No. 2070

GOLDEN CAGES FOR SHOWY BIRDS: OPTIMAL SWITCHING COSTS IN LABOUR MARKETS

Roberto Burguet, Ramon Caminal
and Carmen Matutes

INDUSTRIAL ORGANIZATION AND LABOUR ECONOMICS

Centre for Economic Policy Research

ISSN 0265-8003

GOLDEN CAGES FOR SHOWY BIRDS: OPTIMAL SWITCHING COSTS IN LABOUR MARKETS

Roberto Burguet, Ramon Caminal and Carmen Matutes

Discussion Paper No. 2070
February 1999

Centre for Economic Policy Research
90–98 Goswell Rd
London EC1V 7RR
Tel: (44 171) 878 2900
Fax: (44 171) 878 2999
Email: cepr@cepr.org

CEPR Discussion Paper No. 2070

February 1999

ABSTRACT

Golden Cages for Showy Birds: Optimal Switching Costs in Labour Markets*

Why do some workers sign contracts with high quitting penalties? Are these restrictions on the workers' mobility perverse for efficiency or workers' welfare? We postulate an answer that hinges on the degree of observability of the worker's performance by alternative employers. When performance is privately observed by the employer, alternative employers then face an adverse selection problem when competing for the worker. In equilibrium, separations take the form of lay-offs with compensation to the worker with no role for quitting fees. If performance is quite public, however, this adverse selection problem is absent and buy-out fees serve to appropriate alternative employer's rents from the reallocation of the worker. In this case, efficiency is not affected. Bargaining power (both before and after signing the contract) determines whether buy-out fees are detrimental or not to the worker's welfare.

JEL Classification: J41, J44, L14, L42
Keywords: labour contracts, buy-out fees, severance payments

Roberto Burguet, Ramon Caminal and Carmen Matutes
Institut d'Análisi Econòmica (CSIC)
Campus UAB
08193 Bellaterra
Barcelona
SPAIN
Tel: (34 93) 580 6612
Fax: (34 93) 580 1452
Email: burguet@cc.uab.es
caminal@cc.uab.es
matutes@cc.uab.es

*The authors have benefited from discussions with Melvyn Coles and Gianni de Fraja. The usual caveat applies. They acknowledge financial support from DGICYT grants PB93–0679, PB95–0130–02, PB96–0897 and HCM contract CHRX–CT94–0489.

Submitted 21 December 1998

NON-TECHNICAL SUMMARY

Some types of workers voluntarily sign contracts that restrict their future mobility. The most spectacular examples can be found in particular industries like professional sports, film making or music recording. For instance, soccer players in Europe and baseball or basketball players in the United States sign contracts whereby both the team and the player agree not to breach the contract unilaterally. More specifically, the team can only get rid of the player by paying the full stream of committed wages and the player can only quit and move to a different team if the incumbent accepts a certain monetary compensation. Furthermore, separations occur only after bargaining over the quitting fee. Similarly, pop stars sign long-term contracts with record labels whereby they commit themselves not to perform for another company and actors sign contracts with movie studios so that, unless the incumbent agrees, the actor cannot play in a movie filmed by another studio. One may think that these contracts violate anti-slavery principles. In fact, the media often refers to these workers as 'golden slaves', given that they are typically very well paid, but their mobility is apparently highly restricted.

These examples are in sharp contrast to the standard asymmetric case, in which the worker is free to quit, but the firm is usually required to compensate the worker in the case of a lay-off. Our paper constructs a simple theoretical framework to answer three questions. First, how can we explain the observed heterogeneity of contracting features, particularly concerning quitting fees? In which segments of the labour market are explicit quitting costs more likely to be observed? Second, do quitting and firing costs interfere with the efficient allocation of workers? Third, what is the impact of quitting costs and anti-slavery laws on the distribution of surplus between firms and workers?

Our theory emphasizes the crucial role of the amount of information about the value of the worker that gets revealed to the market. In most cases, the incumbent firm obtains better information about the worker's performance than outsiders do and hence the worker's reallocation is affected by an adverse selection problem. In other words, a firm that succeeds in attracting a particular worker will realize that the worker's ability is likely to be below average, otherwise a well-informed incumbent would not let them go ('winner's curse'). Hence, *ex-post* competition is depressed. As a result, the optimal contract *ex ante* includes a compensation to the worker in the case of lay-offs but does not require quitting fees.

All the examples with explicit quitting costs mentioned above share very similar informational features, however: the performance of the worker is widely observed by outsiders. Hence, *ex-post* competition for the worker is likely to be vigorous and outsiders can potentially obtain positive rents by attracting those workers that fit their needs better. This implies that *ex ante* the pair worker-incumbent firm has incentives to include certain clauses in the contract that *ex post* will allow the incumbent firm to expropriate potential rents arising from reallocating the worker. *Ex ante* the worker will agree to give up their freedom to move. The argument why goes along the following lines. First, quitting fees do not interfere with the efficiency of the allocation, since the incumbent firm always has incentives to revise the fee down to induce the worker to quit every time they are more valuable somewhere else. Second, quitting fees increase the incumbent's profits and provided the worker has enough bargaining power at the contracting stage these larger profits will be translated into a higher stream of wages.

Thus, according to our theory, contracts with large explicit quitting penalties are more likely in those segments of the labour market where the performance of the worker is widely observed, and in contrast we would not expect them to prevail in markets where firms are very asymmetrically informed about the productivity of the worker. This is the answer to the first of the three questions posed above.

With respect to the second question, our results indicate that quitting and firing costs not only do not interfere with the efficient allocation of the worker, but also are sometimes a necessary condition for achieving efficiency.

Third, the distribution of surplus is essentially determined by the relative bargaining power at the contracting stage (the degree of competition in the market for contracts). In the extreme case that the worker enjoys all the bargaining power at the moment of signing the contract and for those workers whose performance is public, quitting fees increase their welfare. If workers enjoy very little market power at the contracting stage, however, quitting fees can be used by incumbent firms to extend their market power over time. In this case, the prohibition of quitting penalties, applying anti-slavery principles, can be justified on distributional grounds, since it would increase workers' welfare.

