requires the contractual severance payment to be nonnegative, while higher values of F_m can be used to introduce a government-mandated minimum payment that more substantially restricts the space of feasible contracts.

While we assume for simplicity full commitment over the contractual wage and severance payment, there is no commitment over the separation rule, which is determined by ex-post incentives. After a productivity shock either party (or both) may wish to end the employment relationship. Formally, the firm decides whether to keep the worker or to issue a dismissal notice and pay the contractual amount F. A worker who is not dismissed can then decide whether to stay in the job or to quit and receive no payment.

Crucially, it is assumed that when separation occurs payments are contingent on which party takes verifiable steps to end the relationship. A separation is deemed a dismissal, and the worker is entitled to the contractual severance payment, if the firm gives written notice that the worker's services are no longer required. On the other hand, a separation is deemed a quit, and no payment is due, if the worker gives written notice that he or she no longer intends to remain in employment (or simply stops showing up for work without obtaining leave). Any claim by one party that the other has unilaterally severed the relationship must be supported by documentation. This accords with existing practices in most industrialized countries.

As stated above, in the main text for simplicity we rule out renegotiation of the contract after a productivity shock. As a consequence, the separation decision is not Pareto-optimal when the government-mandated severance pay minimum is binding. (In this respect the agreed σ is ex ante only *constrained* efficient.) However, Pareto-optimal renegotiation of the severance payment upon separation is allowed for in Appendix A.2.

3 Analysis

To analyze the model we shall restrict attention to stationary equilibria and proceed by backward induction. Section 3.1 studies separation decisions and the associated transfers and payoffs for an ongoing match with an arbitrary contract σ. Section 3.2 characterizes the agreed contract σ^* at the time a new match is formed, with both parties anticipating that the contract will influence behavior and the resulting payoffs according to the preceding analysis. Section 3.3 then adds steady-state conditions to close the model.

[9] Note that the proof of Rudanko's (2009) Proposition 6 can be adapted to show that in our setting the result of Nash bargaining coincides with that of competitive search when γ equals the elasticity of the probability that a vacancy is filled (see Hosios 1990).

3.1 Separation decisions

The state of an ongoing match is fully characterized by the productivity y, the contract $\sigma = \langle w, F \rangle$, and the worker's stock of assets a.[10] In this section we study the separation decisions that follow a productivity shock realizing y', as a function of the state vector.

Let us indicate the value functions by $W^{\mathrm{e}}(\sigma, a)$ for an employed worker, $J^{\mathrm{e}}(y, \sigma, a)$ for a producing firm, $W^{\mathrm{u}}(a)$ for an unemployed worker, and V for a firm advertising a vacancy.[11] Since there is free entry by firms we can conclude that $V = 0$ in equilibrium, and to simplify the analysis we impose this condition from the outset. Finally, let $W^{\mathrm{s}}(y', \sigma, a)$ denote the continuation value function for the worker *after* a shock realizing new productivity y', but *before* the separation decisions are made.

To characterize how the post-shock outcome depends on the state vector $\langle y', \sigma, a \rangle$, it is useful now to introduce the Hamilton-Jacobi-Bellman equation

$$rW^{\mathrm{e}}(\sigma, a) = \max_c [U(c) + (ra + w - \tau - c)W^{\mathrm{e}}_a(\sigma, a)] + \lambda \left[\int_{y_l}^{1} W^{\mathrm{s}}(y', \sigma, a) dG - W^{\mathrm{e}}(\sigma, a) \right] \quad (3)$$

for an employed worker. The worker's choice of c maximizes the total utility from current consumption and savings—with the shadow price of the latter equal to the marginal value $W^{\mathrm{e}}_a(\sigma, a) = \partial W^{\mathrm{e}}(\sigma, a)/\partial a$ of wealth—plus the expected gain in utility from a productivity shock. The match experiences shocks at rate λ, and the integral is the expectation over the new productivity realization y' of the worker's continuation value.

Assume now that $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a)$, so that quitting is not optimal for the worker.[12] After a shock the firm will then compare dismissal to employment with new productivity y', and its continuation value will be $\max\{-F, J^{\mathrm{e}}(y', \sigma, a)\}$. The Bellman equation for a producing firm then appears as

$$rJ^{\mathrm{e}}(y, \sigma, a) = y - w + \lambda \left[\int_{y_l}^{1} \max\{-F, J^{\mathrm{e}}(y', \sigma, a)\} dG - J^{\mathrm{e}}(y, \sigma, a) \right], \quad (4)$$

which is to say that the flow value of production equals the instantaneous profit $y - w$ plus the expected capital gain.

Equation (4) implies $J^{\mathrm{e}}_y(y, \sigma, a) = [r + \lambda]^{-1} > 0$, so for each relevant pair $\langle \sigma, a \rangle$ there exists a unique layoff threshold $\bar{y}(\sigma, a)$ that satisfies $J^{\mathrm{e}}(\bar{y}(\sigma, a), \sigma, a) = -F$. Using this definition to eliminate the wage term and the integral over y' in equation (4), we obtain

$$J^{\mathrm{e}}(y, \sigma, a) = \frac{y - \bar{y}(\sigma, a)}{r + \lambda} - F \quad (5)$$

for each $y \geq \bar{y}(\sigma, a)$. Equation (4) itself now takes the form

$$rJ^{\mathrm{e}}(y, \sigma, a) = y - w + \lambda \left[\int_{\bar{y}(\sigma, a)}^{1} \frac{y' - \bar{y}(\sigma, a)}{r + \lambda} dG - F - J^{\mathrm{e}}(y, \sigma, a) \right]. \quad (6)$$

[10]Given that the contractual severance payment must satisfy $F \geq F_m$, there is no need to keep track of this constraint after the contract is signed.

[11]To streamline notation we anticipate here that W^{e} will be independent of the match productivity.

[12]The assumption is satisfied in equilibrium (see Proposition 1).

Setting $y = \bar{y}(\sigma, a)$ and integrating by parts then yields

$$-rF = \bar{y}(\sigma, a) - w + \lambda \int_{\bar{y}(\sigma,a)}^{1} \frac{1 - G(y')}{r + \lambda} dy'. \tag{7}$$

This relation defines $\bar{y}(\sigma, a)$ implicitly given σ, and since it does not depend on a we can write $\bar{y}(\sigma)$ for the layoff threshold and $J^{\mathrm{e}}(y, \sigma)$ for a producing firm's payoff. If $y' < \bar{y}(\sigma)$, then we have that $J^{\mathrm{e}}(y', \sigma) < -F$, the firm will dismiss, and the continuation values are $W^{\mathrm{s}}(y', \sigma, a) = W^{\mathrm{u}}(a + F)$ for the worker and $-F$ for the firm.

If $J^{\mathrm{e}}(y', \sigma) \geq -F$ then the firm will not dismiss. Hence the worker will be employed with new productivity y' and the continuation values are $W^{\mathrm{s}}(y', \sigma, a) = W^{\mathrm{e}}(\sigma, a)$ for the worker and $J^{\mathrm{e}}(y', \sigma)$ for the firm.

Finally, note that since $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a)$ we can express equation (3) as

$$rW^{\mathrm{e}}(\sigma, a) = \max_{c}[U(c) + (ra + w - \tau - c)W^{\mathrm{e}}_{a}(\sigma, a)] + \lambda[W^{\mathrm{u}}(a + F) - W^{\mathrm{e}}(\sigma, a)]G(\bar{y}(\sigma)). \tag{8}$$

3.2 The initial contract and outside returns

This section derives optimality conditions for the initial contract as well as some properties of the value and policy functions under the maintained assumption of CARA preferences.

When a match is formed, the contract is assumed to arise from Nash bargaining with weight $\gamma \in [0, 1)$ on the worker's gain. Given wealth a, and writing the Nash objective function as

$$\Phi(\sigma, a) := [W^{\mathrm{e}}(\sigma, a) - W^{\mathrm{u}}(a)]^{\gamma}[J^{\mathrm{e}}(1, \sigma) - V]^{1-\gamma}, \tag{9}$$

we have that the chosen contract $\sigma^*(a)$ maximizes $\Phi(\sigma, a)$ subject to the participation constraints $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a)$ and $J^{\mathrm{e}}(1, \sigma) \geq V = 0$ as well as the statutory restriction $F \geq F_m$. By assumption there are positive gains from employment, of which each party will receive a non-negative share. Writing μ for the Lagrange multiplier associated with the worker's participation constraint, the first-order necessary conditions for a maximum are

$$\Phi_w(\sigma^*(a), a) + \mu^* W^{\mathrm{e}}_{w}(\sigma^*(a), a) = 0, \tag{10}$$

$$[F^*(a) - F_m][\Phi_F(\sigma^*(a), a) + \mu^* W^{\mathrm{e}}_{F}(\sigma^*(a), a)] = 0, \tag{11}$$

$$\mu^*[W^{\mathrm{e}}(\sigma^*(a), a) - W^{\mathrm{u}}(a)] = 0. \tag{12}$$

Here Equation (12) is the complementary-slackness condition for the worker's participation constraint. This is needed since we allow the worker's bargaining weight γ to be zero, but since $1 - \gamma > 0$ no such condition is needed for the firm. Since all new matches lead to employment, the worker's value functions satisfy

$$rW^{\mathrm{u}}(a) = \max_{c}[U(c) + (ra + b - \tau - c)W^{\mathrm{u}}_{a}(a)] + p(\theta)[W^{\mathrm{e}}(\sigma^*(a), a) - W^{\mathrm{u}}(a)]. \tag{13}$$

Here the first term on the RHS describes the unemployed worker's consumption-savings choice and the second term is his or her expected gain from finding a job.

While equations (10)–(13) allow the initial contract to depend on the worker's wealth a, the CARA specification for felicity ensures that σ^* and a number of other endogenous variables are in fact independent of the stock of assets.[13] These other variables include the worker's savings policy functions s^{u} and s^{e}, but not the consumption policy functions c^{u} and c^{e}.

Proposition 1. *Given θ and τ:*

A. *The functions σ^*, s^{u}, and s^{e} are independent of wealth, and for all asset levels we have $W^{\mathrm{e}}(\sigma^*, a) \geq W^{\mathrm{u}}(a)$.*

B. *The value and consumption functions satisfy*

$$rW^{\mathrm{u}}(a) = U(c^{\mathrm{u}}(a)) = -e^{-\alpha c^{\mathrm{u}}(a)}, \tag{14}$$

$$rW^{\mathrm{e}}(\sigma, a) = U(c^{\mathrm{e}}(\sigma, a)) = -e^{-\alpha c^{\mathrm{e}}(\sigma,a)}, \tag{15}$$

$$c^{\mathrm{u}}(a) = ra + b - \tau - s^{\mathrm{u}}, \tag{16}$$

$$c^{\mathrm{e}}(\sigma, a) = ra + w - \tau - s^{\mathrm{e}}(\sigma). \tag{17}$$

C. *The savings functions satisfy*

$$rs^{\mathrm{u}} = \frac{p(\theta)}{\alpha}\left[e^{-\alpha(w^* - s^{\mathrm{e}}(\sigma^*) - b + s^{\mathrm{u}})} - 1\right], \tag{18}$$

$$rs^{\mathrm{e}}(\sigma) = \frac{\lambda G(\bar{y}(\sigma))}{\alpha}\left[e^{-\alpha(b + rF - s^{\mathrm{u}} - w + s^{\mathrm{e}}(\sigma))} - 1\right]. \tag{19}$$

Equations (16)–(19) imply that consumption is linear in wealth and savings are independent of asset holdings. With CARA preferences it follows both that $U(c^{\mathrm{u}}(a)) = e^{-\alpha ra}U(c^{\mathrm{u}}(0))$ and that $U(c^{\mathrm{e}}(\sigma, a)) = e^{-\alpha ra}U(c^{\mathrm{e}}(\sigma, 0))$, and we can then write the worker's gain from contract σ as $W^{\mathrm{e}}(\sigma, a) - W^{\mathrm{u}}(a) = e^{-\alpha ra}[W^{\mathrm{e}}(\sigma, 0) - W^{\mathrm{u}}(0)]$. Hence we have $\Phi(\sigma, a) = e^{-\gamma\alpha ra}\Phi(\sigma, 0)$, and so the solution of the Nash bargaining problem does not vary with the worker's wealth.

