

DISCUSSION PAPER SERIES

No. 4198

DOES THE MARKET PROVIDE SUFFICIENT EMPLOYMENT PROTECTION?

Roberto Burguet and Ramón Caminal

LABOUR ECONOMICS



Centre for **E**conomic **P**olicy **R**esearch

www.cepr.org

Available online at:

www.cepr.org/pubs/dps/DP4198.asp

DOES THE MARKET PROVIDE SUFFICIENT EMPLOYMENT PROTECTION?

Roberto Burguet, Institut d'Anàlisi Econòmica (CSIC), Barcelona
Ramón Caminal, Institut d'Anàlisi Econòmica (CSIC), Barcelona and CEPR

Discussion Paper No. 4198
January 2004

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

This Discussion Paper is issued under the auspices of the Centre's research programme in **LABOUR ECONOMICS**. Any opinions expressed here are those of the author(s) and not those of the Centre for Economic Policy Research. Research disseminated by CEPR may include views on policy, but the Centre itself takes no institutional policy positions.

The Centre for Economic Policy Research was established in 1983 as a private educational charity, to promote independent analysis and public discussion of open economies and the relations among them. It is pluralist and non-partisan, bringing economic research to bear on the analysis of medium- and long-run policy questions. Institutional (core) finance for the Centre has been provided through major grants from the Economic and Social Research Council, under which an ESRC Resource Centre operates within CEPR; the Esmée Fairbairn Charitable Trust; and the Bank of England. These organizations do not give prior review to the Centre's publications, nor do they necessarily endorse the views expressed therein.

These Discussion Papers often represent preliminary or incomplete work, circulated to encourage discussion and comment. Citation and use of such a paper should take account of its provisional character.

Copyright: Roberto Burguet and Ramón Caminal

CEPR Discussion Paper No. 4198

January 2004

ABSTRACT

Does the Market Provide Sufficient Employment Protection?*

This Paper examines the role of employment protection when firms learn over time about the value of the match. When parties can commit to future wages, equilibrium contracts stipulate positive severance payments as an instrument to induce efficient lay-off decisions and there is no room for public intervention. When parties cannot commit to future wages, *ex-post* bargaining leads to excessive dismissals, and therefore the market provides insufficient employment protection. In this case, a Pigouvian tax/subsidy scheme will correct the inefficiency by enhancing employment protection.

JEL Classification: J41 and J65

Keywords: employment protection, experimentation, lay-offs and severance payments

Roberto Burguet
Institut d'Anàlisi Econòmica, CSIC
Campus UAB
08193 Bellaterra
Barcelona
SPAIN
Tel: (34 93) 580 6612
Fax: (34 93) 580 1452
Email: roberto.burguet@uab.es

Ramón Caminal
Institut d'Anàlisi Econòmica, CSIC
Universitat Autònoma de Barcelona
Bellaterra
E-08193 Barcelona
SPAIN
Tel: (34 93) 580 6612
Fax: (34 93) 580 1452
Email: ramon.caminal@uab.es

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=110730

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=109343

*We are grateful to Juan Francisco Jimeno for useful comments. We also thank the support of the Barcelona Economics Program of CREA and the Spanish MCyT (grant SEC2002-02506).

Submitted 12 November 2003

Does the market provide sufficient employment protection?*

Roberto Burguet[†] and Ramon Caminal[‡]

January 13, 2004

Abstract

This paper examines the role of employment protection when firms learn over time about the value of the match. When parties can commit to future wages, equilibrium contracts stipulate positive severance payments as an instrument to induce efficient layoff decisions and there is no room for public intervention. When parties cannot commit to future wages, ex-post bargaining leads to excessive dismissals, and therefore the market provides insufficient employment protection. In this case, a Pigouvian tax/subsidy scheme will correct the inefficiency by enhancing employment protection.

JEL Classification numbers: J41, J65.

Key words: severance payments, layoffs, experimentation, employment protection.

1 Introduction

Employment protection, when defined as the set of devices that discourage employment separations, has both a public side (mandatory rules) and a private side (voluntary contract provisions). Many countries have enacted

*We are grateful to Juan Francisco Jimeno for useful comments. We also thank the support of the Barcelona Economics Program of CREA and the Spanish MCyT (grant SEC2002-02506).

[†]Institut d'Anàlisi Econòmica, CSIC.

[‡]Institut d'Anàlisi Econòmica, CSIC, and CEPR.

employment protection legislation (EPL) that aims to protect workers by raising firms' firing costs. A large fraction of these costs take the form of a transfer to the worker (mandated severance payments, advance notice) but a non-negligible fraction represent a cost for the worker-firm pair (like litigation costs).¹ The private side of employment protection has received much less attention, in spite of the fact that it is by no means rare to find employment protection clauses as part of private agreements. For instance, some workers not covered by common labor regulations (like managers or professional sports people) are typically protected against firm-initiated separations by contracts that include large severance payments. Moreover, several authors have reported that in some industries a substantial fraction of collective bargaining agreements include severance payments over and above mandatory levels.²

The pervasiveness of employment protection mechanisms both in public regulations and in private contracts poses two related questions. First, what role do these clauses play in labor contracts? Second, why does the government intervene? The literature has provided several answers to the first question (which will be discussed below). Regarding the second question, we focus exclusively on efficiency-motivated governments.³ That is, public intervention is justified only if there is a market failure, i.e., if the level of employment protection provided by the market is insufficiently low (excessive layoffs). If this is the case, we need to explain why workers and firms are unable to agree privately on the right amount of employment protection. After all, the evidence suggests that severance payments can easily be included in private contracts.

In this paper we provide both a theory of the role of severance payments in labor contracts and an explanation of why privately provided employment protection may be insufficient. The basic hypothesis on which this theory relies is that employers learn over time about the value of their matches with workers. Jobs and workers are heterogeneous, and very of-

¹See OCDE Outlook (1999). For the case of Italy, Garibaldi and Violante (2001) estimate that the transfer amounts to two thirds of total firing costs.

²See Booth (1987), Pencavel (1991), and Lorences et al. (1995) for the UK, US, and Spain, respectively.

³Thus, we adopt a normative point of view. From a positive point of view the current EPL has sometimes been interpreted as a rent-extraction device supported by insiders in an attempt to increase their bargaining power vis-a-vis firms and outsiders. (See, for instance, Saint Paul, 1996.)

ten it is difficult to know a priori which is the most suitable worker for a particular job: how she will get along with her co-workers, manage to adapt to certain routines, etc. The firm learns the value of the match after experiencing this match for some time.⁴ Ex-post asymmetry of information between the worker and the firm implies that contracts are necessarily incomplete; in particular, future wages cannot be a function of the realization of the match value. Thus, an efficient long-run contract must give the firm the right to terminate the relationship and induce the firm to take efficient layoff decisions. Because of the gains from experimentation, the value of young workers is higher than that of the average old worker. Indeed, in the former case if the match turns out to be of low value the worker can be reallocated, whereas if the match turns out to be of high value there is still a future to enjoy the success of the experiment. Competitive pressures imply that this value of experimentation is transferred to the worker. On the other hand, capital market imperfections make workers prefer smooth labor income profiles. As a result their wages with their current employers will tend to be higher than outside. Hence, contracts should stipulate a positive severance payment in order to induce the firm to take efficient layoff decisions.⁵ This is how simple long-run contracts can guarantee the right amount of employment protection making public intervention unnecessary.

Unfortunately, the ability to commit to future wages may be very limited in many contexts. In the real world explicit contracts rarely stipulate wages beyond a two or three year horizon.⁶ When parties cannot commit to future

⁴There is substantial empirical evidence suggesting a negative relationship between the hazard rate of employment separations and job tenure. Two learning processes can explain such a phenomenon: Learning-by-doing and learning about match quality, since in both cases the average productivity of workers increases with tenure. Nagypál (2000) uses a French dataset to distinguish between these two possible explanations and finds that learning about match quality clearly dominates.