1. Introduction

Various types of switching costs are frequent in labor contracts. The most common of these switching costs is the severance payment incurred by the firm that chooses to lay the worker off.[1] Some types of workers who choose to quit, however, often incur costs as well. For instance, managers and other highly qualified workers may be unable to exercise stock options that were given as bonuses. Many types of workers are also entitled to seniority benefits (like pension funds) that they may partially or totally loose if they quit. More generally, any upward sloping wage profile involves implicit quitting costs.

Explicit restrictions on the worker's mobility can also be observed in some segments of the labor market. For instance, managers' contracts often stipulate that in the case of quitting, they cannot work for another firm in the industry for some period of time. Professional sports people, such as soccer players in Europe or baseball and basketball players in the US sign contracts whereby both the team and the player are in principle completely locked in for the duration of the contract. More specifically, the player can only quit and move to a different team if the incumbent accepts certain monetary compensation for letting the player go, and the team can only get rid of the player by paying the full stream of committed wages. Furthermore, separations often occur after bargaining over the quitting fee. Contracts with very large quitting fees are also prevalent in other segments of the labor market. For instance, pop stars sign long-term contracts with record labels whereby they commit themselves not to perform for another company; similarly, actors sign contracts with movie studios so that, unless the incumbent agrees, the actor cannot play in a movie filmed by another studio.

Thus, the nature and magnitude of switching costs varies considerably across types of workers. In one extreme, workers can freely quit but firms must pay a predetermined amount of money in case of layoffs. In the other extreme, both the worker and the firm are in principle completely locked in the relationship and hence separations only occur when both parties agree. The objective of this paper is to propose a theory of switching costs in labor contracts that stresses the importance of the quality of the information about the worker's productivity obtained by potential employers. Specifically, we address the following three questions. First, we study under which circumstances labor contracts are expected to include large severance payments and quitting penalties, and what role do

[1] In some countries there are mandatory firing costs, but very often private contracts and collective bargaining agreements include provisions which push the severance payment above the minimum legal level.

they play. Second, we investigate the interplay between the information structure and contracting features in determining whether separations take the form of voluntary quits or involuntary lay-offs. Third, we study how quitting and firing costs affect firm profitability and workers' welfare and uncover the implications of regulations preventing large and explicit penalties on quits, such as anti-slavery laws.

Undoubtedly, when a worker is first hired there is usually a lot of uncertainty about her quality. An important distinguishing feature among various types of workers is how much potential employers learn about her quality or characteristics once the worker has been hired and has started to work for the incumbent firm. It could be argued that, in most cases, the incumbent firm gets a signal of better quality than outside firms, although such a quality differential varies substantially across different segments of the labor market. We start by considering two extreme cases. We use the term "singular workers" to refer to those individuals whose performance becomes public, so that, after the worker has been employed for some time, all firms learn how valuable the worker is to all of them. By contrast, we term "common workers" those whose performance is the incumbent firm's private information. Thus, after some time, the incumbent firm learns the value of the worker to itself but no other firm is able to observe anything.

Thus, it could be argued that most workers are better represented by the "common worker" case, while some particular types (like movie actors, artists, and professional sports players) are closer to the "singular worker" characterization.

In our model, singular workers sign contracts with sufficiently high buy-out fees (that is, explicit monetary transfers from the worker to the firm when the worker quits) and severance payments (explicit monetary transfers from the firm to the worker when the firm lays the worker off). The reason is that high buy-out fees protect the pair worker-incumbent firm from ex-post competition**.** On the other hand, severance payments are meant to eliminate incentives to lay the worker off since this would increase the outsiders' rents. Despite these high switching costs the worker is actually relocated when there are gains from this move: when outsiders value the worker more than the incumbent firm, the latter finds it optimal to reduce the buy-out fee, induce the worker to quit and collect the gains generated by the reallocation.

Common workers sign contracts that involve a positive and relatively moderate severance payment, tailored to induce the firm to take the efficient layoff decision. In equilibrium workers do not (voluntarily) quit and thus separations take the form of involuntary layoffs. Indeed, the market for common workers is tainted with the adverse selection problem first pointed out by Akerlof (1970). Whenever a firm succeeds in attracting a worker away from a better informed incumbent it revises down its expectations about the worker's productivity ('winner's curse'), provided productivity is positively correlated across firms. Therefore, if the reallocation of the worker were to take place through voluntary quits, such an adverse selection problem would imply a tendency for workers to stay with their current employers more often than efficient. An appropriately set severance payment, on the other hand, can help reducing this inefficiency. Thus, in equilibrium all separations are initiated by the firm (layoffs) and are ex-post undesirable for the worker.

Thus, first, according to our model, contracts with large explicit quitting penalties are more likely in segments of the labor market where the performance of the worker is widely observed; in contrast we would not expect them to prevail in markets where the asymmetry of information across firms results in an adverse selection problem. And second, accordingly, we should expect quits as opposed to lay offs when the market is transparent, while lay offs should be expected when ex-post asymmetric information is important and a 'lemons problem' likely to arise. Such predictions seem to fit quite well the examples mentioned above.

These two results are quite robust. Specifically, they are robust to the distribution of market power, both ex-ante (at the contracting stage) and ex-post (at the reallocation stage). However, market power is obviously crucial to explain the distribution of surplus. In our baseline model firms compete head-to-head for the worker at the contracting stage and contracts are designed in such a way that the worker is efficiently allocated. Thus, the answer to the third question posed above is that ex-ante competition allows the worker to appropriate all potential surplus. In particular, singular workers considerably benefit from giving up the right to move away. Switching costs do not interfere with efficiency and allow the worker to capture the gains from trade. In contrast, if firms enjoy some market power at the contracting stage then buy-out fees help firms in extending their initial market power over time. If workers suffer from a sufficiently weak position at the contracting stage then a ban on quitting fees (based, for instance, on antislavery principles) would increase the worker's welfare.