Equations (18)–(19) highlight that, with the discount and interest rates equal, saving is driven entirely by a precautionary motive. For unemployed workers, saving is negative if consumption increases upon re-employment, since workers self-insure against this risk by running down their assets. For the same reason, saving is decreasing in the coefficient of absolute risk aversion α. For employed workers, saving is negative—and decreasing in α—if consumption increases upon job loss due to overinsurance.

Since the agreed contract σ^* is independent of wealth, the value $J^{\mathrm{e}}(1, \sigma^*)$ of a new job to the employer also does not respond to changes in asset holdings. In consequence the Bellman equation for the value of a vacancy takes the form

$$rV = -m + q(\theta)[J^{\mathrm{e}}(1, \sigma^*) - V]. \tag{20}$$

[13] Indeed, if this were not the case the state space would include the wealth distribution.

Free entry implies $V = 0$, and using equation (5) we obtain the job-creation relation

$$\frac{m}{q(\theta)} = \frac{1 - \bar{y}(\sigma^*)}{r + \lambda} - F^*. \tag{21}$$

3.3 Steady-state conditions

Closing the model requires steady-state conditions for unemployment and the government budget. The unemployment condition mandates balanced flows of workers into and out of jobs. Recalling that u is the mass of unemployed workers, this can be expressed as

$$p(\theta)u = \lambda G(\bar{y}(\sigma^*))[1 - u]. \tag{22}$$

And to balance the government budget we impose the equality

$$\tau = bu \tag{23}$$

of tax revenues received and unemployment benefits paid.

4 Equilibrium

4.1 Definition

A stationary equilibrium of our model can now be defined formally as follows.

Definition. *A* stationary equilibrium *consists of value functions W^{e}, W^{u}, J^{e}, and $V = 0$; savings and consumption policy functions s^{u}, s^{e}, c^{u}, and c^{e}; a separation-decision rule $\bar{y}$; employment and tax variables u^*, θ^*, and τ^*; and a contract $\sigma^* = \langle w^*, F^* \rangle$ and Lagrange multiplier μ^*; jointly satisfying*

- *the Bellman equations* (5), (8), *and* (13)*;*
- *the threshold equation* (7)*;*
- *the consumption and savings equations* (14)–(19)*;*
- *the job-creation equation* (21) *and steady-state conditions* (22)–(23)*; and*
- *the first-order conditions* (10) *and* (12)*, together with either*

$$F^* \geq F_m \text{ and } \Phi_F(\sigma^*, 0) + \mu^* W_F^{\mathrm{e}}(\sigma^*, 0) = 0 \text{ (laissez-faire equilibrium), or}$$
$$F^* = F_m \text{ and } \Phi_F(\sigma^*, 0) + \mu^* W_F^{\mathrm{e}}(\sigma^*, 0) \leq 0 \text{ (binding-constraint equilibrium).}$$

From equations (12) and (14)–(15) we have that consumption rises (weakly) upon the worker finding a job, and employed workers enjoy positive quasi-rents if and only if $\gamma > 0$. In such a case unemployed workers face re-employment risk and run down their savings according to equation (18) in order to partially self-insure.

Proposition 2. *In either a laissez-faire or binding-constraint equilibrium we have $s^{\mathrm{u}} \leq 0$, with equality if and only if $\gamma = 0$.*

4.2 Laissez-faire equilibrium

In this section we study the privately-negotiated contract in the absence of government intervention. Our findings here will be valid whenever $F^* > F_m$.

The following lemma establishes some properties of an arbitrary contract.

Lemma 1. *Given σ and a, the quantities $c^{\mathrm{e}}(\sigma, a) - c^{\mathrm{u}}(a+F)$, $W^{\mathrm{e}}(\sigma, a) - W^{\mathrm{u}}(a+F)$, $s^{\mathrm{e}}(\sigma)$, and $w - b + s^{\mathrm{u}} - rF$ all have the same sign.*

This result is important for two reasons. Firstly, it characterizes (in terms of savings and consumption behavior) the set $\{\sigma : w - b + s^{\mathrm{u}} - rF = 0\}$ of contracts such that the worker is indifferent between working at wage w and dismissal with payment F. Secondly, since equations (14)–(15) together with CARA preferences imply that the worker's value function is proportional to the marginal utility of consumption, such contracts provide full insurance against job-loss risk by ensuring that $W^{\mathrm{e}}(\sigma, a) = W^{\mathrm{u}}(a + F)$.

If $w - b + s^{\mathrm{u}} - rF < 0$, then we have $c^{\mathrm{u}}(a + F) > c^{\mathrm{e}}(\sigma, a)$ and the worker strictly prefers dismissal with the contractual severance payment to working at the contractual wage. Since consumption increases upon job loss—the worker is overinsured—borrowing is used to smooth consumption (i.e., $s^{\mathrm{e}}(\sigma) < 0$).

On the other hand, if $w - b + s^{\mathrm{u}} - rF > 0$ then the worker strictly prefers working to dismissal. Being underinsured against job loss by the contract, he or she thus self-insures by saving (i.e., $s^{\mathrm{e}}(\sigma) > 0$).

Given that there exist contracts that fully insure against job loss, it should not be surprising that the initial contract agreed by the risk-averse worker and risk-neutral firm is of this sort (absent a binding mandate).

Proposition 3. *In the laissez-faire equilibrium, $w^* - b + s^{\mathrm{u}} - rF^* = 0$ and the Nash bargaining problem has a unique solution.*

While the initial contract σ^* fully insures against job loss, Proposition 2 shows that the equilibrium provides *complete* insurance—including against re-employment risk—if and only if $\gamma = 0$ and workers enjoy no rents. If $\gamma > 0$, then the income gain resulting from re-employment constitutes a risk against which workers can only partially self-insure by running down their assets (i.e., setting $s^{\mathrm{u}} < 0$).[14]

Lemma 1 and Proposition 3 together imply $s^{\mathrm{e}}(\sigma^*) = 0$, so from equations (14)–(15) we have that $b - s^{\mathrm{u}}$ is the worker's reservation wage. The contractual severance payment F^* is proportional to the difference $w^* - [b - s^{\mathrm{u}}]$ between the contractual wage and the reservation wage, and thus positive when the former exceeds the latter.

Setting $\sigma = \sigma^*$ in equation (7) now yields

$$b - s^{\mathrm{u}} = \bar{y}(\sigma^*) + \lambda \int_{\bar{y}(\sigma^*)}^{1} \frac{1 - G(y')}{r + \lambda} dy'. \tag{24}$$

[14] It follows (when $\gamma > 0$) that workers with positive unemployment duration have consumption that is both declining and lower than that of their employed counterparts.

The equilibrium layoff threshold $\bar{y}(\sigma^*)$ is therefore determined entirely by the reservation wage, as in the model of Mortensen and Pissarides (1994) with risk-neutral workers. Note that, as in equation (7), equation (24) determines $\bar{y}(\sigma^*)$ only implicitly. Similarly, s^{u} cannot be expressed in closed form, as can be seen from equations (18) and (19).

Our next result establishes a lower bound on the contractual severance payment.

Proposition 4. *In the laissez-faire equilibrium, $F^* \geq [w^* - b]/[p(\theta^*) + r] =: \underline{F}$, with strict inequality for $\gamma > 0$ and $F^* = \underline{F} = 0$ for $\gamma = 0$.*

Here the bound $\underline{F}$ can be interpreted as the expected loss of lifetime wealth associated with transiting through unemployment, and is equal to the present value of the income loss $w^* - b$ over the average unemployment spell.

If $\gamma = 0$, then $w^* = b$ and $\underline{F} = 0$. If $\gamma > 0$, then employed workers enjoy economic rents and the wealth cost $\underline{F}$ of a job loss is positive. In the latter case F^* exceeds $\underline{F}$, and the intuition for this runs as follows. Under a full-insurance contract consumption does not change when the worker enters unemployment. Since the duration of unemployment is uncertain, however, the variability of future consumption is higher for a job loser than for an employed worker with the same assets. In view of the convexity of marginal utility, precautionary saving leads the expected consumption profile of a job loser to be more upward-sloping (i.e., present consumption is further below permanent income) than that of an employed worker. In order for consumption not to fall upon job loss, the permanent income of the job loser must therefore exceed that of his employed counterpart.

4.3 Binding-constraint equilibrium

Characterizing equilibria involving a binding mandate is in general not feasible analytically. In this section we study the effects of a mandated minimum severance payment in the special case of $\gamma = 0$.

When $\gamma = 0$ employed workers enjoy no rents; i.e., $W^{\mathrm{e}}(\sigma^*, a) = W^{\mathrm{u}}(a)$. In this case we have $s^{\mathrm{u}} = 0$ by Proposition 2 and hence $w^* - s^{\mathrm{e}}(\sigma^*) = b$ by equations (14)–(15).

Proposition 5. *If $\gamma = 0$ and $F^* = F_m > 0$, then $w^* < b$.*

Here the worker is indifferent between working and quitting, and prefers dismissal with any strictly positive severance payment. In a laissez-faire equilibrium the agreed contract would set the wage equal to the benefit level and specify no severance payment, and the firm would fire the worker (efficiently) whenever $J^{\mathrm{e}}(y', \langle b, 0 \rangle) < 0$. In a binding-constraint equilibrium, on the other hand, the contractual severance payment is set at the mandated level and wages are strictly lower than benefits. Indeed, government intervention raises the payment to job losers and reduces firms' ex-ante profits, so the wage must fall in order to restore the appropriate ex-ante surplus division. In comparison to laissez-faire, the government mandate thus hinders the provision of insurance.[15] Our next result concerns the allocational effects

[15] The fact that consumption is higher for the marginal job loser than for an employed worker is a consequence of ruling out consensual renegotiation of the severance payment, an assumption that we relax in Appendix A.2.

of binding mandates.

Proposition 6. *If $\gamma = 0$ and $F^* = F_m > 0$, then job creation $p(\theta^*)$ and job destruction $\lambda G(\bar{y}(\sigma^*))$ are lower than under laissez-faire.*

Intuitively, the cost to firms of providing workers with a given level of expected utility (before taxes) increases with consumption variability, so job creation falls. Since also the dismissal threshold and job destruction fall, the net effect on employment is ambiguous. In contrast to Lazear's (1990) conclusions, government intervention is non-neutral in our setting with risk-averse workers and incomplete contracts.