⁵Burguet, Caminal, and Matutes (2002) studied the optimal contracting arrangements in a model where firms learn about the workers' quality. The aim of that paper was to analyze the effect of the information structure on the optimal combination of different types of switching costs (layoff costs versus penalties on quits). In contrast, the goal of the current paper is to understand the effect of the contract length on the efficiency of layoffs and the role of public intervention. Although the two models differ substantially, they share the insight that, under some circumstances, a positive severance payment may be needed to guarantee ex-post efficiency.

⁶At best, firms may try to use alternative commitment devices, like promotion systems or wage setting rules, based on reputation (implicit contracts). Whenever firms can develop these instruments then the outcome may be similar to the case of long-run explicit

wages, the firm and the worker will need to bargain ex-post under asymmetric information. Workers will act strategically and force wages above their outside option level, and as a result the rate of separations will be inefficiently high. Voluntary severance payments cannot guarantee efficiency, since they enhance the workers' bargaining position, which translates into higher future wages and more dismissals. Thus, the *laissez – faire* equilibrium is characterized by insufficient employment protection (separations occur too frequently and displaced workers experience a welfare loss), making room for public intervention. However, in this context the optimal form of intervention differs from standard public employment protection policies. Mandatory severance payments cannot improve efficiency, since they have the same effect on future dismissals as private severance payments. Instead, a tax-subsidy scheme can restore full efficiency. The reason is that a tax on layoffs reduces firms' firing incentives because it has a smaller effect on wages than a severance payment. Thus, we need the direct intervention of a third party and not only a regulation of private relations.⁷

The remainder of the paper is organized as follows. The next section briefly discusses the related literature. Section 3 presents the model. Section 4 considers the case where parties can commit to future wages and shows that there is no room for public intervention in that case. Section 5 considers the alternative case where commitment to future wages is not possible. Equilibrium is characterized by excessive layoffs, but efficiency can be restored by a tax/subsidy scheme and not by mandated severance payments. Finally, Section 6 contains some concluding remarks. Some formal proofs and extensions are contained in the Appendix.

2 Discussion of the literature

The literature on employment protection addresses two related but separate questions. First, under what circumstances will employers and workers agree to include severance payments in their private contracts? Second,

contracts In other circumstances, firms might not be able to develop a reputation.

⁷The asymmetry of information on the realization of the match value is crucial, since it causes inefficient separations. Nagypál (2002) studies a model where both the firm and the worker learn over time about the quality of the match and bargain efficiently about wages (efficient separations). A tax on layoffs reduces productivity and welfare, since it distorts separation decisions.

what are the effects of the standard EPL? In this paper we deal with both issues; we first identify an alternative set of circumstances that determine the use of severance payments in private contracts, and then we offer an efficiency justification for public intervention.

Let us first discuss the literature on severance payments and optimal contracting. The old literature on implicit contracts under asymmetric information (particularly, Grossman and Hart, 1981; Kahn, 1985, and Arnott et al., 1988) argues that severance payments may be part of an optimal risk sharing agreement under various circumstances. Efficiency requires that employment adjusts to shocks to the firm's revenue function, and if labor is indivisible this involves layoffs. Since workers are risk averse, labor contracts attempt to smooth their income across states of nature. Hence, laid-off workers must be compensated for the difference between the inside and the outside wages. However, severance payment may have either sign depending on various assumptions on workers' outside opportunities. More recently, Pissarides (2001) and Bertola (2002) propose dynamic models of the labor market in which risk averse workers cannot buy insurance against idiosyncratic, labor income risk. They show that a severance payment (as well as advance notice) improves risk sharing. Alvarez and Veracierto (2001) also consider the role of severance payments as a risk sharing device in a calibrated general equilibrium model. However, the welfare gains from severance payments are mostly due to the reduction in search costs.

Saint Paul (1995) and Fella (2000) present efficiency wage models with firm-specific shocks, and show that a positive severance payment helps in implementing more efficient levels of employment. The market response to the shirking problem is to create a gap between the value of employment and the value of unemployment for the worker (the main incentive mechanism is the threat of being fired). In the absence of severance payments firms take inefficient layoff decisions when hit by a negative shock, since they do not internalize the loss of utility for the worker. A positive severance payment works as a commitment to more efficient employment decisions in downturns. A key assumption is that disciplinary dismissals and those caused by shocks can be perfectly distinguished. In the real world disciplinary dismissals are declared unfair quite frequently. Thus, severance payments may distort incentives, raise wages, and reduce employment (Galdón-Sánchez and Güell, 2003).

It has also been suggested that contracts involving switching costs improve incentives to acquire firm-specific skills. In a classic paper, Hashimoto

(1981) shows how the optimal response to that problem is a sequence of wages that increase with tenure, which imposes a penalty on quits. Also, Booth and Chatterji (1989) present a model of relation-specific investment where severance payments are part of the equilibrium contract. However, such a contract involves an extreme form of bonding (the first period wage is negative).⁸

In all these models firms and workers would like to include severance payments in their contracts. If they are allowed to do that then no public intervention is required (the market can provide the right amount of employment protection). However, some of these papers, such as Fella (2000), Alvarez and Veracierto (2001), Pissarides (2001), and Bertola (2002), simply assume that private agents cannot include severance payments in their private contracts. As a result, mandatory severance payments increase welfare. In fact, we do find severance payments in private contracts and collective bargaining agreements. So, these are models that explain the demand for employment protection clauses, rather than the role of public intervention. In our model private contracts involve severance payments and achieve efficiency whenever parties can commit to future wages. In contrast to implicit contract theories, our model does not focus on risk sharing (it assumes universal risk neutrality). The friction we emphasize is the private information on the value of experimentation (coupled with wage smoothing, or at least non-decreasing wages).⁹

The literature on EPL has focused either on the effect of exogenous severance payments or the effect of a layoff tax.¹⁰ Since the early contributions of Lazear (1990) and Bentolila and Bertola (1990) the literature has identified a variety of channels through which EPL affects employment and wages (See Ljungqvist (2002) for an interesting comparison of various frameworks.) The effect on job market flows and employment duration seems more robust, with firing costs being associated with lower flows in and out of unemployment and longer unemployment spells.

⁸See also Chiang (1991).

⁹In contrast to Booth and Chatterji (1989), we show that the presence of costly firm-specific investment is redundant. In fact, the crucial assumptions in Booth and Chatterji are the uncertainty of the worker's opportunity cost and the inability to use quitting fees. These two assumptions may reinforce the use of severance payments in our model, provided the wage smoothing motive is not too strong.

¹⁰See Garibaldi and Violante (2002) for a comparison of the results obtained under these two approaches in a search model with wage rigidities.

In the absence of relevant market failures EPL can only reduce welfare. Positive effects of EPL on welfare are reported in those cases in which the optimal contract should include severance payments but such a possibility is ruled out a priori. There may be good reasons why parties do not include employment protection provisions in private contracts and collective bargaining agreements, or why they are insufficient (they do not avoid inefficient separations). However, these reasons may also affect the optimal design of public intervention. Our model illustrates such a possibility: severance payments would be part of private contracts if parties can commit to future wages (achieving efficient separations), but in the absence of commitment to future wages, equilibrium is characterized by excessive layoffs. Nevertheless, mandatory severance payments are counterproductive, and instead a Pigouvian tax/subsidy scheme is required to restore efficiency.