Also, the above results for the singular worker generalize to the case where the market is quite transparent ex-post but still some asymmetric information remains. The difference is that contracts with quitting fees do not induce an efficient allocation in general. Equilibrium contracts will include quitting fees, provided that their impact on the ability of the team incumbent firm-worker to appropriate surplus exceeds their costs in terms of sacrificing total welfare.

Although our model is motivated by labor contracting it can also portray cases like that of a franchiser who is looking for a franchisee to open an outlet in a specific geographical area. Potential franchisees (firms) compete before knowing the actual value of the franchise (which depends on both demand uncertainty and cost uncertainty). The issue addressed is then whether the equilibrium contract with the franchiser (worker) is such that the party who decides to break the relationship compensates the other monetarily. Similar questions have been addressed by Aghion and Bolton (1987), Spier and Whinston (1995), and Gilbert and Shapiro (1997)[2]. These papers consider a given information structure similar to (the extreme version of) our singular workers case, and investigate the impact of buy-out fees either when renegotiation is ruled out (Aghion and Bolton) or when the effect of buy out fees is through the induced investments (Spier and Winston and Gilbert and Shapiro). Our contribution is to show that a key ingredient to obtain equilibrium contracts with compensation damages is precisely the information structure, in a framework where renegotiation is allowed but still quitting fees have a direct effect on the strategies of outsiders. Thus, in our setting allocative efficiency depends not only on the possibility of renegotiation but also on whether ex-post information is perfect or not. A related issue is that we can and do address the question of whether separations are 'friendly' or 'unfriendly' along the equilibrium path. Last but not least, our modelling strategy allows us to disentangle the respective roles played by the transparency of the market and the distribution of bargaining power, which permits to conclude that indeed the information structure is the key factor to explain contracts with quitting fees.

The literature has provided interesting interpretations of the quitting costs implicit in upward sloping wage profiles. First, as a way of reducing the costs associated with the shirking problem (see, for instance, Akerlof and Katz, 1989), and second, as part of the optimal arrangement to share the costs of firm-specific human capital investments (see, for instance, Hashimoto, 1981).[3] Our model abstracts from moral hazard and human capital investment, and focuses instead on how the contract allocates the decision rights to reallocate the worker in order to maximize the joint payoff of the incumbent firm and the worker. In doing so, we distinguish between transfers from one party to the other as a function of who initiates the separation. Moreover, we do not analyze the characteristics

[2] There is also strand of the Law and Economics literature which focuses on the efficiency of damage measures normally imposed by the courts (Shavell 81980), Rogerson (1983), Cooter and Eisenberg (1985), Craswell (1989) and Leitzel (1989), Chung (1992) and Chung and Yeon-Koo (1999)).

[3] Kirman and Waldmann (1992) have pointed out, also in a model with training and hiring costs, that a penalty on quits could improve social welfare. The reason is that in their framework only short-run contracts are feasible. In the absence of quitting costs, firms find it optimal to pay efficiency wages in order to discourage workers from quitting, which results in too little turnover and too high unemployment. In this context a penalty on quits allows firms to cut down wages, increase turnover and reduce unemployment.

of the wage profile explicitly, but focus exclusively on the role of explicit quitting and firing costs.

Our paper is also related to other strands of the literature. First, the implicit labor contracts literature has emphasized the potential role of severance payments as part of an optimal risk sharing agreement (see Hart, 1983, for a survey). For instance, with symmetric information about the workers' productivity and deterministic outside opportunities, a risk-neutral firm can fully insure risk-averse workers. It can do so by offering a contract which includes a uniform wage for those workers that are retained and a (constant) severance payment to laid off workers that compensates them for their reduction in income. If workers' outside opportunities are random (and verifiable) then full insurance is achieved by a contract that contains transfers to either party depending on the state of the world.[4] In our model, by contrast quitting and firing costs are part of optimal contracts even with risk neutral agents.

Second, the literature on adverse selection in labor markets (see, for instance, Greenwald, 1986) has also analyzed the role of ex-post asymmetric information among firms on the productivity of the worker, although it typically abstracts from contracting issues.[5] One exception is Laing (1994), who develops an optimal contracting framework where ex-post outsiders have less information than the incumbent about the worker's ability. However, both the model specification and the focus of the paper are very different from ours.[6]

In contrast to most of the labor contracting literature, we assume that courts can distinguish between quits and layoffs. This assumption is not always an accurate representation of the relationship between a firm and a typical common worker. In some

---

[4] With ex-post complete information the contract fully specifies when separations occur. Thus, no distinction can be made between quits and layoffs. Kahn, (1985) studies a model where ex-post the worker has superior information on her outside opportunities. In this case there is a trade-off between risk sharing and ex-post efficiency, and as a result the equilibrium contract includes a penalty on quits (that is, separations initiated by the worker).

[5] See also Katz and Gibbons, (1991) for empirical evidence about the prevalence of asymmetric information in labor markets.

[6] Laing's models differs from our "common worker" model in several directions. First, there are many workers, and the firm's aggregate productivity parameter is public information. As a result, employment is independent of the wage structure. Second, there is a risk-sharing motive. Third, the firm can not be protected against quits. Fourth, the incumbent firm has no ex-post market power. In terms of the focus of the papers, Laing aims to explain involuntary layoffs in the context of an optimal risk-sharing agreement, while our main concern is the effect of alternative information structures on endogenous switching costs.

instances, instead of laying the worker off and paying the corresponding severance payment, the firm may have a way of making the life of the worker miserable so as to induce quitting. Those moral hazard issues are less likely to arise when the degree of transparency is significant.[7]

The next section presents the basic model, discusses the class of admissible contracts and explains how contracts affect the worker's reallocation. Sections 3 and 4 study the singular and common worker cases respectively and contain the main results of the paper. In section 5, we check the robustness of our results and explore the policy implications of regulating switching costs. Some concluding remarks close the paper.