Note that since $W^{\mathrm{e}}(\sigma^*, a) = W^{\mathrm{u}}(a)$, the worker would prefer dismissal to continued employment if offered any strictly positive severance transfer. However, separation occurs if and only if the firm prefers to fire the worker and make the mandated payment $F_m > 0$. The binding-constraint equilibrium therefore features Pareto-inefficient labor hoarding. As previously mentioned, Appendix A.2 allows the severance payment to be renegotiated in order to achieve Pareto-optimal separation.

While the qualitative analysis above for $\gamma = 0$ is a useful starting point, to study the case of $\gamma > 0$ and to determine the *quantitative* effects of binding mandates we must proceed numerically.

5 Quantitative implications

5.1 Actual versus privately-optimal severance pay

An important implication of our model is the lower bound $\underline{F}$ (in Proposition 4) on the privately-optimal payment, which depends on wages, benefits, the duration of unemployment, and the interest rate. Since severance payments are usually expressed in relation to the last wage, it is useful to define the relative lower bound $\underline{f} := \underline{F}/w^*$ and the replacement rate of benefits $\rho := b/w^*$. The relative lower bound then takes the form

$$\underline{f} = \frac{1-\rho}{p(\theta^*) + r} \tag{25}$$

and depends only on three observable quantities: the replacement rate, the unemployment duration, and the interest rate. Equation (25) is thus a useful tool for determining whether observed employment-protection measures are excessive.

In order to study this question, we choose an annual interest rate of 4 percent and use data on unemployment durations and replacement rates for seventeen OECD countries to construct a series for $\underline{f}$. We also construct series for legislated dismissal payments and notice periods for blue-collar and white-collar workers in the same countries, assuming a representative worker with job tenure equal to the average completed tenure in the worker-flow data in Nickell et al. (2002). (These series and the data used to construct them are described in Appendix A.3.) Since in a number of countries it is notice periods that constitute

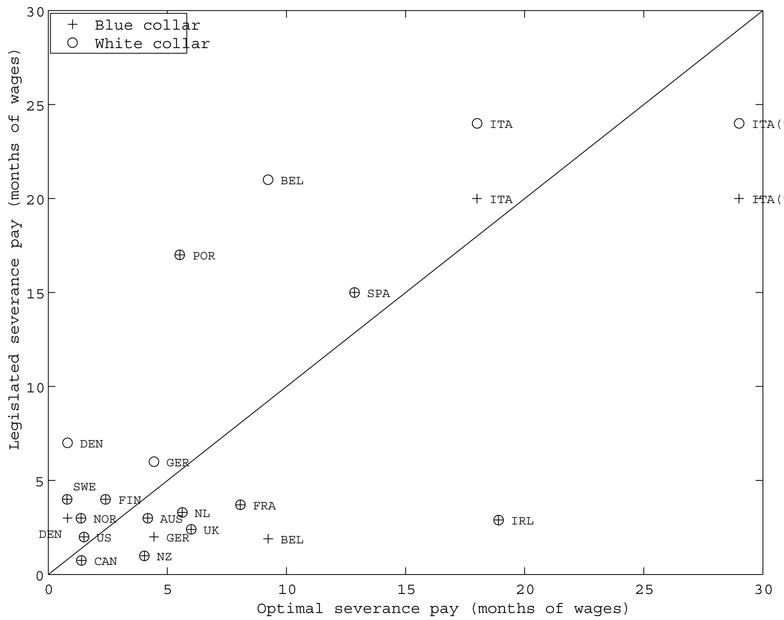

Figure 1: The relative lower bound $\underline{f}$ (horizontal axis) versus actual severance payments (vertical axis) in seventeen OECD countries.

the bulk of firing costs for firms, they are combined with outright dismissal payments in our series for legislated severance pay.

Figure 1 plots the relative lower bound $\underline{f}$ against the two series for legislated severance payments to a worker of average tenure. In interpreting the figure, it is important to note not only that $\underline{f}$ is a lower bound, but also that our legislated payments series is an upper bound for the actual cost to firms since workers may find a new job before the expiration of the mandated notice period. Thus if legislated severance payments matched optimal private arrangements, we would expect to observe data points lying above the forty-five degree line.

The figure shows that for several countries legislated payments are significantly below the level consistent with optimal insurance. In particular, payments for all workers in Ireland and for blue-collar workers in Belgium are well below their optimal levels. Given the high duration of unemployment in these two countries over the sample period, these legislated payments underinsure workers. (The same is true for France and New Zealand.) Spain and Italy, two countries often deemed to have extreme levels of employment protection, turn out to have legislated payments that exceed the relevant lower bound by, respectively, one month and at most six months. This is not surprising in light of the average unemployment duration exceeding thirty months for Italy and forty months for Spain. Note that the two starred observations for Italy refer to the period before 1991, when the replacement rate was raised from three to forty percent. These observations make clear the extent to which, despite the very high level of dismissal costs, Italian workers were underinsured before the reform.

Portugal is the most extreme case, where mandated severance payments exceed the lower bound by slightly more than eleven months. With effectively the same replacement rate and an unemployment duration roughly one-third of the Spanish one, its privately-optimal severance payment should also be approximately one third that in Spain. Yet observed legislated payments in Portugal are even higher than the Spanish level. Note that severance payments for white-collar workers in Belgium also exceed the lower bound by eleven months. In this case, however—as in countries such as Denmark and Sweden—notice periods constitute the bulk of the legislated payment reported in the figure (see Appendix A.3) and so the actual cost to firms is likely to be lower.

The above discussion makes clear that if legislated employment protection is judged by the extent to which it insures against job loss, then—with the possible exception of Portugal—there is little support for the view that most OECD or even Mediterranean countries offer protection significantly above privately-optimal levels. However, since our series for privately-optimal payments has been constructed using *observed* unemployment durations, this comparison does not allow for the widely-debated possibility that the positive relationship between legislated protection measures and unemployment duration reflects reverse causation from high mandated job security to low job creation. We shall return to this issue below, showing in Section 5.3 that the question of observed versus counterfactual—laissez-faire—durations is not quantitatively important.

5.2 Calibration

We calibrate our model to the Portuguese economy. There are several reasons for this choice. First, Portugal has a notoriously high level of employment protection.[16] Second, severance pay mandates matter in our setting only insofar as they exceed private optima. Intuitively, it is the difference between the former and the latter that determines the allocational and welfare effects of government intervention. As noted in Section 5.1, Portugal—together with Belgium—has the largest measured difference between mandated and optimal severance pay, and is also one of the countries where outright payments are the main component of firing costs. Thus the Portuguese case seems a natural setting in which to investigate the consequences of excessive mandated severance pay.

We choose parameter values using a combination of external sources and calibration. We adopt the Cobb-Douglas matching function $M(u, v) = u^{\eta} v^{1-\eta}$ and assume that the productivity distribution G is uniform on $[0, 1]$.[17] Unemployment benefits and mandated severance payments relative to wages are defined as $\rho := b/w$ and $f_m := F_m/w$. Hence the model has a total of eight parameters: r, α, m, λ, γ, η, ρ, and f_m.

All flow variables are per quarter, and the interest rate is $r = 0.01$. The coefficient of absolute risk aversion is set at $\alpha = 1.7$, which implies a value of $\alpha c^{\mathrm{u}}(0) = 1.5$ for the coefficient of relative risk aversion of an unemployed worker with zero wealth. The latter

[16]See, for example, Blanchard and Portugal (2000) and the sources therein.

[17]Normalizing to unity the scale parameter of the matching function is without loss of generality. This merely determines the units in which v (and hence θ) are measured.

Parameter	Value	Moment to match
Absolute RA coefficient α	1.7	Estimates in Attanasio (1999)
Interest rate r	0.01	Average real interest rate
Matching elasticity η	0.5	Estimates in Petrongolo and Pissarides (2001)
Bargaining power γ	0.5	Hosios (1990) condition
Productivity lower support y^l	0	Normalization
Benefit replacement rate ρ	0.65	Estimates in Nickell (1997)
Mandated sev. pay f_m	5.7	Estimates in European Foundation (2002)
Vacancy posting cost m	10.4	Unemployment duration of 17 months†
Shock arrival rate λ	0.015	Unemployment rate of 6.5%†

† See footnote 18 for source.

Table 1: Summary of the model calibration.

lies in the middle of the range of available estimates (see, e.g., Attanasio 1999). We set the elasticity of the matching function at $\eta = 0.5$, consistent with the evidence supplied in Petrongolo and Pissarides (2001). The workers' bargaining power parameter is chosen to be $\gamma = 0.5$, which implies (see footnote 9) that the outcome of bargaining coincides with that of competitive search. (This also implies that the decentralized equilibrium is efficient if workers are risk neutral and there are no unemployment benefits.)

The remaining parameters are calibrated to Portuguese policies and data, including a replacement rate of $\rho = 0.65$ and a mandated severance payment of $f_m = 5.7$ times the quarterly wage (or 17 times the monthly wage; see Appendix A.3). Finally, the cost of posting a vacancy and the productivity shock arrival rate are set at $m = 10.4$ and $\lambda = 0.015$, to match an average unemployment duration of 17 months and an unemployment rate of 6.5 percent (or equivalently an unemployment inflow rate of 1.2 per cent per quarter).[18] Our calibration is summarized in Table 1. Appendix A.5 discusses some of the calibration choices.

5.3 Quantitative impact of binding mandates

We now investigate the impact of severance-pay mandates relative to laissez-faire. In Table 2 the second and third columns show the allocational and welfare effects in our calibrated economy of mandates corresponding to 17 and 24 months of wages, with the laissez-faire situation in the first column.[19] The privately-optimal severance payment is 6 months, against

[18]The unemployment duration and rate targets come from the OECD unemployment statistics (1985–94); see Blanchard and Portugal's (2000) Figure 4. Using the Portuguese Labour Force Survey, Bover et al. (2000) find a slightly higher duration of 20 months over 1992–97. Despite using the same worker outflow data in their empirical exercise, Blanchard and Portugal (2000) assume a much lower value of 9 months in their calibration.

[19]The quantities with no meaningful unit of measurement, namely net output and welfare, are reported as a percentage of their values in the fourth column (describing the efficient, laissez-faire equilibrium). The (present value of) net output is the shadow value of an unemployed worker, which—as in Acemoglu and

	(l.-f.)	(+11)	(+18)	(l.-f.)	(+11)	(+18)
Months of wages	6	17	24	10	21	28
Value of $\rho = b/w$	0.65	0.65	0.65	0.05	0.05	0.05
Job finding rate (%)	18.2	17.8	17.6	28.7	28.3	28.0
Job destruction (%)	1.4	1.2	1.2	1.3	1.2	1.1
Unemployment rate (%)	7.0	6.5	6.2	4.3	4.0	3.8
Gross wage ($\times 100$)	92.8	88.7	86.5	88.8	85.2	83.2
Tax ($\times 100$)	4.0	3.8	3.6	0.2	0.2	0.2
Net output	98.4	98.4	98.2	100.0	99.8	99.5
Employed Welfare	100.1	100.1	99.9	100.0	99.8	99.4
Unemployed Welfare	101.3	101.3	101.1	100.0	99.7	99.3

Table 2: Allocational and welfare effects of severance-pay mandates in the economy with $\rho = 0.65$ and in the (constrained-efficient) economy with $\rho = 0.05$.