3 The model

The purpose of this paper is to study private and public employment protection in a parsimonious model that emphasizes firms' learning about match quality. Thus, the model abstracts from all other interesting aspects of the labor market, including mobility costs, market power, demand shocks, and labor market institutions other than EPL. We consider a partial equilibrium model with infinitely-lived firms and overlapping generations of workers who live for two periods. The size (mass) of generations is constant over time, and denoted by N , and the mass of firms is assumed to be 1.¹¹

Firms in each period produce output out of labor, and according to the production function $Y_t = f(L_t)$, where f is a twice differentiable function, with $f' > 0$, $f'' < 0$, and L_t is the total mass of labor employed, measured in efficiency units, in period t . Firms take prices parametrically in both output (whose price is normalized to one) and labor markets. They maximize the expected present value of profits, using a discount factor γ .

Worker i is able to supply q_{ij} efficiency units of labor to firm j . We assume that all q_{ij} are realizations of independent and identically distributed random variables¹² distributed over the interval $[q, \bar{q}]$ according to the den-

¹¹Thus, throughout we will assume that firms are small in their effect on the market, and also that firms hire a large number of workers, so that the realized efficiency units hired coincide ex-post with the expected number of efficiency units with probability 1.

¹²In contrast, in the real world different jobs may share similar characteristics, which

sity function $h(q_{ij})$. The value of the match, q_{ij} , is constant over time. The independence assumption allows us to dispose of the subscripts ij when we analyze decisions concerning a single firm-worker pair. The cumulative distribution function is denoted by $H(q)$. For economy of notation, we assume $E(q) = 1$. Let $\Psi(q)$ be the inverse of the hazard rate, i.e., $\Psi(q) = \frac{1-H(q)}{h(q)}$. We assume that $\Psi'(q) < 0$, which is a standard assumption in the literature on optimal contracting under asymmetric information and implies that h' is not too negative. The realization of q is only observed by the incumbent firm after employing the worker for one period. Ex-post efficiency requires that a young worker is retained if and only if $q \geq 1$.

The quality of the match is only observed by the firm after one period of employment. Thus, the firm can experiment with young workers and dismiss those who do not perform satisfactorily.

We focus on stationary equilibria. Hence, the only reference to the time dimension that matters refers to the worker's age. Thus, a subscript 1 will refer to young workers (first period of their life) and a subscript 2 will refer to old workers (second period of their life).

Workers have identical preferences. The utility of a representative worker is given by:

$$U_t^i = u(c_1) + \gamma u(c_2) \tag{1}$$

with $u' > 0$, $u'' < 0$, and c_t denotes the *expected value* of consumption in period t . Thus, the concave utility function $u(\cdot)$ captures the consumption smoothing motive, which will play some role in the model in combination with capital market imperfections. However, in order to emphasize the differences of the current model with respect to the implicit contract theory we assume that workers are risk neutral. In other words, workers wish to smooth their consumption across periods but not necessarily across states of nature.¹³

Implicit in this utility function is the assumption that workers supply their endowment inelastically. Finally, we assume that workers hold zero financial wealth at the beginning of their lifetimes.

would imply that the worker's performance could be correlated across firms. For the sake of simplicity, we assume independent performances, although we discuss the role of such an assumption in the next section.

¹³Hence, our utility specification is in the spirit of Epstein and Zin (1989), in the sense of disentangling intertemporal substitution and risk aversion.

Capital markets are not perfect. Let us denote the discount factor associated with workers' lending and borrowing as $\underline{\beta}$ and $\overline{\beta}$, respectively. We assume that $\underline{\beta} < \gamma < \overline{\beta}$. In other words, workers face a lower lending rate and a higher borrowing rate than firms.¹⁴

Finally, we assume that markets are perfectly competitive and there are no costs of reallocating workers.

4 Commitment to future wages

In this section we assume that the only restrictions on contracting possibilities are given by the information structure. In contrast, in the remaining sections we will consider the case in which young workers and firms are not able to commit themselves to future wages.

4.1 Market efficiency and severance payments

Contracts with old workers stipulate a wage, w^* , for the only remaining period of activity of such workers. In contrast, in this section, contracts with young workers stipulate a sequence of wages (w_1, w_2) .¹⁵ We also allow the contract to include a severance pay, s , to be paid in case of a layoff. Workers are allowed to quit at the end of the first period and quitting penalties are ruled out for the usual reasons. An old worker can obtain a wage w^* in the market, and therefore she will not quit her current job if $w_2 \geq w^*$.

At the end of the first period firms learn the realization of q and decide to retain the worker only if it is profitable to do so, i.e., retention will occur if and only if $qw^* - w_2 \geq -s$. The left hand side of the inequality is the firm's surplus from employing the worker, where the realized efficiency units are valued at the replacement cost: the market price. The right hand side is the net revenue if the worker is laid off: the severance pay. Thus, ex-post a worker is laid off if and only if $q < q^c$, where q^c is given by:

¹⁴Very often intertemporal models of the labor market assume that workers are excluded from financial markets ($\underline{\beta} = 0, \overline{\beta} = \infty$). See Bertola (2002) for a recent example. In our case we simply require a small interest rate differential in order to break the multiplicity of optimal contracts, as discussed below.

¹⁵Since the realization of q is the firm's private information, wages cannot be a function of q . The same information structure implies that the separation decision must be taken by the firm.

$$q^c \equiv \frac{w_2 - s}{w^*}. \quad (2)$$

On the other hand, in equilibrium firms must be indifferent between hiring young and old workers. This arbitrage condition can be written as:

$$w^* = \frac{w_1 + \gamma \{H(q^c) s + [1 - H(q^c)] w_2\}}{1 + \gamma \int_{q^c} q dH(q)}. \quad (3)$$

The left hand side is the wage of old workers per efficiency unit. The numerator of the right hand side is the expected present value of payments to a young worker and the denominator is the expected present value of the efficiency units to be supplied by a young worker.

One fundamental element of our model is the existence and management of experimentation. Firms experiment with young workers and, when the outcome of the experiment is not satisfactory, workers are dismissed and reallocated. This means that, measured in efficiency units, the supply of labor that is expected from a young worker is larger than 1 per period. Note that workers appropriate the returns of this experimentation. Indeed, according to equation 3 firms pay w^* for each efficiency unit that the worker will provide in expected terms.

The optimal long-run contract is the solution to the following optimization problem: choose (w_1, w_2, s) in order to maximize 1, subject to 3 and subject to the optimal private choice of savings.

Proposition 1 *The optimal contract involves full wage smoothing and efficient layoffs, i.e., $w_1 = w_2$, $q^c = 1$. Moreover, laid-off workers receive a positive severance pay, $s > 0$.*

The proof can be found in the Appendix.¹⁶ These results are easy to interpret. The value of an efficiency unit of labor is w^* , which is the wage old workers are offered. Competition implies that young workers are offered contracts that remunerate their expected supply of labor at this rate. Thus, young workers receive the expected value of experimentation rents, which evaluated in second period terms equals $[1 - H(q^c)] [E(q|q \geq q^c) - 1] w^*$. given imperfections in capital markets, workers strictly prefer contracts with smooth labor income, which implies that expected second period labor

¹⁶Note that ex-post efficiency implies that the equilibrium contract is renegotiation-proof.

income, $H(q^c)(w^* + s) + [1 - H(q^c)]w_2$, is above w^* . If $s = 0$, then $w_2 > w^*$, which implies inefficient layoff decisions (equation 2). Therefore, efficient separations require a positive severance payment. In fact, the severance payment is equal to the per period expected gains from experimentation:

$$s = \frac{\gamma}{(1 + \gamma)} \frac{1}{2} [E(q|q \geq 1) - 1] w^*.$$

A consequence of efficiency and equation (2) is the following result.

Remark 1: The optimal contract provides full insurance (in spite of universal risk neutrality) in the sense that the workers' second period income is constant across states of nature: $w^* + s = w_2$.