2. The baseline model

In this section we present a partial equilibrium model of the labor market. In the demand side there are three ex-ante identical firms, indexed by i, i = A, B, C, and labor is supplied by a single worker. Any finite number of firms larger than two would yield the same results and would make the presentation unnecessarily cumbersome. Indeed, three is the minimum number of firms necessary to allow for some competition among firms that have not hired the worker.

The productivity of the worker is uncertain and may differ across firms. More precisely, the value of the worker to firm i is denoted by q_i, where (q_A, q_B, q_C) is distributed according to the joint density function $h(q_A, q_B, q_C)$ which takes strictly positive values on $\left[\underline{q},\ \overline{q}\right] \times \left[\underline{q},\ \overline{q}\right] \times \left[\underline{q},\ \overline{q}\right]$. Function h satisfies the following properties:

A1.- $h(q_A, q_B, q_C)$ is permutation invariant (symmetric firms)

A2.- $E(q_i) = 1$

A3.- $E(q_i|q_j = \underline{q}) > 0, i \neq j$.

A4.- $E(q_i|q_j = 1) = 1, i \neq j$

A5.- $0 < \dfrac{dE\left(q_i\middle|q_j\right)}{dq_j} < 1, i \neq j$.

Assumption A2 is just a normalization. Assumption A3 helps to simplify the characterization of equilibria in the case of common workers, but it is not essential. Symmetry of h with respect to the mean vector implies assumption A4 but it is not

[7] Another important feature is that in regular labor markets, firms tend to contract with a union rather than with individual workers. Thus, employment decisions could be partially separated from individual compensation schemes. In contrast, in the "singular" worker examples we have discussed it is the individual worker who signs the contract, and aggregate employment is quite irrelevant.

necessary. Finally, assumption A5 implies that q_i's are positively but imperfectly correlated.

We assume that the worker is indifferent with regard to working at any of the three firms and only derives utility from her wage income. We normalize the wage reservation value (the opportunity cost in other segments of the labor market) to 0.[8] All the firms and the worker are assumed to be risk neutral. Finally, firms face no bankruptcy constraints, in the sense that ex-post they can make large negative profits.

Timing and information structure

STAGE 1: CONTRACTS ARE SIGNED

(1.1) Firms simultaneously offer contracts knowing $h(q_A, q_B, q_C)$.

(1.2) The worker signs one of the contracts. The chosen firm is called the incumbent, and the contract is observable to all parties.

STAGE 2: INFORMATION REVELATION AND CONTRACT REVISION

(2.1) The values of the random variables (q_A, q_B, q_C) are realized.

(2.2) The incumbent firm can implement the contract or offer the worker to revise it, subject to some restrictions which we specify below.

(2.3) Outside firms simultaneously offer employment to the worker at a certain wage.

(2.4) The worker chooses within the feasible set. Again, the set of alternatives will be specified below[9].

STAGE 3: PRODUCTION

(3.1) Production takes place and players obtain their payoffs.

The distinguishing feature that we wish to emphasize about various types of workers is how much firms learn about their characteristics. In the "singular worker" game (Section 3) we assume that the realizations of (q_A, q_B, q_C) become common knowledge, and that the offer of the incumbent to revise the contract is also public. Thus, the basic model of singular workers is a game of complete information at stage 2, where given that the firms' valuations for the worker are imperfectly correlated it implies that outsiders have different willingness to pay to attract the worker.

[8] $\underline{q}$ could be higher or lower than 0. In the latter case, there are realizations of the random variables for which efficiency requires the worker to leave the industry.

[9] As usual, we assume that when the worker is indifferent, she makes the socially efficient choice.

One could argue that the job performance of, say, movie actors, popular singers, professional sports people, etc. fits well with such a characterization of singular workers. Also, the performance of top executives and other highly qualified workers is generally well known to (the relevant) outsiders. In any case, the results of this rather extreme version generalize to the point where there is an important flow of information so that rivals learn a considerable amount, although some uncertainty and asymmetric information still remain. (See Section 5).

In the "common worker" game, rival firms neither observe the realization of any of the qs nor observe the employer's offer to revise the contract (stage 2.2), which could constitute a signal to rival firms. The incumbent, on the other hand, observes its own q, but learns nothing about the realization of the qs of other firms. In section 5 we check that our main conclusions remain even if outsiders can upgrade their beliefs about the quality of the worker after observing the revision of the contract (after observing the moves made by the incumbent firm at stage 2.2). The key ingredient of the common worker model is the fact that outsiders information set is coarser than the incumbent's. The outsiders' uncertainty about the value of the worker together with the symmetry of the model results in outsiders competing à la Bertrand.

The timing of our model is analogous to the one used in most of the labor contracting literature (See, for instance, Hart (1983)). It would be natural to give an explicit dynamic interpretation of the model by assuming that the worker is engaged in productive activities at stage 1. In this alternative setting, the contract would determine two different wages, one for the first period (before qs are realized) and another for the second period. In our model this would be formally equivalent to allowing for side payments at the time of signing the contract. Hence, if we were to follow this path we would introduce additional considerations associated with the possibility of bonding, the potential role of wage smoothing, and so on, which would considerably complicate the analysis. [10]

Admissible contracts

We make the plausible assumption that the productivity of the worker is not verifiable by the courts and hence the terms of the contract cannot be made conditional on the realization of the qs even when they are observable. Thus, we are dealing with incomplete contracts. A novel aspect of our model consists in allowing for payments of different signs and absolute values depending on who initiates the separation. More specifically, a contract can specify three numbers (w, b, s), where w is the wage, b is the buy-out fee, i.e., the amount of money that the worker has to pay the firm if she chooses

[10] See the last section for a discussion of some of these issues.

to quit at the end of stage 2, and s is the severance payment, i.e., the sum the firm must pay the worker if it lays her off at stage 2. In other words, if the firm does not pay s at stage 2, then the worker is entitled to work at the firm at stage 3 at the contracted wage w. Similarly, if the worker does not pay b to the firm at stage 2, then the worker must work for the incumbent firm at stage 3 at the contracted wage, w. Hence, before information is revealed, the firm and the worker can commit themselves to trade at a given price (w), but after some information is revealed each party can break its commitment by paying a predetermined amount to the other party (b and s for the worker and the firm, respectively). Of course, this is so unless the contract is revised, as specified below.