17 months in our benchmark case of Portugal and the maximum of 24 months in Figure 1. For the sake of comparison, the fourth column reports outcomes for the constrained-efficient economy where (as in Acemoglu and Shimer 1999) a planner chooses the benefit rate to maximize net output, setting $\rho = 0.05$.[20]

Qualitatively, introducing severance-pay mandates reduces both job creation and job destruction, in line with our theoretical results. Although the employment and welfare effects are a priori ambiguous, mandates increase employment and reduce both efficiency and workers' welfare, in the calibrated as well as the efficient economy. Quantitatively, however, both the allocational and welfare effects are remarkably small even for mandates dramatically in excess of the private optimum.

Severance-pay mandates have an ambiguous effect on net output because of the usual entry/exit externalities on the job-creation and job-destruction margins. Fella (2012) shows that in the absence of imperfectly experience-rated unemployment benefits, it is not socially optimal to distort the privately-determined separation decision. This is no longer necessarily true if benefits are inefficiently high and lead to excessive job destruction. With lump-sum taxes and benefits only the entry externalities are relevant for efficiency, but with regard to welfare there are two further effects. Firstly, a fall in unemployment reduces taxes and increases welfare. This externality is unambiguously positive and is not internalized by the firm-worker pair. And secondly, when workers are risk-averse, mandates reduce welfare to the

Shimer (1999)—is maximized in the efficient equilibrium. Welfare is thus measured as the percentage of permanent consumption in the efficient equilibrium that yields an equivalent level of utility. Of course, non-normalized welfare is higher for employed than for unemployed workers. The former is about 3.5 percentage points higher than the latter in the efficient equilibrium.

Since allocational and welfare effects are monotonic functions of the size of the severance-pay mandate, we report simulations for a small number of values only.

[20]In contrast to Acemoglu and Shimer's (1999) model, here the equilibrium is only constrained efficient since one instrument is insufficient to align both job creation and job destruction. In practice, however, the equilibrium allocation agrees with the efficient allocation with risk-neutral workers to at least three decimal places.

extent that they increase the re-employment risk by lengthening unemployment durations.

The fifth and sixth columns in Table 2 show the effects in the constrained-efficient economy of introducing mandates that exceed privately-optimal severance pay by the same amounts (11 and 18 months) as simulated in the economy with $\rho = 0.65$. Here the effects are qualitatively similar but larger in magnitude. Intuitively, when the planner sets unemployment benefits at their efficient level the privately optimal separation rate in the laissez-faire equilibrium is close to the efficient one. Therefore the labor hoarding associated with a binding mandate further reduces efficiency, as it no longer counteracts an inefficiently-high separation due to inefficiently-high benefits. Moreover, since employment and hence also the lump-sum tax fall by less in this case, the welfare loss is larger than when $\rho = 0.65$.

It is also instructive to compare the laissez-faire outcomes across the two economies. Note in this regard that severance payments are not a perfect substitute for unemployment benefits, even for the purpose of output maximization. Indeed, the benefit rate in the efficient economy is 0.05, rather than zero.[21] In addition, although even mandated severance payments dramatically above the private optimum have only small allocational and welfare effects, raising the benefit rate from 0.05 to 0.65 increases unemployment by nearly 70 percent and reduces output by nearly 12 percent.

Observe in addition that the optimal severance payment is decreasing in the benefit replacement rate—it is ten months of wages when $\rho = 0.05$ versus six months when $\rho = 0.65$. The lower bound in equation (25) reveals the two opposing forces affecting the optimal payment. On the one hand, a smaller ρ exacerbates the fall in income associated with job loss and calls for a higher payment. On the other, a smaller ρ reduces workers' bargaining power and thereby both the average unemployment duration $1/p(\theta)$ and the cost of job loss. As it turns out, the first effect prevails and the relationship between the benefit rate and the optimal payment is negative.

We next investigate whether this negative relationship is a robust feature of the model and whether the magnitude of the allocational and welfare changes is sensitive to the size of the benefit replacement rate. To do this, we repeat the above exercise for values of the benefit rate ranging from zero to 0.9 and with all other parameters as in the benchmark economy. In the spirit of bounding the quantitative effects from above, we impose a mandate that exceeds the laissez-faire severance payment by 11 months—the largest difference observed in Figure 1 and equal to the difference between the first and second columns in Table 2.

The results of these simulations are displayed in Figure 2, where the horizontal axis reports the benefit replacement rate in the laissez-faire equilibrium.[22] Here the heavy solid line plots the privately-optimal severance payment, measured on the right-hand axis. This quantity declines from ten months when $\rho = 0.0$ to three months when $\rho = 0.9$. The left-

[21] Here the intuition is as in Acemoglu and Shimer (1999), and is clearest in the present setting where there are no wealth effects and past severance payments do not affect bargaining power. For given Nash weights, increased concavity of the felicity function reduces the worker's effective bargaining strength. Thus, if Hosios's (1990) condition holds and there are no benefits, the firm's share of surplus is inefficiently high provided workers' marginal utility is decreasing.

[22] Note the minor difference relative to Table 2, where the benefit replacement rate equals 0.65 in the benchmark (not the laissez-faire) economy.

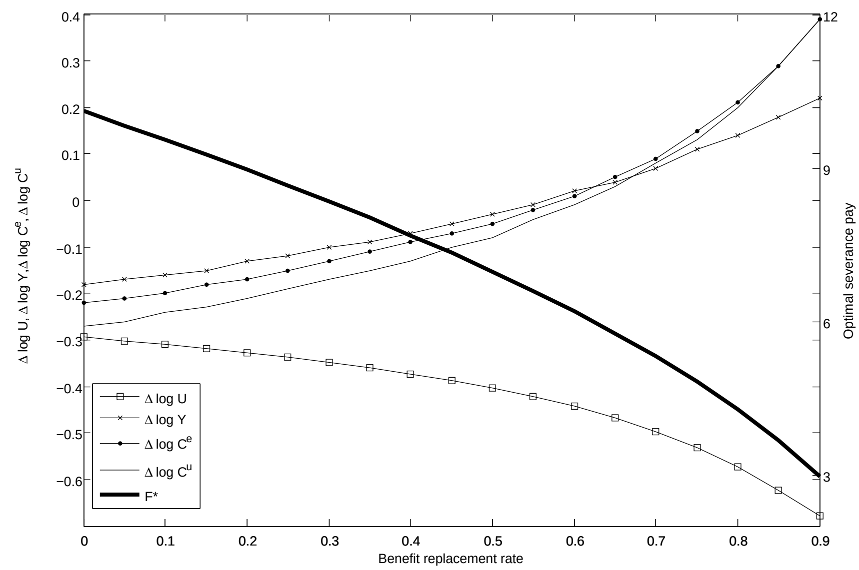

Figure 2: Effects of severance-pay mandates for a range of benefit replacement rates.

hand axis measures the change in the unemployment rate and the percentage changes in net output and welfare relative to laissez-faire.

The change in unemployment is negative and mildly decreasing, and the changes in net output and welfare are mildly increasing in the benefit rate. Indeed, mandates *increase* output and welfare when $\rho > 0.65$, as the social benefit from privately-inefficient labor hoarding is higher the more the unemployment benefits exceeds its socially-efficient level.[23] But overall, our finding that the allocational and welfare effects of mandates are small is seen to be robust.

The intuition for the small magnitude of these effects is that the wage falls as a prepayment for the higher (mandated) severance transfer. The increased income uncertainty associated with government intervention raises the cost to the firm of providing the worker with a given level of utility, thereby reducing job creation. But this effect is small, both because the fixed wage smoothes the prepayment over employment states, and because the overinsurance against job loss is effectively undone by the employed worker's savings behavior.

[23]This effect is absent, and the output and welfare changes are negative and decreasing in ρ, if efficient separation can be achieved via renegotiation (see Appendix A.2).

6 Discussion

6.1 Assumptions

With a view towards bounding from above the impact of government intervention, this paper has restricted attention to highly incomplete contracts featuring state-independent wages and severance payments. As we have seen, with CARA felicity this class of contracts is rich enough to provide full insurance against job loss in laissez-faire. It is not, however, sufficient to sustain full insurance when a severance-pay mandate is imposed. Enriching the space of contracts—for example, by allowing ex-ante agreements on state-contingent rebates of part of the mandated payment—would trivially reestablish full neutrality, a fact pointed out by Lazear (1990). But as noted in Section 1, such a contract would be unenforceable.

Note that we have also ruled out lump-sum wealth transfers at the beginning of a match. If such transfers were possible, insurance against job loss would not necessarily require a positive severance payment. An optimal contract could then specify a wage equal to the unemployed worker's reservation value $b - s^{\mathrm{u}}$, no severance payment, and an upfront wealth transfer giving the worker the appropriate share of quasi-rents.[24]

From the empirical point of view, this assumption is justified by the observation that upfront wealth transfers are observed only rarely, likely because they can leave firms exposed to opportunistic shirking or quitting.[25] From the theoretical perspective, our analysis of the laissez-faire equilibrium in Section 4.2 would still be valid, since our modeling choice is just a normalization. The only caveat here is that the lower bound on the severance payment in Proposition 4 would no longer be determinate.

Of course, in the binding-constraint equilibrium our choice of contracting margins is no longer simply a normalization. In this case, absent borrowing constraints, allowing lump-sum transfers of unrestricted sign would once again lead to neutrality. By Proposition 3, full insurance against job loss could still be achieved by *raising* the wage in response to an increase in the mandate F_m to maintain the optimality condition $w - b + s^{\mathrm{u}} - rF_m = 0$, while at the same time reducing the lump-sum transfer to the worker to reestablish the correct ex-ante shares of surplus. Moreover, our analysis in Sections 4.3 and 5—which assumes zero hiring transfers—would still apply provided transfers from firms to workers upon hiring cannot be negative.

Throughout the paper we have also assumed that unemployment benefits are lump sum. If, on the other hand, they were to respond strongly to wages—for example, if they were proportional with a replacement rate above 0.5—then the fall in benefits resulting from the fall in wages would reduce the threat point and equilibrium utility of new hires by so much that firms' profits would increase. In such cases government intervention would lead to more job creation and higher employment. With a replacement rate above 0.8, the

[24]It is well known that if agents are not subject to liquidity constraints, then the timing of transfers is indeterminate given enough degrees of freedom; see, e.g., Werning (2002). Our normalization is equivalent to that of Werning, who disallows taxes upon employment.

[25]Also, to the extent that unemployment benefits are an increasing function of the last wage, it is not optimal for a contract to front-load payments to workers.

increase in employment would be significant for mandated severance payments that are large in comparison to the private optimum.[26]

Finally, we have assumed, as in Shimer and Werning (2008), that leisure yields zero utility. As long as consumption and leisure are imperfect substitutes and their utility additively separable,[27] the privately-optimal severance payment will still be determined by consumption insurance, and our result on the optimal size of this payment will still apply, even if the utility of leisure were different from zero. As a further robustness exercise, Appendix A.4 explores the case in which consumption and leisure are perfect substitutes.

6.2 Concluding comments

This paper studies the provision of insurance to workers by means of simple employment contracts when asset markets are incomplete and searching for a job is costly. We establish that positive severance payments are part of the optimal contract whenever employed workers enjoy positive rents. More importantly, we derive a lower bound on the optimal payment as a function of observable quantities. This bound amounts to the fall in lifetime wealth associated with job loss, and hence decreases with the benefit replacement rate and increases with the duration of unemployment.

The paper does not provide normative support for minimum severance payments to be enshrined in legislation. Firms have an incentive to evade both legislated and privately-contracted payments, and courts face the same informational asymmetries in enforcing both types of measures. From a positive perspective, one explanation for government intervention (along the lines of Saint-Paul 2002) is that it reflects the ability of employed insiders to extract a one-off gain at the expense of the present and future unemployed.[28] Nevertheless, if we are willing to assume that legislated measures reflect, to some extent, the degree to which the private optimum calls for them, then our model predicts (ceteris paribus) a direct relationship between job-security measures and the expected income loss associated with transiting through unemployment.