In this model, ex-post efficiency and insurance go hand in hand. This demonstrates that the role of severance payments in this model is completely orthogonal to the risk sharing motive in implicit contract theory.

Workers' consumption smoothing is attained in this model through the most efficient channel, which is the contract with the employer. If the capital market were perfect, this would not be the only way to attain the same goal.

Remark 2 : Under perfect capital markets ($\gamma = \underline{\beta} = \bar{\beta}$) the contract characterized in Proposition 1 is still optimal. However, it is not the only one. In particular, there is a contract with zero severance payments and a decreasing wage sequence that is also optimal. If $\underline{\beta} < \gamma = \bar{\beta}$, there are also multiple solutions but in all of them $s > 0$.

See Appendix. Note that the result in Proposition 1 does not hinge on ruling out bonding (increasing wage sequences). Contracts with positive severance payments are strictly better than contracts with zero severance payments if workers dislike decreasing wages. In other words, it is sufficient that workers face a small transaction cost when lending.

Some authors argue¹⁷ that severance payments cannot be included in private contracts because of enforceability problems or for other reasons. In our context, if severance payments are forbidden then under the equilibrium contract there are excessive layoffs and the wage sequence is increasing:

Remark 3 : Under the constraint that $s = 0$, the equilibrium contract is characterized by $w_1 < w_2$, $q^c > 1$.

¹⁷See, for instance, Bertola (2002) and Pissarides (2001).

We can now close the analysis of the model. Since w^* is the price of one efficiency unit of labor, the demand for labor is the result of static profit maximization and is characterized by the familiar condition:

$$f'(L^d) = w^*. \quad (4)$$

In a stationary equilibrium it must be the case that:

$$L^d = N + [1 - H(q^c)] N E(q|q \geq q^c) + L^o.$$

The right hand side is the sum of three terms. The first is the efficiency units of labor supplied by young workers (each one supplies on average one unit). A proportion $1 - H(q^c)$ of the young workers hired last period will be retained, and each one supplies $E(q|q \geq q^c)$ units of labor in expectation. Thus, the second term are the units supplied by retained old workers. Firms also hire L^o workers from the market for old workers. In a stationary equilibrium the representative firm sets $L^o = H(q^c) L$; that is, the number of old workers hired must be equal to those young workers laid off in the previous period. Therefore, we have:

$$N \left\{ 1 + \int_{q^c} q dH(q) + H(q^c) \right\} = L^d. \quad (5)$$

Finally, combining 4 and 5 we have that w^* is a non monotonic function of q^c , decreasing if $q^c < 1$ and increasing otherwise (w^* reaches a minimum at $q^c = 1$).

This closes the model. Summarizing, under long-run commitment the market delivers full efficiency, both ex-ante (full employment of young workers) and ex-post (the reallocation of workers is also efficient). Moreover, workers enjoy the right temporal consumption profile. As a result, there is no room for efficiency-motivated public intervention.

4.2 A few remarks on robustness

The model we have just discussed is a very stylized one. We next comment on how some of the assumptions can be relaxed without major consequences. First, the assumption that workers live for two periods is convenient but by no means essential.

Remark 4: All the main insights of Proposition 1 extend very easily to the case of workers who live for T periods, $T \geq 2$, and there is uncertainty

about the timing of the realization of q . In such a case, severance payments increase with seniority and are always positive.

See Appendix. The value of a worker increases with the number of remaining periods of her active life. Since the value of experimentation is transferred to the worker, the utility of a new employment decreases with age. As a result the efficient cut-off point, q^c , decreases over time. A contract can still achieve both allocation efficiency and wage smoothing (as well as full insurance), by stipulating a sequence of severance payments that increases over time.

Second, we have assumed that only the firm learns the quality of the match and that workers' outside opportunities are certain. If we relax either of these features, and we do not expand contracting possibilities (in particular, if we do not allow penalties on quits) then it is not possible to achieve efficient separations. However, the qualitative characteristics of the equilibrium contract remain roughly unchanged, even under perfect capital markets.¹⁸ In order to illustrate this point in the appendix we analyze the case where the outside wage that a particular worker can obtain after separation is λw^* , and λ is random. We show that in this case, the optimal contract involves a positive severance payment:¹⁹

Remark 5 : Under perfect capital markets and uncertainty concerning the outside wage that a particular individual can achieve in the second period the optimal contract involves $s > 0$.

Finally, we could also consider the case that q 's are positively correlated across firms, in which case layoffs convey a stigma for the worker. It turns out that it is important whether contracts are or are not observable to outside firms. If they are observable then laid-off workers experience a utility loss (see Burguet, Caminal and Matutes, 2002), but the other features of the optimal contract remain unchanged. If contracts are unobservable then separations are excessively infrequent ($q^c < 1$) which reinforces the role of severance payments.²⁰

¹⁸The case of imperfect capital markets is slightly more complicated analytically, since in that case there is a trade-off between ex-post efficiency and consumption smoothing.

¹⁹This shows that the main result in Booth and Chatterji (1989) is driven by the uncertainty concerning the worker's outside opportunity cost and not by the sharing of firm specific human capital investment.

²⁰On the other hand, if firms can compete for retained workers then second period wages must be very high in order to discourage quits, which would tend to raise q^c above one.

5 Contracting under limited commitment power

In the real world explicit contracts typically exclude wages beyond a relatively short horizon (two or three years at most). However, firms may be able to develop various alternative commitment devices, like wage setting rules or promotion systems, based essentially on reputation. In this section we consider the extreme case that parties cannot ex-ante commit to future wages. If contracts for young workers can not include w_2 then at the beginning of the second period parties are in a bargaining situation (under asymmetric information). In particular, this bargaining is about how to share the possible difference between the productivity of the worker at the firm and the expected productivity elsewhere ($qw^* - w^*$).²¹ Different bargaining procedures result in different outcomes. Next we analyze an extreme, simple case, where the worker (the uninformed party) makes a take-it-or-leave-it offer to the firm (the informed party). Later in this section, we will discuss alternative procedures. The important point at this stage is that the results we are about to present are generic in a qualitative sense.

5.1 A simple bargaining model

Thus, assume that firm and worker can contract on (w_1, s) , i.e., the wage for the current period and the severance payment that would apply at the end of it in the case of separation.²² At the end of the first period, after the firm learns the realization of q , the worker proposes a take-it-or-leave-it second period wage, w_2 . If the firm does not accept, then the worker leaves the job after collecting the severance payment, s . The firm's acceptance rule is the usual one: accept if and only if $q \geq q^c$, where q^c is given by equation 2. Taking this decision rule into account, the worker chooses w_2 in order to maximize the expected second period consumption,

²¹Thus, our model has nothing to do with the existence of market power in the labor market, which is typically associated to unions and the structure of collective bargaining. Union-firm bargaining tends to create a gap between the marginal product of labor and the workers' reservation wage. As a result, severance payments may also help to improve the efficiency of employment decisions. See Booth (1995).

²²Under bargaining there is no distinction between quits and layoffs: separations occur when parties do not reach an agreement.

$$c_2 = H(q^c)(s + w^*) + [1 - H(q^c)]w_2. \quad (6)$$

The first order condition of this maximization problem characterizes the equilibrium value of q^c , and can be written as

$$q^c - \Psi(q^c) = 1. \quad (7)$$

Since $\Psi(q^c) > 0$, the cutoff point is above the efficient level (excessive layoffs), and is independent of w^* and s . The reason is that workers will attempt to obtain from the firm a wage over and above their reservation value ($w^* + s$). And this implies that $q^c > 1$.