<u>Contract revision</u>

At stage (2.2) the incumbent firm has the following alternative options[11]:

- fire the worker and pay s,
- offer the worker to stay in the firm at a salary w'.
- offer the worker a different buy-out fee, b'.

Clearly, the incumbent firm may offer w' = w and b' = b, but we assume that it can only modify either the second period wage or the buy-out fee. The idea is that the firm might have to raise the salary if it wants to keep the worker, or might have to reduce the buy-out fee if it prefers to induce her to quit. Such an assumption is not important for the main qualitative results but it highly simplifies the presentation.[12]

At stage (2.4) the worker has different options depending on the action chosen by the incumbent firm at stage (2.2). If the incumbent firm has laid her off, then the worker can only choose between the offers of the two outside firms. If the incumbent firm has offered a different second period wage, w', then the worker chooses from these alternatives:

- staying at the firm and getting w',
- staying at the firm and getting w,
- quitting and paying b to the incumbent firm, and choosing one of the outside options.

[11] Revisions of the severance payment are ruled out since they are only a redundant way of inducing the worker to quit. First, the incumbent firm never finds it optimal to increase s. Second, whenever the incumbent firm offers the worker a lower severance payment, since it would have to be acceptable to the worker, the firm would in fact be inducing the worker to quit, which (by definition) can always be implemented by revising down the buy out fee.

[12] See Section 5.

If the incumbent firm has offered a different buy-out fee, b', then the worker chooses from:

- staying at the firm and getting w,
- quitting and paying b' to the firm and choosing one of the outside options,
- quitting and paying b to the firm and choosing one of the outside options.

The timing, and not only the information revealed, can influence the relative bargaining power of the parties. We assume that the incumbent moves first in the renegotiation stage (3.2), which in case of complete information implies an extreme bargaining power, similar to the ability of making "take it or leave it" offers in a "sharing of the pie" game. To separate the effects of the "order of moves" from that of the information flow, in Section 5 we generalize the renegotiation process in the case of singular workers and show that our main results do not depend on the former but on the latter. Indeed, the discussion that follows is "generic", in the sense that it describes the results for any distribution of bargaining power, except the most extreme cases favoring the outsider or the worker. This last, extreme case would be consistent with letting the outsider move first (as in Spier and Winston, 1995).

In the "common worker" case it will be relevant whether the incumbent firm can commit itself not to make new offers to the worker after laying her off, that is, at stage 2.3. In principle, the incumbent firm could lay the worker off, pay s, and then offer the worker employment again at any wage. If the parties wish to avoid such a possibility then the contract can simply state that the incumbent firm cannot employ the worker at a wage w' < w. Such a clause is renegotiation-proof and only requires that the initial contract be filed (even when terminated) so that the worker can eventually claim the rights stated there.[13] Section 5 discusses what happens when we relax the assumption, and the incumbent firm, after paying s, can employ the worker again at a wage below w.

Selection of equilibria:

At the revision stage, especially in the case of the singular worker, where offers are publicly observable, any contract will have multiple continuation equilibria. In order to characterize equilibrium contracts, we would then have to specify an equilibrium selection criterion. In our case, the following weak requirement is sufficient for uniqueness of the

[13] In other words, suppose that the incumbent firm executes the contract firing the worker (and paying s) and then offers employment (a new contract) at a wage below w. If the worker accepts, at the end of the second period she can take the firm to court and claim the initially contracted wage w.

equilibrium path: at stage 2 no firm makes an offer to the worker that, if accepted, could only result in a payoff below the status quo.

The criterion above precludes wage revisions $w' > w$ by an incumbent with valuation q for the worker, so that $q - w' < b$. Indeed, such an offer might not prevent the worker from leaving, and then the payoff for the incumbent would not change. However, it may have an effect because the worker stays in either case, or because the worker stays only for a revised wage w'. In the former case, the incumbent obtains $q - w'$ instead of $q - w$. In the latter, the incumbent gets $q - w'$ instead of b. The criterion precludes outside firms' offers above their valuation, too: an outside firm can guarantee zero profits by not making offers.[14]

3. The case of "singular workers"

In this section we consider the case in which at stage 2.1 the realization of all qs becomes common knowledge and the contract revision (stage 2.2) is public.

Let Q denote the maximum total surplus of this market from an ex-ante (beginning of the game) point of view:

$$Q \equiv E\left(\max\left\{q_A, q_B, q_C, 0\right\}\right)$$

and let firm I (incumbent) denote the one that hires the worker at the beginning of the game, firm O denote the outside firm with the highest q, and firm R (the residual firm) the outside firm with the lowest q, i.e., $q_O \geq q_R$, although q_I can be higher or lower than q_O, and q_R.

In searching for the set of equilibrium contracts, we first need to analyze the equilibrium behavior after the information is revealed for any given contract. Once (q_A, q_B, q_C) are realized, and given the terms of the contract (w, s, b), firm I considers three possibilities: (1) retaining the worker; (2) letting the worker go; and (3) laying the worker off. The Appendix contains a careful characterization of these three alternatives and the associated pay-offs for the firms and the worker. Here it suffices to note the following. Consider a team incumbent-worker deciding together the design of a rent maximizing contract under the constraint that ex post all parties will be opportunistic. In order to characterize such a contract we have to take into account the following two points.