Indirect evidence consistent with this prediction is supplied by Boeri et al. (2001), who find a negative correlation between measures of employment protection and unemployment benefits. More direct evidence comes from regressing legislated dismissal costs on the expected income cost $\underline{f}$ of job loss. Estimating this relationship separately for blue-collar and white-collar workers yields the following (standard errors in parentheses):

[26]Recall from Section 5.3 that only two of the OECD countries in our data set have rates above 0.8.

[27]These two assumptions are standard in the literature on optimal unemployment insurance to which our paper is related; e.g., Shavell and Weiss (1979), Hopenhayn and Nicolini (1997), Acemoglu and Shimer (1999), Shimer and Werning (2008), Coles and Masters (2006), Coles (2008), and Pavoni (2009).

[28]The outcome is self-sustaining as new generations of insiders, whose contract wage was determined based on the excessive mandated severance pay, would be harmed by a reform that reduced the latter.

$$f^{\mathrm{BC}} = \underset{(1.90)}{1.84} + \underset{(0.23)}{0.55}\underline{f} \qquad \bar{R}^2 = 0.23 \qquad \text{s.e.} = 5.20, \tag{26}$$

$$f^{\mathrm{WC}} = \underset{(2.34)}{2.74} + \underset{(0.28)}{0.70}\underline{f} \qquad \bar{R}^2 = 0.24 \qquad \text{s.e.} = 6.39. \tag{27}$$

We find a positive and statistically significant relationship between the series for $\underline{f}$ and for legislated dismissal costs (measured by the sum of outright payments and notice periods) f^{BC} for blue-collar and f^{WC} for white-collar workers.

In principle, the positive association observed here could reflect reverse causation from high legislated job security to high unemployment duration, as emphasized in the literature on employment protection. However, it is a robust finding of this paper that even with very incomplete markets, severance pay mandates do not cause high unemployment rates or durations. In the context of our model, it is rather the factors that affect the duration of unemployment—including matching frictions, unemployment benefits, and workers' bargaining power—that can be said to determine optimal severance payments.

A Appendix

A.1 Proofs

Proof of Proposition 1. From the worker's sequence problem we have the Euler equation $U'(c_{t_0}) = \mathbb{E}_{t_0} U'(c_t)$ for each $t \geq 0$. The CARA felicity function satisfies $U'(c) = -\alpha U(c)$, and it follows that $U(c_{t_0}) = \mathbb{E}_{t_0} U(c_t)$. For an unemployed worker equation (1) can then be written as $W^{\mathrm{u}}(a_{t_0}) = U(c^{\mathrm{u}}(a_{t_0})) \int_{t_0}^{\infty} e^{-r[t-t_0]} dt = U(c^{\mathrm{u}}(a_{t_0}))/r$, and stationarity allows us to drop the time subscript. Thus we have $rW^{\mathrm{u}}(a) = U(c^{\mathrm{u}}(a))$, and similarly for an employed worker $rW^{\mathrm{e}}(\sigma, a) = U(c^{\mathrm{e}}(\sigma, a))$. Differentiating these equations with respect to a and using the first-order conditions $U'(c^{\mathrm{u}}(a)) = W^{\mathrm{u}}_a(a)$ and $U'(c^{\mathrm{e}}(\sigma, a)) = W^{\mathrm{e}}_a(\sigma, a)$ for the consumption choices, we obtain $c^{\mathrm{u}}_a(a) = r = c^{\mathrm{e}}_a(\sigma, a)$. The dynamic budget identity then ensures that $s^{\mathrm{u}}(a)$ and $s^{\mathrm{e}}(\sigma, a)$ are independent of a and so equations (14)–(15) hold.

From equations (16)–(17) we see that consumption depends on wealth only through the additively separable term ra. Together with the CARA felicity function this implies that $W^{\mathrm{e}}(\sigma, a) - W^{\mathrm{u}}(a) = e^{-\alpha ra}[W^{\mathrm{e}}(\sigma, 0) - W^{\mathrm{u}}(0)]$ for any $\langle \sigma, a \rangle$. Hence maximization of the Nash objective function $\Phi(\sigma, a) = e^{-\alpha ra\gamma}\Phi(\sigma, 0)$ is unaffected by changes in wealth, and so $\sigma^*(a)$ is independent of a.

Finally, substituting for the value functions in equations (8) and (13), using the first-order conditions for consumption optima, and rearranging terms yields

$$rs^{\mathrm{u}} = \frac{p(\theta)}{\alpha} \left[\frac{U'(c^{\mathrm{e}}(\sigma^*, a))}{U'(c^{\mathrm{u}}(a)} - 1 \right], \tag{28}$$

$$rs^{\mathrm{e}}(\sigma) = \frac{\lambda G(\bar{y}(\sigma))}{\alpha} \left[\frac{U'(c^{\mathrm{u}}(a + F))}{U'(c^{\mathrm{e}}(\sigma, a))} - 1 \right]. \tag{29}$$

Equations (18)- (19) then follow from the CARA functional form and replacing for consumption using (16)-(17). □

Proof of Proposition 2. In text. □

Proof of Lemma 1. We have $c^{\mathrm{e}}(\sigma, a) \geq c^{\mathrm{u}}(a+F)$ if and only if $U'(c^{\mathrm{e}}(\sigma, a)) \leq U'(c^{\mathrm{u}}(a+F))$, which by equation (19) is equivalent to $s^{\mathrm{e}}(\sigma) \geq 0$. The equivalence of both

$$w - b + s^{\mathrm{u}} - rF = [c^{\mathrm{e}}(\sigma, a) - c^{\mathrm{u}}(a+F)] + s^{\mathrm{e}}(\sigma) \geq 0 \tag{30}$$

and $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a+F)$ then follows from equations (14)–(15). □

Lemma 2. *We have*

$$J_w^{\mathrm{e}}(y, \sigma) = \frac{-1}{r + \lambda G(\bar{y}(\sigma))} \tag{31}$$

$$J_F^{\mathrm{e}}(y, \sigma) = \frac{-\lambda G(\bar{y}(\sigma))}{r + \lambda G(\bar{y}(\sigma))}. \tag{32}$$

Furthermore,

$$W_w^{\mathrm{e}}(\sigma, a) \leq \frac{W_a^{\mathrm{e}}(\sigma, a) + s^{\mathrm{e}}(\sigma) W_{aw}^{\mathrm{e}}(\sigma, a)}{r + \lambda G(\bar{y}(\sigma))} \tag{33}$$

and

$$W_F^{\mathrm{e}}(\sigma, a) \geq \frac{\lambda G(\bar{y}(\sigma)) W_a^{\mathrm{u}}(a+F) + s^{\mathrm{e}}(\sigma) W_{aF}^{\mathrm{e}}(\sigma, a)}{r + \lambda G(\bar{y}(\sigma))} \tag{34}$$

are each separately equivalent to $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a+F)$.

Proof. From equation (7) we have $\bar{y}_F(\sigma) = -r[r+\lambda][r + \lambda G(\bar{y}(\sigma))]^{-1} = -r\bar{y}_w(\sigma)$, and using these relationships to differentiate (5) leads to (31)–(32). Moreover, differentiating equation (8) with respect to w yields

$$[r + \lambda G(\bar{y}(\sigma))] W_w^{\mathrm{e}}(\sigma, a) + \lambda \bar{y}_w(\sigma)[W^{\mathrm{e}}(\sigma, a) - W^{\mathrm{u}}(a+F)] = W_a^{\mathrm{e}}(\sigma, a) + s^{\mathrm{e}}(\sigma) W_{aw}^{\mathrm{e}}(\sigma, a). \tag{35}$$

Since $\bar{y}_w(\sigma) > 0$ we have that $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a+F)$ is equivalent to equation (33), and the equivalence of (34) is established by a similar argument employing $\bar{y}_F(\sigma) < 0$. □

Lemma 3. *We have*

$$\frac{W_F^{\mathrm{e}}(\sigma, a)}{W_w^{\mathrm{e}}(\sigma, a)} \geq \frac{J_F^{\mathrm{e}}(y, \sigma)}{J_w^{\mathrm{e}}(y, \sigma)} \tag{36}$$

if and only if $w - b + s^{\mathrm{u}} - rF \geq 0$.

Proof. Equations (31)–(32) yield

$$\frac{J_F^{\mathrm{e}}(y, \sigma)}{J_w^{\mathrm{e}}(y, \sigma)} = \lambda G(\bar{y}(\sigma)). \tag{37}$$

Moreover, equations (14)–(15) and the CARA specification for U imply that

$$W^{\mathrm{u}}_a(a) = U'(c^{\mathrm{u}}(a)) = -r\alpha e^{-\alpha r a} W^{\mathrm{u}}(0), \tag{38}$$

$$W^{\mathrm{e}}_a(\sigma, a) = U'(c^{\mathrm{e}}(\sigma, a)) = -r\alpha e^{-\alpha r a} W^{\mathrm{e}}(\sigma, 0). \tag{39}$$

Thus $W^{\mathrm{e}}_{aw}(\sigma, a) = -r\alpha W^{\mathrm{e}}_w(\sigma, a)$ and $W^{\mathrm{e}}_{aF}(\sigma, a) = -r\alpha W^{\mathrm{e}}_F(\sigma, a)$; and equations (33), (34), and (37) can be combined to show that

$$\frac{W^{\mathrm{e}}_F(\sigma, a)}{W^{\mathrm{e}}_w(\sigma, a)} \geq \frac{U'(c^{\mathrm{u}}(a + F))}{U'(c^{\mathrm{e}}(\sigma, a))} \frac{J^{\mathrm{e}}_F(y, \sigma)}{J^{\mathrm{e}}_w(y, \sigma)} \tag{40}$$

is equivalent to $W^{\mathrm{e}}(\sigma, a) \geq W^{\mathrm{u}}(a + F)$. The result then follows from Lemma 1. □

Lemma 4. *Given J°, the unique Pareto-optimal contract σ satisfying $J^{\mathrm{e}}(1, \sigma) = J^\circ$ is such that $w - b + s^{\mathrm{u}} - rF = 0$. Moreover, the Pareto frontier in payoff space is strictly decreasing, strictly concave, and differentiable.*

Proof. Pareto optimality of σ ensures that $W^{\mathrm{e}}_F(\sigma, a)/W^{\mathrm{e}}_w(\sigma, a) = J^{\mathrm{e}}_F(1, \sigma)/J^{\mathrm{e}}_w(1, \sigma)$, and from Lemma 3 it follows that $w - b + s^{\mathrm{u}} - rF = 0$. Since the locus of contracts satisfying $J^{\mathrm{e}}(1, \sigma) = J^\circ$ is downward-sloping in $\langle w, F\rangle$-space, these two equations characterize the unique Pareto optimum for fixed J°. Setting $w = b - s^{\mathrm{u}} + rF$ in equation (7), we obtain

$$b - s^{\mathrm{u}} = \bar{y}(\sigma) + \lambda \int_{\bar{y}(\sigma)}^{1} \frac{1 - G(y')}{r + \lambda} dy'. \tag{41}$$