Let us now turn to the beginning of the relationship, when firms and young workers sign contracts (w_1, s) . Since the market is Walrasian there is full employment. However, workers are inefficiently allocated ex-post, and hence the gains from experimentation are lower than in the case of complete contracts. Thus, an equilibrium is a vector of values for (q^c, L^d, w^*) , an expected bargained wage w_2 , and a contract (w_1, s) that satisfy equations 2, 3, 4, 5, and 7 together with the consumption smoothing condition:

$$u'(w_1) = u'(H(q^c)(s + w^*) + [1 - H(q^c)]w_2). \quad (8)$$

This equilibrium satisfies the following proposition.

Proposition 2 *If contracts can only stipulate (w_1, s) then separations occur with an inefficiently high probability, $q^c > 1$, and as a result employment (in efficiency units) and output are lower than in the case of full commitment.*

When workers bargain with firms they take as their fall-back option whatever they obtain if these negotiations break down: $w^* + s$. Workers have incentives to set a wage, w_2 , above their fall-back option. From equation 2 this implies that separations are inefficient (too frequent) and, as a result, experimentation rents are lower.

The non contractibility of w_2 affects the equilibrium value of s through different channels. On the one hand, for a given w^* , when parties cannot commit to future wages s is lower than under full commitment. The reason is that s is both an instrument for transferring experimentation rents to the worker (part of her compensation package) and also the fall-back option in the second period bargaining. If w_2 cannot be contracted upon,

experimentation rents are lower which calls for a reduction in the worker's compensation. Also, consumption smoothing requires a moderate w_2 , which can only be obtained by reducing the worker's fall-back option (lower s). On the other hand, less efficient separations induce lower supply of labor in efficiency units, which raises the short term wage, w^* , and increases the total compensation of a young worker (higher s). Obviously, if the demand for labor is sufficiently elastic the first effect dominates and the level of s is lower under limited commitment.

Here we are assuming that the worker enjoys all the bargaining power in the negotiation (except the information advantage held by the firm). Note, however, that a sufficient condition for the inefficiency that drives the results is that the worker appropriates *some* of the surplus when this negotiation is successful, i.e., that $w_2 > w^* + s$.²³ Also, note that a higher s raises the reservation value for the worker and reduces the reservation value for the firm by the same amount, while leaving the surplus over which the parties bargain unaffected. Thus, w_2 increases with s on a one-to-one basis, and hence s cannot affect q^c .²⁴

With long-run contracts, workers and firms agree on strictly positive severance payments. Indeed, in the absence of severance payments, and if the contract implemented the efficient allocation, $q^c = 1$, second period wages w_2 would be equal to w^* . That would mean that the rents from experimentation would not translate into workers' consumption when old. This would go against consumption smoothing, and therefore could not be an equilibrium outcome. With short-run contracts the situation is different. Now, retained workers obtain a wage above w^* even in the absence of severance payments, and then their second period expected revenue already include rents from experimentation. In fact, equilibrium may call for *negative* severance payments.

Remark 6: If only non negative severance payments are allowed, then for some distribution functions of q this restriction is binding and hence in equilibrium we have that $s = 0$.

²³This is independent of the bargaining procedure, and is a corollary of the famous theorem by Myerson and Satterthwaite (1983). See below.

²⁴This is so because we are assuming that the firm's layoff cost is a pure transfer. If severance payments involve transaction costs (for instance, costs of litigation), then higher s would result in lower q^c . In this case, the main insight of this paper is still valid but the argument becomes more complicated.

See the Appendix. In these cases, consumption smoothing cannot be attained by adjusting the pattern of wages, $w_1 < w_2$. Thus, workers would have to rely on borrowing in the less efficient capital market, if they want to flatten their consumption pattern.

Finally, if severance payments are not contractible ($s = 0$), then if our previous equilibrium implied positive severance payments, workers will have to resort to saving, $w_1 > w_2$, if they still want to flatten their consumption pattern.

Remark 7: If workers borrow or save through the capital market, either because severance payments are non contractible or because the non negativity constraint is binding, separations would still occur too often.

5.2 Discussion: alternative bargaining models

As we mentioned above, the extreme model of ex-post bargaining that we have just analyzed is not the only possible. For instance, we may consider the polar case, where it is the firm that, after learning the value of q , makes a take-it-or-leave-it, second-period wage offer to the worker, w_2 . If the worker does not accept then she quits and takes the severance payment, s . In this case, the firm can retain the worker by matching what she can earn with alternative employers, $w^* + s$. The firm indeed prefers to make this offer to the worker instead of firing her and, for instance, hiring old workers, if the realization of q is such that $qw^* + s \geq w_2 = w^* + s$. Thus, the firing decision is efficient: the firm will fire the worker if $q < q^c = 1$, and will retain the worker otherwise.

Given this anticipated outcome, firms and workers will contract a wage and a severance payment, (w_1, s) , equal to those stipulated in the long-run equilibrium contract of the previous section. Therefore, ex-ante commitment power is redundant if the ex-post market power is monopolized by the firm. short-run contracts provide the right amount of employment protection in this case.

This extreme case is, however, special, as we have argued above. What makes it special is the fact that ex-post all the surplus is captured by the firm. Myerson and Satterthwaite (1983) have proved that under two-sided private information, whenever it is not common knowledge that the gains from trade are positive, and without payments from or to third parties, bargaining results in too little trade with positive probability no matter

what bargaining mechanism is used. Here we are considering a problem of one-sided private information, and therefore Myerson-Satterthwaite's result does not immediately apply. A simple perturbation allowing the worker some private information (for instance, on outside opportunities) would restore this result. Moreover, and more importantly for our model, it is a simple exercise to show that, without the need for any perturbation, the result is still true whenever the mechanism used is such that ex-post the informed party (the firm) does not gain all the surplus with probability one. That is, whenever bargaining takes place in any fashion other than the extreme version that we have just discussed. In any other case, the outcome of bargaining is too much firing, and then severance payments are too low relative to w_2 as to provide the right amount of employment protection.

Note that we are always assuming that bargaining takes place between the firm and a single worker and that there is no friction other than the ex-post information asymmetry. Thus, the inefficiency only comes from asymmetric information, and is completely unrelated to other common frictions like search costs or union power.

5.3 Optimal public intervention under limited commitment power

The previous subsections have shown that, in the absence of commitment to long-run wages, layoffs are excessively frequent (there is too little employment protection). This opens the question of whether public intervention can enhance welfare. The origin of the inefficiency is the inability of parties to set the future terms of trade, therefore having to resort to bargaining when their information will be asymmetric. Inefficiencies will then be unavoidable if they cannot make payments or receive them from third parties. This is where a public authority can make a difference by means of a Pigouvian tax/subsidy scheme.

Consider a combination of a tax on layoffs, τ , and a subsidy to employment, σ . We require that the scheme balances the budget. The firm's firing decision should now consider the extra cost that the tax represents. Then, the firm will lay the worker off if and only if $q < q^c$, where

$$q^c = \frac{w_2 - (\tau + s)}{w^*} \tag{9}$$

The worker's ex-post problem is not affected, although the worker now takes this new layoff decision rule into account. Thus, substituting this rule into the first order condition for the optimal offer, w_2 , we have:

$$q^c - \Psi(q^c) = 1 - \frac{\tau}{w^*} \quad (10)$$

Note that, since we are assuming that the inverse of the hazard rate, $\Psi(q^c)$, is a monotonically decreasing function, then for given w^* , q^c is decreasing in τ . The arbitrage condition 3 becomes:

$$w^* = \frac{w_1 - \sigma + \gamma \{H(q^c)(s + \tau) + [1 - H(q^c)]w_2\}}{1 + \gamma \int_{q^c} q dH(q)} \quad (11)$$

Finally, the balanced budget condition is $\sigma = -H(q^c)\gamma\tau$.