First, layoffs are not an appropriate way to transfer the worker. Indeed, once the worker is laid off the outside firm offers the worker max (q_R, 0) and earns min ($q_O - q_R$,

---

[14] One could postulate other more "game-theoretical" refinement criteria to deal with a problem that has to do with the fact that an omniscient firm has no preference among many offers that all imply that the worker quits and pays the same buy out fee. The one offered here is, in our view, the most intuitive.

q_O). Thus, the equilibrium contract must discourage layoffs by setting a high enough severance payment. Second, high buy-out fees are also necessary to avoid leaving rents to outsiders and do not interfere with the efficient allocation of the worker. Indeed, a sufficiently high buy-out fee can always be reduced to $b' = q_O - w$, which induces the worker to quit, since the outsider in this case has incentives to attract the worker by offering q_O. The incumbent firm prefers to let the worker go if and only if $b' = q_O - w \geq q_I - w$; that is, if only if it is efficient. Whenever the worker quits the incumbent appropriates all the profits from the reallocation. On the other hand, the worker would never agree to an upward revision of the buy-out fee. Then, if $b < q_O - w$ and $q_I < w + b$, in the continuation game the outsider gets the worker by paying a buy-out fee of b, a wage of w, and making profits of $q_O - \max\{w + b, q_R\} > 0$.[15] Thus, if the buy-out fee is not high enough the outsider will appropriate some rents. Hence, this argument is in line with Gilbert and Shapiro (1997) and it is not surprisingly so, since in the singular worker game the information structure is identical in both models. Completely novel instead is that our model allows us to address the issue of which party initiates the separation. In this case, we show that in equilibrium there are no involuntary layoffs and that all separations take the form of voluntary quits. [16]

Proposition 1 formally states that these features indeed characterize an equilibrium contract and it investigates the properties of the equilibrium path:

Proposition 1

a) An equilibrium contract requires sufficiently high switching costs (both severance payments and buy-out fees) and grants the worker the entire surplus. More specifically, a contract is an equilibrium contract if and only if it satisfies the following conditions:

(i) $s \geq w$,

(ii) $b \geq \bar{q} - w > 0$, and

(iii) $w = Q$

b) The equilibrium contract induces an efficient allocation of the worker, and there are no layoffs along the equilibrium path. That is, the worker quits whenever it is

[15] This is where our selection criterion plays a role: the incumbent, knowing that the outsider would match any wage offer w' so that $q_o \geq w'+b$, could also raise the wage offered to the worker to levels that, if accepted, would result in a loss for it. This "charitable" behavior by the incumbent is what the selection precludes.

[16] Also, regarding the lock of impact of buy-out on efficiency due to renegotiation we will see in section 5 that it does not generalize to the case where some ex-post asymmetric information remains.

efficient. Furthermore, in order to quit the worker must pay a revised down buy-out fee, which is positive with positive probability.

Proof: See Appendix A.

That is, under complete information and imperfectly correlated values the main goal of a contract is to eliminate all the potential profits of outside, well informed, and perhaps ex-post stronger, competitors**.** The team incumbent-worker is able to appropriate all the potential gains from the worker reallocation. The worker happily accepts important mobility restrictions, since they result in higher wages.

Thus, in those labor markets where there is ex-ante uncertainty about the productivity of the worker and the ex-post value of the worker becomes known and differs across firms, equilibrium contracts will tend to be characterized by high switching costs.

As pointed out in the introduction, the contracting problem for singular workers bears some resemblance with the literature on entry deterrence through provisions on liquidated damages. Unlike this literature, however, our contract design problem explicitly addresses the issue of which party should initiate the separation. Accordingly, we allow for different payments depending on who initiates the separation, and show that in equilibrium contracts include in either case high compensations to the passive party. Such a feature is also new to the labor literature, which typically focuses on severance payments as part of risk-sharing agreements. In our model agents are risk neutral and the role of severance payments is to discourage involuntary layoffs.

Notice that $b = s = \infty$ are included in the set of equilibria. These are rather common among soccer players in Europe or basketball and baseball players in the US. As we have argued in the introduction, such athletes are an extreme case of "singular workers" in the sense that their performance is by definition observed by rival teams. This is also a clear instance where layoffs are rear and where buy-out fees are very often renegotiated down, sometimes even to negative amounts: some teams are willing to transfer the worker to a different team after paying part of the player's salary.

Thus, the issue arises as to what is the economic rationale of anti-slavery laws in our framework, since mobility costs create no inefficiencies and allow the worker to appropriate all the surplus. This issue is taken up in Section 5.[17]

---

[17] Our results are in contrast with some of the literature on the economics of sports, which predicts that infinite quitting penalties simply result in lower salaries and larger profits (Fort and Quirk, 1995). The reason why this is so in Fort and Quirk is that there is built-in market power of teams when they first hire a player. Our model makes it clear that when clubs compete ex-ante for the

4. The case of "common workers"

We now consider the case in which at the end of the first period the incumbent firm only learns its own q, but nothing else is directly revealed to anyone else. Hence, in the second period outside firms find themselves in an identical position (we cannot distinguish between firm O and firm R). Since we assume that outside firms are not able to observe the revision of the contract, they make their offers in the understanding that they will succeed in attracting the worker only when she is of low value to the incumbent firm.

As in many other models of the labor market (like in Greenwald, 1986), in the renegotiation stage potential alternative employers face an adverse selection problem. Thus, the contract signed by the incumbent and the worker must deal with this problem. That is, in contrast with the singular worker case, where the contract was designed to protect the incumbent-worker team from potential outside strong competitors, here the contract is designed to mediate a situation where these competitors will be afraid to outbid the incumbent. Indeed, winning in the competition for the worker means that the worker was not very productive at the incumbent. If the productivity of the worker at various firms is correlated, the situation is one of a winner's course. Reallocation through voluntary quits is then problematic. Thus, even though it depresses the worker's wage prospects ex-post, costly firing may be the only way to ensure an efficient allocation of the worker, which is the main goal of the contract from an ex-ante point of view. Certainly, extracting rents from outsiders is not an issue here: the mere lack of information makes outside firms compete à la Bertrand. We show next how this goal is attained in equilibrium.

The second best allocation consists of the worker staying at the incumbent firm if $q_I \geq 1$, and otherwise moving to either of the other two firms. Thus, the potential expected surplus, Q', in this case is:

$$Q' = E\left(\max\left\{q_I, E\left(q_i \middle| q_I\right)\right\}\right) \qquad i \neq I$$

Therefore, in a second best efficient equilibrium, the sum of expected profits and worker's expected income is equal to Q'.