Hence $\bar{y}(\sigma)$ is independent of F for contracts yielding payoff vectors on the Pareto frontier, and so from equation (5) we have $dJ^{\mathrm{e}}(1, b - s^{\mathrm{u}} + rF, F)/dF = -1$. In view of Lemma 1 and equation (14), we have also that $W^{\mathrm{e}}(b - s^{\mathrm{u}} + rF, F, a) = W^{\mathrm{u}}(a + F)$ is differentiable, strictly increasing, and strictly concave in F; and the desired properties of the Pareto frontier follow as a consequence. □

Proof of Proposition 3. Since the agreed contract σ^* maximizes the objective function in equation (9), the associated payoff vector $\langle W^{\mathrm{e}}(\sigma^*, a), J^{\mathrm{e}}(1, \sigma^*)\rangle$ is on the Pareto frontier. Moreover, this frontier is strictly concave by Lemma 4 and the Nash maximand is strictly quasi-concave in the payoffs, so the solution is uniquely determined. Finally, Lemma 4 ensures that $w^* - b + s^{\mathrm{u}} - rF^* = 0$. □

Proof of Proposition 4. We have $w^* - b + s^{\mathrm{u}} - rF^* = 0$ by Proposition 3, and so $F^* \geq \underline{F}$ is equivalent to $s^{\mathrm{u}} \geq -p(\theta^*)[w^* - b]/[p(\theta^*) + r]$. Moreover $s^{\mathrm{e}}(\sigma^*) = 0$ by Lemma 1, and so Equation (18) takes the form

$$\alpha r s^{\mathrm{u}} = p(\theta^*) \left[e^{-\alpha[w^* - b + s^{\mathrm{u}}]} - 1\right]. \tag{42}$$

Since the LHS and the RHS of this equation are strictly increasing and decreasing in s^{u}, respectively, it suffices to show that the LHS is no larger than the RHS for the value $s^{\mathrm{u}} = -p(\theta^*)[w^* - b]/[p(\theta^*) + r]$. This amounts to the inequality

$$1 + \frac{-\alpha r[w^* - b]}{p(\theta^*) + r} \leq \exp \frac{-\alpha r[w^* - b]}{p(\theta^*) + r}, \tag{43}$$

which is easily seen to hold strictly for $w^* > b$ and as an equality for $w^* = b$. It follows that when $\gamma > 0$ and the income loss $w^* - b$ from unemployment is strictly positive, we have $F^* > \underline{F}$. Alternatively, when $\gamma = 0$ and $w^* - b = 0$ we have $F^* = \underline{F} = 0$. □

Proof of Proposition 5. Since $\gamma = 0$ we have $W^{\mathrm{e}}(\sigma^*, a) = W^{\mathrm{u}}(a)$ and thus $w^* = b + s^{\mathrm{e}}(\sigma^*)$ by equations (14)–(15) and Proposition 2. Furthermore, since $F^* = F_m > 0$ we have that $c^{\mathrm{u}}(a + F^*) > c^{\mathrm{u}}(a) = c^{\mathrm{e}}(\sigma^*, a)$, that $U'(c^{\mathrm{u}}(a + F^*)) < U'(c^{\mathrm{e}}(\sigma^*, a))$, and that $s^{\mathrm{e}}(\sigma^*) < 0$ by equation (19). Hence $w^* < b$. □

Proof of Proposition 6. Since $\gamma = 0$ and $F^* = F_m > 0$ we have $w^* < b$ by Proposition 5, and moreover $s^{\mathrm{u}} = 0$ by Proposition 2. Hence $w^* - b + s^{\mathrm{u}} - rF^* < 0$, and thus by Lemma 3 we have $W^{\mathrm{e}}_F(\sigma^*, a)/W^{\mathrm{e}}_w(\sigma^*, a) < J^{\mathrm{e}}_F(y, \sigma^*)/J^{\mathrm{e}}_w(y, \sigma^*)$. This establishes that the contract σ^* is inefficient, and nevertheless the worker obtains the same payoff gross of lump-sum taxes as under (efficient) laissez-faire. It follows that the firm's payoff $J^{\mathrm{e}}(1, \sigma^*)$ is lower; equation (20) then implies that $q(\theta^*)$ is higher; and since the matching technology M is strictly increasing we have that job creation $p(\theta^*)$ is lower. Furthermore, writing σ for the laissez-faire equilibrium contract, we have

$$\bar{y}(\sigma^*) + \lambda \int_{\bar{y}(\sigma^*)}^{1} \frac{1 - G(y')}{r + \lambda} dy' = w^* - rF^* < b = \bar{y}(\sigma) + \lambda \int_{\bar{y}(\sigma)}^{1} \frac{1 - G(y')}{r + \lambda} dy' \tag{44}$$

by equation (7). This yields $\bar{y}(\sigma^*) < \bar{y}(\sigma)$, and so job destruction $\lambda G(\bar{y}(\sigma^*))$ is lower. □

A.2 Renegotiation of the severance payment

After a productivity shock (i.e., for $y < 1$) the agreed contract may no longer be efficient. In this section we consider the possibility of renegotiation to capture additional surplus. For simplicity we model only the option to adjust the severance payment, since this is what is important for determining the impact of a government mandate.[29]

Renegotiation after a shock proceeds as follows. The worker employed under contract $\sigma = \langle w, F \rangle$ makes a new severance offer F' to the firm. The firm can accept this offer and pay F', reject it and propose that employment continue under the contract σ, or dismiss the worker outright and pay F. Continuation of employment requires the consent of the worker, who remains free to quit and receive no payment. Importantly, the renegotiated quantity F' is paid on the spot and unconstrained by the government-mandated minimum F_m on the contractual amount.[30]

Note first that if $W^{\mathrm{e}}(\sigma, a) < W^{\mathrm{u}}(a)$, then a worker who is not dismissed will choose to quit. Monotonicity of U guarantees that W^{e} will be strictly increasing in all arguments, and it follows that for each relevant $\langle F, a \rangle$ there exists a unique reservation wage $\underline{w}(F, a)$ that

[29] In fact, it can be shown that renegotiating the contract wage would never be optimal.

[30] Indeed, the firm-worker pair can implement a spot payment $F' < F_m$ in two equivalent ways: They can agree to call the separation a quit (or "voluntary redundancy") rather than a dismissal, in which case transfers between them are unconstrained by legislation. Or they can describe the separation as a layoff, with the worker rebating to the firm, on the spot, the difference $F - F' > 0$.

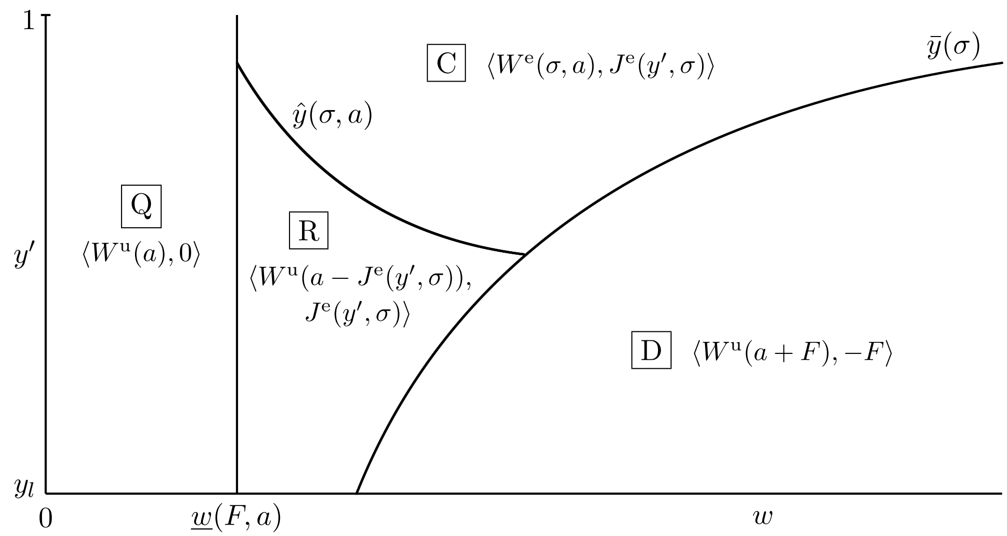

Figure 3: Post-shock outcomes allowing for renegotiation. Given $\langle F,a\rangle$, the consequences of a productivity shock are shown in $\langle w,y'\rangle$-space. The worker quits (case Q) if the wage is below $\underline{w}(F,a)$. The firm dismisses the worker (case D) if productivity is below $\bar{y}(\sigma)$. Employment continues (case C) if productivity exceeds both $\hat{y}(\sigma,a)$ and $\bar{y}(\sigma)$. And the two parties separate with a renegotiated severance payment (case R) if productivity is between $\hat{y}(\sigma,a)$ and $\bar{y}(\sigma)$. In each region the first component of the payoff vector accrues to the worker and the second to the firm.

satisfies $W^{\mathrm{e}}(\underline{w}(F,a),F,a)=W^{\mathrm{u}}(a)$. If w is below $\underline{w}(F,a)$ then the worker will quit and the continuation values are $W^{\mathrm{s}}(y',\sigma,a)=W^{\mathrm{u}}(a)$ for the worker and 0 for the firm.

Renegotiation is relevant when the worker will not quit and the firm will not dismiss. (The condition for dismissal remains as in Section 3.1.) Since the worker makes a take-it-or-leave-it offer, the amount proposed will be the firm's reservation payoff $F'=-J^{\mathrm{e}}(y',\sigma)$, and the firm will be left indifferent between accepting the offer and continuing the match. Moreover, the productivity threshold $\hat{y}(\sigma,a)$ below which renegotiation occurs is determined by the relation

$$W^{\mathrm{e}}(\sigma,a)=W^{\mathrm{u}}(a-J^{\mathrm{e}}(\hat{y}(\sigma,a),\sigma)). \tag{45}$$

When y' is above this threshold the match survives and the continuation payoffs remain $\langle W^{\mathrm{e}}(\sigma,a),J^{\mathrm{e}}(y',\sigma)\rangle$, as in the model without renegotiation. Alternatively, if $y'<\hat{y}(\sigma,a)$ then the two parties separate with a renegotiated transfer and the continuation payoffs are $\langle W^{\mathrm{u}}(a-J^{\mathrm{e}}(y',\sigma)),J^{\mathrm{e}}(y',\sigma)\rangle$. For fixed $\langle F,a\rangle$, Figure 3 plots the renegotiation threshold in $\langle w,y'\rangle$-space together with the thresholds $\underline{w}(F,a)$ for quitting and $\bar{y}(\sigma)$ for dismissal.