Suppose that τ is such that $q^c = 1$, for the value of w^* that prevailed under long-run contracts (Section 4). Anticipating this wage, and given this tax, firms and workers anticipate that indeed $q^c = 1$. The next proposition shows that consumption smoothing will be achieved with short-term contracts, and then both productive efficiency and the expected consumption for the worker will mimic those obtained with long-term contracts.

Proposition 3 *Under one-period contracts, and if the worker sets the second period wage, then there exists a tax/subsidy scheme that implements the first best, i.e. eliminates inefficient layoffs, without distorting workers' intertemporal allocation of consumption, and hence increases welfare.*

See Appendix. The result in Proposition 3 assumes no constraint on the sign of s . If negative severance payments are not allowed (and such a constraint is binding), and in equilibrium $w_1 < w_2$, a tax/subsidy scheme can still restore ex-post efficiency, but makes it more costly for workers to smooth their consumption. Thus,

Remark 8: If $s \geq 0$ is binding and workers borrow in equilibrium without intervention, then the proposed tax/subsidy scheme cannot implement the first best, but a sufficiently small tax/subsidy still improves welfare.²⁵

²⁵There is still a third possibility, which is that $s = 0$, but workers do not borrow in equilibrium. That is, workers would like to borrow *through the firm*, but are not willing to borrow in the more expensive capital market. In this case, even a low tax rate has first order effects both on efficiency and consumption smoothing, and then the net welfare effect of this intervention has an ambiguous sign.

See Appendix.²⁶ A tax raises w_2 (the worker faces a lower probability of being laid off for a given wage), and a subsidy raises w_1 . Consumption smoothing then calls for a lower s . If this is not possible then there is a trade-off between productive efficiency and consumption smoothing. If the tax is such that $q^c = 1$ then the expected consumption in the second period is too high and consumption in the first period is too low. However, if workers are smoothing their consumption (imperfectly) by borrowing in the capital market, a small tax/subsidy will have a second order effect on consumption smoothing and a first order effect on efficiency. This explains the unambiguous remark above.²⁷

In most European countries the typical instrument for employment protection consists of mandating a minimum level of severance payments. However,

Remark 9: In the model in this section mandatory severance payments cannot improve welfare.

In the absence of transaction costs, a binding, minimum level of severance payments cannot affect firms' layoff decisions and hence can only make things worse, i.e., raise second period wage at the cost of a lower first period wage (distort the workers' consumption profile). This results in lower utility for the worker, with no effect on the level of employment (measured in efficiency units).²⁸

6 Concluding remarks

When the quality of the matches between workers and their employers is uncertain and is only revealed through experience, labor contracts have to address the problem of how to share the resulting experimentation rents. This is the issue analyzed in this paper, under the assumption that the

²⁶If negative values of s are not feasible, and such a constraint is binding, then in the optimal policy the worker must pay some share of the tax on separations. This may look implausible. In order to analyze this issue rigorously we need to explicitly model the reasons behind restricting to non-negative severance payments.

²⁷Again, more efficiency does not have to translate into a higher wage bill. If workers' welfare is the goal, this labor market intervention may need a complementary, more standard redistributive public intervention.

²⁸In fact, if we assumed an elastic supply of labor, this lower utility of workers would translate into lower level on employment.

employer has an advantage in observing the quality of the match, but competes with other firms to attract new workers. In this context, contracts should pursue possibly conflicting goals. One of these goals is to provide the right incentives for workers' reallocation (dismissals). The second one is to provide an adequate labor income profile, when workers have a preference for consumption smoothing and capital markets are less than perfect. We have shown how these two goals are made compatible by long-run contracts that stipulate positive severance payments.

When long-run contracts are not feasible, however, and future wages cannot be committed to, the two goals are no longer compatible. Then, the ensuing need for bargaining under incomplete information will result in excessive dismissals (too little employment protection). Equilibrium contracts may still include positive severance payments, but nevertheless labor relations will break too often.

This inefficiency result is due to a friction, information asymmetry, which does not cause any non-pecuniary externality. Therefore, a public intervention that limits itself to restricting the set of feasible contracts cannot improve efficiency. Thus, mandatory severance payments, which simply put a floor to the terms of contracts that employers and employees can sign, do not remedy this inefficiency.

Yet, a more active public policy may do the job. The ex-post allocation inefficiency in which the two parties are locked in as a consequence of bargaining under asymmetric information may be corrected only by the intervention of a third party. In our case, a form that this intervention may take is the introduction of taxes on dismissals, coupled with subsidies for new hires.

Thus, our paper can also contribute to the debate on the desirability of experience rated unemployment insurance.²⁹ In the US the firm's contribution to the unemployment insurance fund depends on the number of workers who claimed unemployment benefits after being laid off by the firm. Thus, such a scheme works as a tax on layoffs. According to our theory, experience rated unemployment insurance is a superior device for discouraging layoffs than the standard European EPL.

²⁹Fuest and Huber (2003) and Fath and Fuest (2002) provide different arguments in favor and against experience rated unemployment insurance and review the existing literature.

7 References

Alvarez, F. and M. Veracierto (2001), Severance payments in an economy with frictions, *Journal of Monetary Economics* 47, 477-498.

Arnott, R. A. Hosios, and J. Stiglitz. (1988), Implicit Contracts, Labor Mobility, and Unemployment, *American Economic Review* 78(5), 1046-66.

Bentolila, S. and G. Bertola (1990), Firing costs and labour demand: How bad is eurosclerosis. *Review of Economic Studies* 57, 381-402.

Bertola, G. (2002), A pure theory of job security and labour income risk, CEPR discussion paper No. 3430.

Booth, A. (1995), Layoffs with Payoffs: A Bargaining Model of Union Wage and Severance Pay Determination, *Economica* 62, 551-564

Booth, A. (1987), Extra-statutory Redundancy Payments In Britain, *British Journal of Industrial Relations*, 25, pp 401-418.

Booth, A. and M.Chatterji (1989), Redundancy Payments and Firm-specific Training, *Economica* 56, 505-521.

Burguet, R., R. Caminal and C. Matutes (2002), Golden cages for showy birds: Optimal switching costs in labor contracts, *European Economic Review* 46, 1153-85.

Chiang, S. H. (1991), Redundancy Payments and Firm-specific Training: A Comment, *Economica* 58, 257-259.

Epstein, L. and S. Zin (1989), Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework, *Econometrica* 57, 937-969.

Fath, J. and C. Fuest (2002), Experience Rating versus Employment Protection Laws in a Model where Firms Monitor Workers, mimeo University of Cologne.

Fella, G. (2000), Efficiency wage and efficient redundancy pay, *European Economic Review* 44 (8), 1473-1490.

Fuest, C. and B. Huber (2003), Is experience rated unemployment insurance bad for employment in the presence of asymmetric shocks? the role of decentralisation, mimeo University of Cologne.

Galdón-Sánchez, J. and M. Güell (2003), Dismissal conflicts and unemployment, *European Economic Review* 47, 323-335.

Garibaldi, P. and G. Violante (2002), Firing Tax and Severance Payment in Search Economies: A comparison, CEPR discussion paper #3636.

Grossman, S. and O. Hart (1981), Implicit Contracts, Moral Hazard and Unemployment, *American Economic Review* 71, 301-07.

Hashimoto, M. (1981), Firm-specific human capital as a shared investment, *American Economic Review* 71, 475-82.

Kahn, Ch. (1985), Optimal Severance Pay with Incomplete Information, *Journal of Political Economy* 93, 435-51.

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

Ljungqvist, L. (2002), How Do Layoff Costs Affect Unemployment?, *Economic Journal*.

Lorences, J. Fernandez, V., and C. Rodriguez (1995), Diferencias interterritoriales de salarios y negociación colectiva en España, *Investigaciones Económicas* 19 (2), 309-324.