---

player, she can appropriate all the surplus so that penalties by themselves are not the source of the problem. As we will see in Section 5, however, ex-ante competition between clubs is essential, and when this fails to be the case penalties on quits allow clubs to extend their monopoly power over time.

Given a signed contract (w, b, s) a (pure strategy, perfect Bayesian) equilibrium corresponding to such a subgame could be summarized by:

1) strategy for the incumbent as to when to lay the worker off and how much to offer (w' or b') otherwise.

2) beliefs for outsiders as to when the incumbent either fires the worker or makes an offer w' so that w'+b < x, or when it makes an offer b' so that w+b' < x. $\left(\text{Set } Q^x \subset \left[\underline{q}, \bar{q}\right]\right)$, for any outside offer x.

3) the highest wage offer by outside firms, denoted by w^e,

4) beliefs should be consistent with strategies, and agents should maximize pay-offs given their beliefs.

Let us first argue that in a second best efficient equilibrium the worker never quits voluntarily. Suppose she does. Efficiency implies that outsiders believe that they can attract the worker if and only if it is efficient , i.e., $Q^{w^e} = \left[\underline{q}, 1\right]$ in the relevant range. But, $E\left[q_i \middle| q_I < 1\right] < 1$, and therefore $w^e < 1$ in any efficient equilibrium, since otherwise expected profits would be negative. But, whenever $w^e < q_I < 1$ the incumbent prefers to match w^e (i.e., keep the worker) rather than let the worker go, which violates efficiency.

Let us define the following notation:

$$\alpha \equiv \left[1 - H(1)\right] E\left(q_I \mid q_I \geq 1\right) + H(1)\, 1$$

$$\beta \equiv E(q_i | q_I \leq 1)\,,\ i \neq I,$$

where

$$H\left(q_I\right) \equiv \int_{\underline{q}}^{\bar{q}} \int_{\underline{q}}^{\bar{q}} \int_{\underline{q}}^{q_I} h(x,\ y,\ z)\, dx\, dy\, dz\, .$$

is the marginal distribution function of q_I. Notice that $\alpha > 1 > \beta$. Proposition 2 shows how equilibrium contracts set the proper incentives for reallocating the worker.

Proposition 2

a) The equilibrium contract does not require a positive buy-out fee, but it does require a positive severance payment. Specifically, a contract (w, b, s) is an equilibrium contract if and only if the following conditions hold:

(i) $s = w - 1 > 0$

(ii) $b > 1 - w < 0$

(iii) $w = \alpha > Q'$

b) The equilibrium induces a (second best) efficient allocation of the worker and the worker gets the entire expected surplus. Separations take place through lay offs. Despite the existence of positive severance payments, if the worker is laid off her utility drops.

Proof: See Appendix A.

Notice that b could even be negative, and moreover no buy-out fee is paid along the equilibrium path. Condition (ii) ensures that the worker does not quit voluntarily. However, given the equilibrium contract outside firms will still get the worker when it is efficient, i.e., if $q_I < 1$, since the incumbent lays the worker off in that case (condition (i))**.**Thus, they are willing to pay β. Given that the contracted wage is equal to α, quits will be discouraged even with negative buy-out fees.

Finally, ex-ante competition among firms implies that the worker gets the entire surplus. That is, the expected surplus of the worker is:

$$\left[1 - H(1)\right] w + H(1) \left(\beta + s\right) = Q'$$

and since

$$Q' = \left[1 - H(1)\right] E(q_I | q_I \geq 1) + H(1) \beta$$

and

$$s = w - 1$$

condition (iii) is satisfied in equilibrium. Notice that the wage is above the unconditional expected value of the worker when she is reallocated efficiently. This is so because the worker's income drops in case her productivity is low. That is, the severance payment plus the wage with outside firms is lower than the contracted wage w, and thus separations are indeed undesirable for the worker.

Summarizing, with ex-post asymmetric information separations take the form of involuntary layoffs. Because of the adverse selection problem a contract that induces voluntary quits involves excessive retention of the worker. Thus, there is no role for positive buy-out fees and the severance payment must be set appropriately so as to induce the incumbent to fire the worker only when efficient.

5. Discussion

We have shown that the quality of information about the worker’s performance determines both the extent to which penalties on quits are observed as well as the form of separations. Specifically, complete information ex-post is associated with downward renegotiation of buy-out fees to induce quitting whenever efficient, while ex-post asymmetric information is associated with involuntary layoffs whenever the performance of the worker at the incumbent firm is below expectations. In this section we discuss the sensitivity of these results to various assumptions.

5.1. *Ex-post bargaining power*

As we pointed out in Section 2, in the renegotiation stage we have made extreme assumptions concerning the relative bargaining power of the various parties. In the singular worker case, the incumbent firm enjoys a first mover advantage and hence a great deal of bargaining power. One could therefore suspect that our results hinge on the order of moves rather than on the information structure.

In order to investigate this issue, we extend the singular worker model and allow for a more general renegotiation process (See Appendix B). We envision such a phase as a complex renegotiation process between two pairs, worker and incumbent, on one side, and worker and outsider, on the other. Both bargaining situations are resolved simultaneously and the outcome of each negotiation satisfies the Nash bargaining solution. We assume exogenous relative bargaining power of the two parties in each of the negotiations, and endogenous threat points: the threat point in one of the negotiations is determined in equilibrium by the outcomes in the other negotiation. With this model, we show that generically high buy-out fees are an adequate way of extracting rents from outsiders, without affecting efficiency**.** Specifically, except when the outsider has all the bargaining power when negotiating with the worker, he obtains a lower payoff with contracts that includes high buy-out fee and infinite severance payment than in the case of no switching costs. Thus, we conclude that, indeed, the use of such clauses is a consequence of the information flow and not just an artifact of the order of moves of our initial model[18]**.**

5.2. *Information structure*

[18] This conclusion is also confirmed if we modify the order of moves within the framework of the benchmark model. Consider the case where the incumbent and the outsiders makes offers simultaneously. This is equivalent to the case that the incumbent moves first but his offer is not observable to outsiders. We show in Appendix B that the only difference with respect to Proposition 1 is that with simultaneous moves outside firms generically make positive expected profits, which reduces the contracted wage. The reason is that at stage 2 the incumbent firm can no longer commit to a certain reduced buy-out fee and as a result there is a continuum of equilibria. Each of these equilibria can be interpreted as arising from a different distribution of ex-post market power between the incumbent and the outside firm, since they give rise to a different distribution of surplus. In all these equilibria contracts involve a sufficiently high buy-out fee, except in the case that the outside firm gets all the gains from reallocating the worker, in which case buy-out fees are redundant.