When $W^{\mathrm{e}}(\sigma,a)\geq W^{\mathrm{u}}(a)$ and so the worker does not quit, we can now express the job destruction threshold and the severance payment after renegotiation as

$$y^{\mathrm{d}}(\sigma, a) = \max\{\hat{y}(\sigma, a), \bar{y}(\sigma)\}, \tag{46}$$

$$F^{\mathrm{r}}(y', \sigma) = F - \frac{\max\{y' - \bar{y}(\sigma), 0\}}{r + \lambda}. \tag{47}$$

With these definitions, equation (3) can be written as

$$rW^{\mathrm{e}}(\sigma, a) = \max_{c}[U(c) + (ra + w - \tau - c)W^{\mathrm{e}}_{a}(\sigma, a)] + \cdots$$
$$\lambda \left[\int_{y_l}^{y^{\mathrm{d}}(\sigma,a)} W^{\mathrm{u}}(a + F^{\mathrm{r}}(y', \sigma))dG - G(y^{\mathrm{d}}(\sigma, a))W^{\mathrm{e}}(\sigma, a) \right]. \tag{48}$$

Allowing for renegotiation requires the following modifications to Proposition 1. First, in part A we show also that $\underline{w}$, $\hat{y}$, and y^{d} are independent of wealth. Second, in part C we replace equation (19) by

$$rs^{\mathrm{e}}(\sigma) = \frac{\lambda}{\alpha} \int_{y_l}^{y^{\mathrm{d}}(\sigma)} \left[\frac{U'(c^{\mathrm{u}}(a + F^{\mathrm{r}}(y', \sigma)))}{U'(c^{\mathrm{e}}(\sigma, a))} - 1 \right] dG. \tag{49}$$

And third, we show in addition that the job-destruction threshold is given by

$$y^{\mathrm{d}}(\sigma) = \bar{y}(\sigma) + \frac{r + \lambda}{r} \max\{c^{\mathrm{u}}(a + F) - c^{\mathrm{e}}(\sigma, a), 0\}. \tag{50}$$

(This implies that separation is consensual for the marginal job loser—the job destruction threshold is above the firing threshold—as long as workers strictly prefer being fired to continuing employment under the existing contract.) Moreover, equation (22) must be replaced by

$$p(\theta)u = \lambda G(y^{\mathrm{d}}(\sigma^*))[1 - u]. \tag{51}$$

Renegotiation does not affect Lemma 1 or Propositions 2–4, which continue to hold as stated. In Proposition 5 we can show also that $y^{\mathrm{d}}(\sigma^*) > \bar{y}(\sigma^*)$, establishing that in the binding-constraint equilibrium the severance payment is renegotiated with positive probability. The optimality of separation, together with the functional form for the value function, also implies that the consumption of the marginal job loser is not higher than it would be in case of continuation.

As for Proposition 6, when renegotiation is allowed this result is replaced by the following.

Proposition 7. *If $\gamma = 0$ and $F^* = F_m > 0$, then unemployment u^* and job destruction $\lambda G(y^{\mathrm{d}}(\sigma^*))$ are higher while job creation $p(\theta^*)$ and workers' welfare $W^{\mathrm{e}}(\sigma^*, a) = W^{\mathrm{u}}(a)$ are lower than under laissez-faire.*

Figure 4 is the counterpart of Figure 2 above for the case of renegotiation. Note that, in line with our theoretical result, binding mandates increase rather than decrease unemployment in the presence of renegotiation.

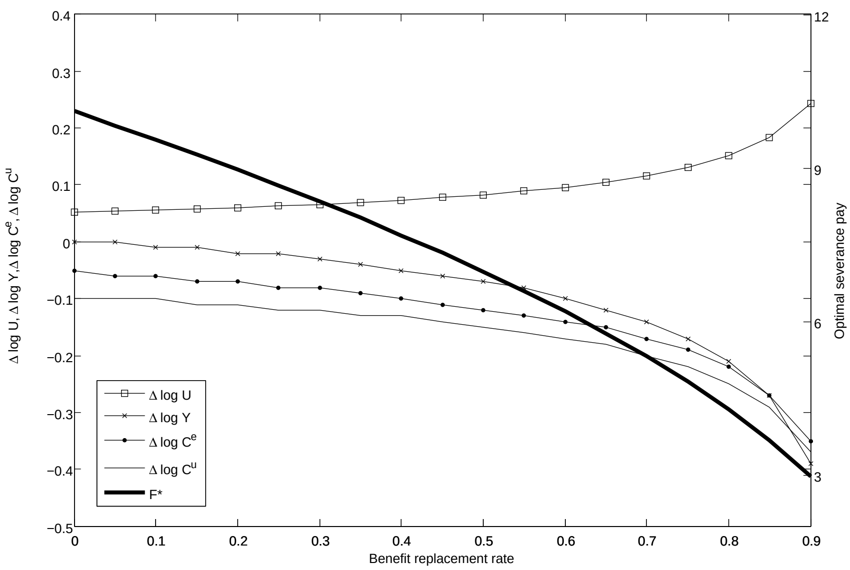

Figure 4: Effects of severance-pay mandates for a range of benefit replacement rates, with optimal, ex-post renegotiation of the severance payment.

A.3 Data and data sources

Table 3 contains the data used to construct the country-specific upper bounds on the excess of mandated over privately-optimal severance pay used in Sections 5–6. These bounds, reported in the last column of the table, amount to the maximum (over white and blue collar workers) difference between the legislated payment f_m and the bound on the privately-optimal payment in equation (25).

The monthly exit rates from unemployment $p(\theta)$ are from the OECD unemployment duration database. The benefit replacement rates ρ come from Nickell (1997), except for the Italian rate which has been updated using Office of Policy (2002). The interest rate is set at 4 percent annually.

Legislated dismissal costs are constructed as the maximum over blue-collar and white-collar workers of the sum of notice-period and severance pay. The latter quantities are obtained by applying the formulas for legislated payments to the average completed job tenures (ACJT) in the third column of the table (from the data set in Nickell et al. 2002), averaged over each country's sample period. The formulas for European countries come from Grubb and Wells (1993); with the exception of those for Austria, Finland, Norway, and Sweden, which are derived from IRS (Industrial Relations Service) (1989). The size of the legislated severance payment for Italy includes damages workers are entitled to if their dismissal is deemed unfair (5 months) plus the amount they receive if they give up their right

Country	$p(\theta)$	ρ	ACJT	$\underline{f}$	blue collar n.p.	blue collar sev.	white collar n.p.	white collar sev.	max $f_m - \underline{f}$
Australia	0.15	36	7.6	4.2	11	2	1	2	8.8
Belgium	0.04	60	24.4	9.2	1.9	—	21[a]	—	11.8
Canada	0.29	59	3.5	1.4	0.5	0.3	0.5	0.3	−0.4
Denmark	0.12	90	11.9	0.8	3	—	6	1	6.2
Finland	0.15	63	10.4	2.4	4	—	4	—	1.6
France	0.05	57	21.1	8	2	1.7	2	1.7	−4.3
Germany	0.13	63	26.5	4.4	2[b]	—	6[b]	—	1.6
Ireland	0.03	37	11.4	19	1.5	1.4	1.5	1.4	−16.1
Italy	0.03	40	41.2	18	0.5	20	4	20	6
Netherlands	0.05	70	15.3	5.6	3.3	—	3.3	—	−2.3
Norway	0.25	65	11.6	1.4	3	—	3	—	−1.6
New Zealand	0.17	30	6.8	4	1	—	1	—	−3
Portugal	0.06	65	14.9	5.7	2	15	2	15	11.3
Spain	0.02	70	26.8	12.9	3	12	3	12	2.1
Sweden	0.25	80	10.6	0.8	4[b]	—	4[b]	—	3.2
UK	0.1	38	4.5	6	1.2	1.2	1.2	1.2	−4.8
USA	0.33	50	3.1	1.5	2[c]	—	2[c]	—	0.5
	per month	%	years	months	months		months		months

Notes:

[a] ACJT × 0.86; an approximation of the Claeys formula in Grubb and Wells (1993).

[b] Dependent on age and length of service; we assume employment started at age 20.

[c] Applies only to large-scale layoffs covered by the Worker Adjustment and Retraining Notification Act.

Table 3: Legislated and privately-optimal dismissal costs for blue-collar and white-collar workers in various countries, including both notice-period (n.p.) and severance (sev.) pay.

to reinstatement (15 months). Our value is consistent with the estimates in Ichino (1996).[31] The data for Portugal and New Zealand come from European Foundation (2002) and CCH New Zealand Ltd (2002), respectively. The data for legislation in Australia, Canada, and the United States are from Bertola et al. (1999).

A.4 Positive utility from leisure

As a further robustness exercise, this section presents an alternative calibration of the model which allows for a positive utility from leisure and perfect substitutability of consumption

[31] Note that the formula in Grubb and Wells (1993) wrongly treats as severance pay the "trattamento di fine rapporto," a form of forced savings workers are entitled to whatever the reason for termination, including voluntary quits and summary dismissal. On this point see Brandolini and Torrini (2002).

Months of wages	(l.-f.) 1	(+11) 12	(+16) 17	(+18) 19	(+23) 24
Job finding rate (%)	19.1	18.4	17.9	17.6	16.9
Job destruction (%)	1.4	1.3	1.2	1.2	1.2
Unemployment rate (%)	6.8	6.5	6.5	6.5	6.5
Gross wage (×100)	98.6	94.1	92.3	91.6	89.9
Tax (×100)	6.3	6.0	5.9	5.9	5.9
Net output	100.0	99.9	99.6	99.5	99.0
Employed welfare	100.0	100.0	99.7	99.6	99.1
Unemployed welfare	100.0	100.0	99.7	99.6	99.2

Table 4: Allocational and welfare effects of severance-pay mandates with $\rho = 0.65$ and utility from leisure.

and leisure.[32] The felicity function becomes

$$U(c, l) = -e^{-\alpha(c-\psi l)}, \tag{52}$$

where leisure l equals zero for an employed and one for an unemployed worker.

Calibration now requires an additional moment to pin down the extra parameter ψ. Following Mortensen and Pissarides (1999), we set the cost of posting a vacancy m so that the average cost per hired worker $m/q(\theta) = 0.33$. This corresponds to the average cost of recruiting and hiring a worker in the U.S., according to the survey results in Hamermesh (1993).[33] Matching the Portuguese average unemployment duration and unemployment rate requires setting $\psi = 0.316$ and $\lambda = 0.143$. All other parameters are the same as in the main calibration.

Table 4 is the counterpart of Table 2 for the case of positive utility from leisure, and reports equilibrium quantities for different levels of severance pay in the calibrated economy.

The third column corresponds to the benchmark calibration, and the first column to its laissez-faire counterpart. Note that the optimal severance payment in the latter equals one month, rather then six months as in the original calibration. Because of the perfect substitutability of leisure and consumption and the calibrated value of the rate of substitution ψ, the utility from leisure compensates job losers for a substantial fraction of their loss of income.

For comparison, the second and fourth columns of Table 4 report equilibrium quantities for mandated severance pay that exceeds the laissez-faire quantity by 11 and 18 months, respectively (the same differences as in columns two and three of Table 2). It is clear that

[32]From an empirical perspective, the assumption of perfect substitutability between consumption and leisure, which is also incompatible with balanced growth, is problematic. If anything, applying the calibration strategy in this section across countries would imply that the utility of leisure is lower in countries with higher benefit replacement rates. This not only seems counter-intuitive, but would also be contrary to a well-established tradition (e.g., in the international trade literature) of assuming that tastes are invariant across countries and policies.

[33]A comparable estimate for Portugal, our calibrated economy, is not available.