Nagypál, E. (2002), The cost of employment protection in the presence of match-specific learning, mimeo Northwestern University.

Nagypál, E. (2000); Learning-by-Doing versus Learning about Match Quality: Can We Tell Them Apart? mimeo.

OECD (1999), *OECD Employment Outlook*. Paris: OECD.

Pencavel, J. (1991), *Labour Markets under Trade Unionism*, Oxford: Basil Blackwell.

Pissarides, Ch. (2001), Employment protection, *Labour Economics* 8, 131-159.

Saint Paul, G. (1996), Exploring the political economy of labour market institutions, *Economic Policy* 23, 263-315.

Saint Paul, G. (1995), Efficiency Wage, Commitment, and Hysteresis, *Annales d'Economie et de Statistique* 37/38, 39-53.

8 Appendix

8.1 Proof of Proposition 1

Given (w_1, w_2, s) a young worker chooses the optimal level of savings, b , in order to maximize:

$$U = u(c_1) + \gamma u\{H(q^c) \underline{c}_2 + [1 - H(q^c)] \bar{c}_2\}$$

where:

$$c_1 = w_1 - b$$

$$c_2 = w^* + s + \frac{b}{\beta}$$

$$\bar{c}_2 = w_2 + \frac{b}{\beta}$$

where $\beta = \underline{\beta}$ if $b < 0$, and $\beta = \bar{\beta}$ if $b > 0$. From the first order condition, if $b \neq 0$ (c_2 stands for expected second period consumption):

$$u'(c_1) = \frac{\gamma}{\beta} u'(c_2) \quad (12)$$

The optimal contract consists of choosing (w_1, w_2, s) in order to maximize 1 subject to 3. Suppose $b \neq 0$, then by the envelop theorem and if we denote the worker's utility under optimal saving by U^* , the first order conditions are (using 12):

$$\frac{\partial U^*}{\partial w_2} = \gamma u'(c_2) \left\{ [1 - H(q^c)] \left(1 - \frac{\gamma}{\beta}\right) + \frac{h(q^c)}{w^*} (w^* + s - w_2) \right\} = 0 \quad (13)$$

$$\frac{\partial U^*}{\partial s} = \gamma u'(c_2) \left\{ H(q^c) \left(1 - \frac{\gamma}{\beta}\right) - \frac{h(q^c)}{w^*} (w^* + s - w_2) \right\} = 0 \quad (14)$$

Note that $1 - \frac{\gamma}{\beta} \neq 0$. Hence, these two first order conditions cannot hold simultaneously. It must be the case that under the optimal contract $b = 0$. In this case the optimal contract consists of choosing (w_1, w_2, s) in order to maximize:

$$U = u(w_1) + \gamma u \{ H(q^c) (w^* + s) + [1 - H(q^c)] w_2 \}$$

subject to 3. From the first order condition, we obtain that $w_1 = w_2 = w^* + s$, which implies that $q^c = 1$ (Ex-post efficiency).

Finally, using $w_1 = w_2 = w^* + s$ in 3, it can be seen immediately that $s > 0$.

8.2 Proof of Remark 2

If $\bar{\beta} = \underline{\beta} = \gamma$ then the first order conditions 13 and 14 hold and both imply that $w_2 = w^* + s$, but no further restriction is placed on the optimal contract. As a result there is a continuum of solutions. Using 3, it can be confirmed that these solutions include $w_1 = w_2$, $s > 0$, and $w_1 > w_2$, $s = 0$.

8.3 Proof of Remark 4

Let us prove Remark 4 for the case $T = 3$. The same method can be applied for any value of T .

Suppose that q is revealed at the end of any period with probability μ , $0 < \mu < 1$. If q is revealed at the end of $t = 2$, then as in the text the ex-post efficient separation rule at the beginning of $t = 3$ is $q_3^c = 1$. Under ex-post efficiency, the expected present value of efficiency units that a worker delivers if she takes a new job at the beginning of $t = 2$ is given by:

$$Q_2 \equiv 1 + \gamma + \gamma \frac{\mu}{2} [E(q|q \geq 1) - 1]$$

Note that $Q_2 > 1 + \gamma$. The optimal separation rule at the beginning of $t = 2$ if q has been revealed is:

$$q_2^c = \frac{Q_2}{1 + \gamma}$$

Hence, $q_2^c > 1$. Under ex-post efficiency, the expected present value of efficiency units that a worker delivers if she takes a new job at the beginning of $t = 1$ is given by:

$$Q_1 \equiv 1 + \gamma Q_2 + \gamma(1 + \gamma)\mu [1 - H(q_2^c)] [E(q|q \geq q_2^c) - q_2^c]$$

Note that $Q_1 > 1 + \gamma + \gamma^2$. As in Proposition 1 equilibrium contracts can achieve both ex-post efficiency and wage smoothing (and full insurance). By w_n^* let us denote the (constant) wage in a contract for n remaining periods, $n = 1, 2, 3$. Thus, a three-period contract specifies (w_3^*, s_2, s_3) , where s_t is the severance payment that the worker obtains if laid off at the beginning of period t , $t = 2, 3$. In order to implement ex-post efficiency it must be the case that:

$$q_3^c = \frac{w_3^* - s_3}{w_1^*} = 1$$

$$q_2^c = \frac{w_3^*}{w_1^*} - \frac{s_2}{(1 + \gamma) w_1^*}$$

In equilibrium firms must be indifferent between hiring workers in the third period of their lives and those in their first period. This arbitrage condition can be written as:

$$w_1^* = \frac{(1 + \gamma + \gamma^2) w_3^*}{Q_1}$$

Let us first show that $s_3 > s_2$. From the cutoff points, we have that:

$$\frac{s_3 - s_2}{w_1^*} = Q_2 - \frac{\gamma Q_1}{1 + \gamma + \gamma^2}$$

Using the definitions of Q_1 and Q_2 and manipulating:

$$sg \{s_3 - s_2\} = sg \{[E(q|q \geq 1) - 1] - [E(q|q \geq q_2^c) - q_2^c]\}$$

Thus, the sign of $\{s_3 - s_2\}$ is positive if $\Omega'(x) < 1$, where

$$\Omega(x) \equiv E(q|q \geq x)$$

Let us check the later condition:

$$\Omega'(x) = \frac{\Omega(x) - x}{\Psi(x)} > 0$$

$$\Omega''(x) = \frac{[\Omega'(x) - 1] \Psi(x) - \Psi'(x) [\Omega(x) - x]}{\Psi(x)^2} > 0$$

Thus, the function $\Omega(x)$ is convex because the inverse of the likelihood ratio has been assumed to be negative. As a result, $\Omega'(x)$ will attain its maximum at $x = 2$. Applying l'Hôpital's rule:

$$\lim_{x \rightarrow 2} \Omega'(x) = \frac{1}{2}$$

Therefore, $\Omega'(x) < 1$. Next, let us show that $s_2 > 0$. From the equation associated with the implementation of the optimal q_2^c , we have that:

$$\frac{s_2}{(1 + \gamma) w_1^*} = \frac{Q_1}{1 + \gamma + \gamma^2} - \frac{Q_2}{1 + \gamma}$$

Note that Q_1 is higher than when learning takes place only at the end of the first period in a new job and that the separation rule when learning takes place is $q^c = 1$. Hence,

$$\frac{Q_1}{1 + \gamma + \gamma^2} > 1 + \frac{\gamma(1 + \gamma)\mu}{2(1 + \gamma + \gamma^2)} [E(q|q \geq 1) - 1] > 1 + \frac{\gamma\mu}{2(1 + \gamma)} [E(q|q \geq 1) - 1] = \frac{Q_2}{1 + \gamma}$$

8.4 Proof of Remark 5

Assume that $\bar{\beta} = \underline{\beta} = \gamma$ and that each individual worker in the second period will have access to a wage equal to λw^* , where λ is distributed over $[1 - \bar{\lambda}, 1 + \bar{\lambda}]$ according to $G(\lambda)$, $E(\lambda) = 1$. Ex-post efficiency requires that the worker be retained if and only if $q \geq \lambda$. The firm fires the worker if and only if $q < q^c$, where:

$$q^c = \frac{w_2 - \frac{s}{G(\lambda^c)}}{w^*}.$$

The worker quits if and only if $\lambda > \lambda^c$, where $\lambda^c = \frac{w_2}{w^*}$.

The arbitrage condition can be written as:

$$w^* \left[1 + \gamma G(\lambda^c) \int_{q^c} q dH(q) \right] = w_1 + \gamma G(\lambda^c) [1 - H(q^c)] w_2 + H(q^c) s$$

Since capital markets are perfect the worker only cares about the expected present value of her income:

$$U = w_1 + \gamma G(\lambda^c) [1 - H(q^c)] w_2 + \gamma H(q^c) (s + w^*) + \gamma [1 - H(q^c)] \int_{\lambda^c} \lambda w^* dG(\lambda)$$

Using the arbitrage condition we can rewrite the worker's utility:

$$U = w^* \left[1 + \gamma G(\lambda^c) \int_{q^c} q dH(q) \right] + \gamma H(q^c) w^* + \gamma [1 - H(q^c)] \int_{\lambda^c} \lambda w^* dG(\lambda)$$

The first order conditions fully characterizes (λ^c, q^c) from where (w_2, s) can be recovered:

$$\lambda^c = E(q|q \geq q^c) \tag{15}$$

$$G(\lambda^c) q^c + \int_{\lambda^c} \lambda dG(\lambda) = 1$$

Condition 15 is satisfied if and only if $\lambda^c > q^c$, which implies that $s > 0$.

8.5 Proof of Remark 6

Equations 2, 3 and 8 determine (w_1, s, w_2) for given values of (w^*, q^c) . Manipulating these equations it can be shown that $s < 0$ if and only if $\eta(q^c) < 0$, where $\eta(q^c)$ is given by:

$$\eta(q^c) \equiv 1 + \gamma \int_{q^c} q dH(q) - H(q^c) - (1 + \gamma) [1 - H(q^c)] q^c$$

In the case that q is uniformly distributed, then according to equation 7, we have that $q^c = \frac{3}{4}$, and $\eta = -\frac{5}{8}$.

8.6 Proof of Remark 7

Workers make their w_2 offers to maximize 6, whether s is positive or not, and whether they borrow or save. On the other hand, firms' firing decisions still satisfy 2. Thus, 7 still describes the equilibrium firing decisions.

8.7 Proof of Proposition 3

Let \hat{w}^* be the spot market wage in the full commitment contract equilibrium of the previous section. Also, for this value of the spot market wage, let τ solve 10 for $q^c = 1$. That is, $\tau = \hat{w}^* \Psi(1)$. For this tax rate and if agents expect \hat{w}^* to be the spot market wage, then they will agree on a contract (w_1, s) such that $w_1 = \hat{w}_1$ and $s = \hat{s} - \frac{\tau}{2}$, where \hat{w}_1 and \hat{s} are the long-run

equilibrium values of the first period wage and the severance payment of the previous section. We can confirm that given \hat{w}^*, τ , and s , the optimal take-it-or-leave-it offer for the worker is $w_2 = \hat{w}_2 + \frac{\tau}{2}$, where again \hat{w}_2 refers to the long-run equilibrium value of w_2 . The response of the firm is to retain the worker if $q \geq 1$. Finally, expecting this decision and this spot market wage, (s, w_1) solves the arbitrage condition of the firm and the maximization of the worker's utility with no savings and consumption smoothing. This solution implies the same expected consumption per period as the long-run equilibrium contract. QED.

8.8 Proof of Remark 8

Assume that the solution to 2, 3, 4, 5, 7, and 8 gives $s < 0$, and this is not feasible. Also assume that when setting $s = 0$, equations 2, 3, 4, 5, 7 still hold but we have that $b > 0$, where b satisfies:

$$u'(w_1 - b) = \frac{\gamma}{\beta} \left\{ [1 - H(q^c)] w_2 + H(q^c) w^* + \frac{b}{\beta} \right\}$$

That is, the non negativity condition on s is binding (workers would prefer negative severance payments) but imperfections in the capital market are not too great, so that workers use the less effective substitute which is borrowing (negative savings).

Note that from 9, $\frac{dq^c}{d\tau} < 0$. Also note that in the absence of public intervention $\frac{dq^c}{d\tau} > 1$. That is, an increase in τ and σ from their zero levels will induce higher efficiency in the use of labor (higher output in equilibrium). Workers are smoothing their consumption (at the rate given by $\frac{\gamma}{\beta}$), both before and after the policy change. Thus, total welfare unambiguously increase: there exists a monetary transfer from firms to workers that leave both workers and firms better off.

As an example of such transfer, consider the following. Each worker receives a subsidy of $\alpha \left\{ 1 + \gamma \int_{q^c} (q - q^c) dH(q) \right\}$ when young and a subsidy of $\alpha \left\{ H(q^c) + [1 - H(q^c)] q^c \right\}$ when old, where

$$\alpha = - \frac{dw^*}{dq^c} \frac{dq^c}{d\tau} \Big|_{\tau=0}.$$

That is, they are compensated in their wages for the loss they would have incurred from lower spot market wages, had the cut-off level q^c not changed.

With this complementary transfer, we compute the change in utility of the worker due to an increase in τ (and, correspondingly, σ) when $\tau = 0$. Using the envelope theorem, so that $\frac{\partial U}{\partial b} = 0^{30}$, this effect is:

$$\left. \frac{dU}{d\tau} \right|_{\tau=0} = \left(\left. \frac{dq^c}{d\tau} \right|_{\tau=0} \right) \left[u'(c_1) \frac{\partial c_1}{\partial q^c} + \gamma u'(c_2) \frac{\partial c_2}{\partial q^c} \right],$$

where $c_1 = w^* \left(1 + \gamma \int_{q^c} (q - q^c) dH(q) \right) - b$, and $c_2 = w^* (H(q^c) + [1 - H(q^c)] q^c) + \frac{b}{\beta}$. Taking derivatives, we obtain

$$\frac{\partial c_1}{\partial q^c} = -w^* \gamma [1 - H(q^c)] < 0,$$

and

$$\frac{\partial c_2}{\partial q^c} = -w^* (h(q^c)(q^c - 1) + [1 - H(q^c)]) = 0,$$

where this last equality follows from 10 at $\tau = 0$. Thus, since $\frac{dq^c}{d\tau} < 0$, we conclude that this transfer renders the effect on the utility of the worker positive. The transfer may be financed by a lump sum tax on firm's profits. Indeed, the net wage bill per worker (including the lump sum tax and the hiring/firing tax/subsidies) then increases by

$$\left(\frac{\partial (c_1 + b)}{\partial q^c} + \gamma \frac{\partial \left(c_2 - \frac{b}{\beta} \right)}{\partial q^c} \right) \left(\left. \frac{dq^c}{d\tau} \right|_{\tau=0} \right) = - \left(\left. \frac{dq^c}{d\tau} \right|_{\tau=0} \right) w^* \gamma [1 - H(q^c)],$$

which equals the increase in the value of efficiency units per worker obtained:

$$-w^* \left(\left. \frac{dq^c}{d\tau} \right|_{\tau=0} \right) \gamma h(q^c)(q^c - 1),$$

an equality that again follows from 10. QED

³⁰Here we use the fact that the savings/borrowing are non zero.