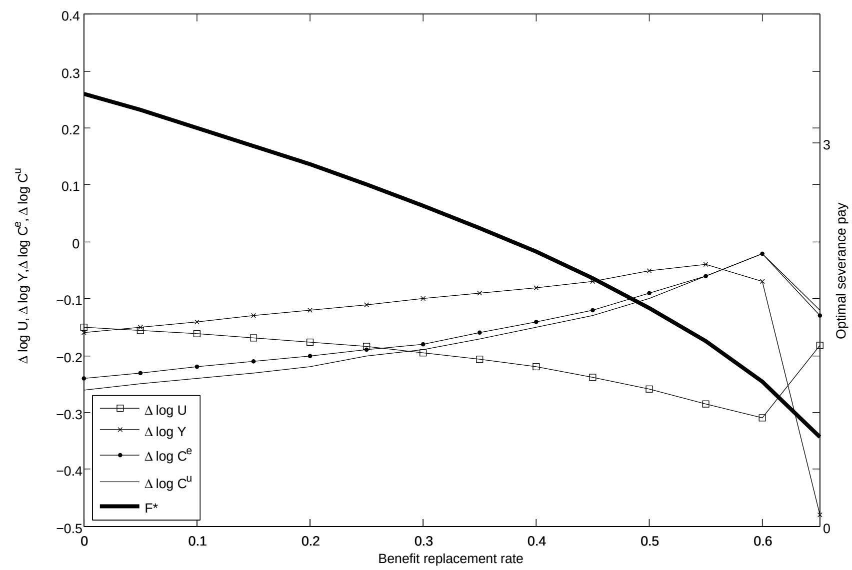

Figure 5: Effects of severance-pay mandates for a range of benefit replacement rates, with utility from leisure.

the allocational and welfare implication of these deviations are both small and very similar under the two calibrations. However, a mandate of 24 months, shown in the fifth column, generates sizeable efficiency and welfare losses in the new calibration.

Figure 5 is the counterpart of Figure 2 for the case of positive utility from leisure. Here, for different values of the benefit replacement rate, we plot the optimal severance payment and the employment, efficiency, and welfare changes associated with a mandate 11 months higher than the private optimum. In this case an equilibrium with positive employment does not exist for ρ exceeding 0.65.

A.5 Calibration choices

In this section we discuss choices involved in the calibration of the model's parameters. The two moments used in the calibration are the value of the exit rate from unemployment (or equivalently its inverse, the unemployment duration) and the value of the job destruction rate (or equivalently the unemployment rate, given the flow equilibrium condition in equation (22)). Let p^* and s^* denote, respectively, the target values for the unemployment exit and job destruction rates.

Consider first calibration of the parameters that determine the job destruction rate, assuming that some other parameters can be adjusted to keep the unemployment duration at its target level. That is to say, consider how the targeted job destruction rate identifies the shock arrival rate and the distribution of shocks via the moment condition

$$\lambda G(\bar{y}) = s^*. \tag{53}$$

Given the assumption of a uniform distribution of shocks with upper support normalized to 1, this condition involves two parameters: the arrival rate λ and the lower support y_l of the distribution. Blanchard and Portugal (2000) choose y_l to match the coefficient of variation for output in Portugal while we set $y_l = 0$. In either case, λ is calibrated to satisfy the moment condition. Note that, since the uniform distribution has a flat density, the decomposition of the separation rate $\lambda G(\bar{y})$ between the arrival rate λ and the conditional probability of separation $G(\bar{y})$ is of little relevance provided the lower bound of the support is not binding (i.e., $\bar{y} > y_l$) in equilibrium. Mortensen and coauthors normally set λ to some arbitrary value (typically 0.1 for the US) and then choose y_l to satisfy the moment condition in equation (53). That is to say, in this sort of model λ and y_l are not separately identified without an additional "normalization." Normalizing y_l to zero seems the least objectionable choice.

We turn now to the calibration of the parameters that affect the job creation margin, assuming that (for example) λ is adjusted to keep the job destruction rate at its target value s^*. Note that given the matching function $M(u, v) = A(uv)^{0.5}$ we have

$$A(v/u)^{0.5} = p^*, \tag{54}$$

which implies that the equilibrium vacancy filling cost equals $q^* = A^2/p^*$ in the calibrated economy. Substituting for q^* in the job creation equation (21) then yields

$$\frac{mp^*}{A^2} = \frac{1 - \bar{y}(\sigma^*)}{r + \lambda} - F^* = J^{\mathrm{e}}(1, \sigma^*). \tag{55}$$

Given the equilibrium value of $J^{\mathrm{e}}(1, \sigma^*)$ implied by the targeted moments, it follows that there is an infinite set of $\langle m, A\rangle$-pairs consistent with the targeted p^*. In other words, m and A are also not separately identified without an additional normalization. The main calibration normalizes A to one and calibrates m to satisfy equation (55).[34]

The calibration reported in Appendix A.4 introduces an extra parameter, the marginal utility of leisure ψ, leaving us short one moment condition. In the absence of a comparable number for Portugal we have again followed Mortensen and set m such that the average cost of posting a vacancy $m/q(\theta)$, on the left hand side of equation (55), equals its estimate of 0.33 for the US. We then choose ψ so that $J^{\mathrm{e}}(1, \sigma^*)$ satisfies the moment condition in equation (55).

The effect of mandates is small under all of these parameterizations, which we take as evidence that this result is driven by the economics of the model and not any particular parameter choice.

[34]The calibration is similar to that in Shimer (2005), with the difference that he normalizes A such that $v/u = 1$ while we have followed Mortensen and set $A = 1$.

References

Acemoglu, Daron and Shimer, Robert (1999), 'Efficient unemployment insurance', *Journal of Political Economy* **107**, 893–928.

Alvarez, Fernando and Veracierto, Marcelo (2001), 'Severance payments in an economy with search frictions', *Journal of Monetary Economics* **47**, 477–498.

Attanasio, Orazio (1999), Consumption, *in* John B.Taylor and MichaelWoodford, eds, 'Handbook of Macroeconomics', Vol. 1B, North Holland, Amsterdam.

Bertola, Giuseppe (2004), 'A pure theory of job security and labor income risk', *Review of Economic Studies* **71**, 43–61.

Bertola, Giuseppe, Boeri, Tito and Cazes, Sandrine (1999), Employment protection and labour market adjustment in OECD countries: Evolving institutions and variable enforcement, Employment and Training Papers 48, ILO.

Bishow, John and Parsons, Donald O. (2004), Trends in severance pay coverage in the United States, 1980-2001. Available at SSRN: http://ssrn.com/abstract=878144.

Blanchard, Olivier and Portugal, Pedro (2000), 'What hides behind an unemployment rate: Comparing Portuguese and U.S. labor markets', *American Economic Review* **91**, 187–207.

Blanchard, Olivier J. and Tirole, Jean (2008), 'The joint design of unemployment insurance and employment protection: A first pass', *Journal of the European Economic Association* **6**, 45–77.

Boeri, Tito, Borsch-Supan, Axel and Tabellini, Guido (2001), 'Welfare state reform', *Economic Policy* **32**, 7–44.

Bover, Olympia, García-Perea, Pilar and Portugal, Pedro (2000), 'Iberian labour markets', *Economic Policy* **31**, 380–428.

Brandolini, Andrea and Torrini, Roberto (2002), La tutela del rapporto di lavoro subordinato secondo gli indicatori dell'OCSE. Mimeo, Bank of Italy.

CCH New Zealand Ltd (2002), Court of appeal sets the rules. Available at http://www.cch.co.nz/employ/articles/appcourt.asp.

Coles, Melvyn (2008), 'Optimal unemployment policy in a matching equilibrium', *Labour Economics* **15**, 537 – 559.

Coles, Melvyn and Masters, Adrian (2006), 'Optimal unemployment insurance in a matching equilibrium', *Journal of Labor Economics* **24**, 109–138.

European Foundation (2002), Portugal: Termination of the contract of employment, Technical report, European Foundation for the Improvement of Living and Working Conditions, http://www.eurofound.eu.int/emire/portugal/terminationofthecontractofemployment-pt.html.

Fella, Giulio (2005), 'Termination restrictions and investment in general training', *European Economic Review* **49**, 1479–1499.

Fella, Giulio (2007), 'When do firing taxes matter?', *Economics Letters* **97**, 24–31.

Fella, Giulio (2012), 'Matching, wage rigidities and efficient severance pay', *The B.E. Journal of Economic Analysis and Policy* **12**.

Garibaldi, Pietro and Violante, Giovanni L. (2005), 'The employment effects of severance payments with wage rigidities', *Economic Journal* **115**, 799–832.

Grubb, David and Wells, William (1993), 'Employment regulation and patterns of work in E.C. countries', *OECD Economic Studies* **21**, 7–58.

Hamermesh, Daniel S. (1993), *Labor Demand*, Princeton University Press, Princeton: NJ.

Hopenhayn, Hugo A. and Nicolini, Juan P. (1997), 'Optimal unemployment insurance', *Journal of Political Economy* **105**, 412–438.

Hosios, Arthur J. (1990), 'On the efficiency of matching and related models of search and unemployment', *Review of Economic Studies* **57**, 279–298.

Ichino, Pietro (1996), *Il lavoro e il mercato*, Mondadori, Milano.

IRS (Industrial Relations Service) (1989), Termination of contract in Europe, Technical report, EIRR: Report No. 1, London: Eclipse Publications.

Lazear, Edward P. (1990), 'Job security provisions and employment', *Quarterly Journal of Economics* **105**, 699–726.

Lorences, Joaquín, Fernandez, Víctor and Rodriguez, Csar (1995), 'Diferencias interterritoriales de salarios y negociacion colectiva en España', *Investigaciones Economicas* **XIX**, 309–324.

Millward, Neil et al. (1992), *Workplace Industrial Relations in Transition*, Aldershot, Dartmouth.

Mortensen, Dale T. and Pissarides, Christopher A. (1994), 'Job creation and job destruction in the theory of unemployment', *Review of Economic Studies* **61**, 397–415.

Mortensen, Dale T. and Pissarides, Christopher A. (1999), Job reallocation, employment fluctuations and unemployment, *in* John B. Taylor and Michael Woodford, eds, 'Handbook of Macroeconomics', Vol. 1B, Elsevier Science B.V., Amsterdam, The Netherlands, pp. 1171–1228.

Nickell, Stephen (1997), 'Unemployment and labor market rigidities: Europe versus North America', *Journal of Economic Perspectives* **11**, 55–74.

Nickell, Stephen, Nunziata, Luca, Ochel, Wolfgang and Quintini, Glenda (2002), The Beveridge curve, unemployment and wages in the OECD from the 1960s to the 1990s. CEP Discussion paper 502.

Office of Policy (2002), Social security programs throughout the world, Technical report, U.S. Social Security Administration, http://www.ssa.gov/policy/docs/progdesc/ssptw/.

Pavoni, Nicola (2009), 'Optimal unemployment insurance, with human capital depreciation, and duration dependence', *International Economic Review* **50**, 537–559.

Petrongolo, Barbara and Pissarides, Christopher A. (2001), 'Looking into the black box: A survey of the matching function', *Journal of Economic Literature* **39**, 390–431.

Pissarides, Christopher A. (2001), 'Employment protection', *Labour Economics* **8**, 131–159.

Pissarides, Christopher A. (2004), Consumption and savings with unemployment risk: Implications for optimal employment contracts. Mimeo, LSE.

Rudanko, Leena (2009), 'Labor market dynamics under long-term wage contracting', *Journal of Monetary Economics* **56**, 170–183.

Saint-Paul, Gilles (2002), 'The political economy of employment protection', *Journal of Political Economy* **110**, 672–704.

Shavell, Steven and Weiss, Laurence (1979), 'The optimal payment of unemployment insurance benefits over time', *Journal of Political Economy* **87**(6), 1347–62.

Shimer, Robert and Werning, Ivan (2008), 'Liquidity and insurance for the unemployed', *American Economic Review* **98**, 1922–1942.

Werning, Ivan (2002), Optimal unemployment insurance with unobservable savings. Mimeo, MIT.