Our informational characterization of singular workers in Section 3 was a bit extreme since we assumed that even outsiders' valuations become common knowledge at the renegotiation stage. Let us now consider a perhaps more plausible information structure. Suppose $q_i = q + \varepsilon_i$, with q and ε's being independent random variables. At the renegotiation stage, the realization of q is common knowledge and in addition each firm learns the realization of its own ε, but not that of its rivals. The interpretation is straightforward. The value of the worker for a particular firm has two components, a common component, the objective quality of the worker, and the idiosyncratic component, which depends on things like the financial situation of the firm, complementarities with other inputs, and so on. Throughout the paper we have emphasized that the main characteristic of singular workers is the observability of their performance. Hence, to be consistent with this the realization of q must be assumed to be common knowledge. However, there is no particular reason to presume that the idiosyncratic component should be observable to other firms.

In order to fix ideas, consider the case that ε can take only two values, σ and -σ with equal probabilities. If the contract includes w = b = s = 0 (spot contracts) then in all equilibria outside firms make positive expected profits. The reason is that if the incumbent gets $\varepsilon_I = -\sigma$, it will never offer a wage above $q - \sigma$. Given that, any of the outside firms that obtained a good realization ($\varepsilon = \sigma$) offers a wage below its reservation value ($q + \sigma$) since the optimal wage offer trades off the probability of winning with the size of the surplus. In contrast, in the case that $b = s = \infty$, the optimal strategy of the incumbent firm is too keep b' sufficiently high, in order to retain the worker whenever $\varepsilon_I = \sigma$, and to set $b' = q + \sigma - w$ if $\varepsilon_I = -\sigma$. Under such a strategy the incumbent will be able to extract all potential gains from reallocating the worker. Also, it must be noticed that despite of the asymmetry of information the worker is always efficiently allocated. [19]

Thus, as the previous example illustrates, the principle that buy-out fees are tools that allow the pair incumbent-worker to extract rents from outsiders generalizes to the case where the market is quite transparent ex-post, but still some asymmetric information remains. On the other hand, the lack of impact of penalty quits on efficiency depends on the two-point support. Indeed, the Appendix B discusses the case of a continuous distribution and indicates that the comparison between spot markets and contracts with infinite switching costs is more complicated. On the one hand, as in the previous example, infinite switching costs make the incumbent firm more aggressive so that the outsider is forced to bid higher to attract the worker (the rent extraction effect). More precisely, in spot markets the incumbent never bids above q_I: however, with very large b and s the incumbent's reservation value is q - w and it thus sets $b' > q_I - w$, since he trades

[19] In addition, notice that the fact that ε_I is private information to the incumbent is not necessary.

off a higher surplus with a lower probability of earning it. On the other hand, and for the same reason, switching costs imply that the worker stays at the incumbent more often than it should. Hence they have a cost in terms of efficiency[20]. Since the rent extraction effect pushes towards contracting with penalty quits, only if the efficiency cost is important enough will equilibrium contracts exclude switching costs. When the ε's are uniformly distributed, switching costs do create inefficiencies, but still the rent extraction effect dominates the efficiency loss so that equilibrium contracts include buy-out fees.

5.3. *Efficiency and switching costs*

As we just argued only when information is ex-post complete it can be guaranteed that buy-out fees will not cause efficiency losses. On the other hand, in some instances, switching costs, and specifically severance payments may be needed to ensure efficiency. Indeed, assume that both severance payments are forbidden. For the common worker case, this means that the worker will be laid-off whenever the productivity at the incumbent is above the contracted wage. The worker will not get any compensation in this case, and therefore her income conditional on firing is just the wage offered by outside firms (after they adjust their beliefs on the worker's productivity). Then, ex-ante the worker and the incumbent sign a contract higher than the expected productivity (see Appendix B), which implies too frequent lay-offs.

5.4. *Switching costs and the distribution of surplus*

In the baseline singular worker model buy-out fees are not necessary for efficiency. However, if buy-out fees are forbidden (even if severance payments are not) no firm is willing to offer a positive wage $w > 0$ at the contracting stage: every firm prefers to have its hands free to offer any wage in the renegotiation stage rather than being forced to pay at least w if it wants to keep the worker (see Appendix B). In this case, in equilibrium the contract includes $w = 0$ (spot market), and firms make positive profits. This result seems to challenge antislavery provisions that aim at protecting workers' interests by ruling out clauses tying the worker to the employer. This, however, is a consequence of the ex-ante distribution of bargaining power that we have assumed. Indeed, assume all the bargaining power is in the hands of one of the firms at the contracting stage. This would be the case, for instance, if, whenever no contract is signed at stage 1, the rival firms do not even know about the existence of the worker and hence in the spot market the worker gets 0.

[20] With $b = s = 0$ the worker is not necessarily allocated efficiently either since the incumbent firm moves first. The problem here is that the worker may switch firms when she should optimally stay at the incumbent firm.

In the singular worker case, it is clear that b will be sufficiently high and w = 0 (s will be irrelevant). Ex-post, whenever $q_O > q_I$, the incumbent firm will find it optimal to reduce the buy-out fee to q_O and let the worker go. In this case, we can interpret a buy-out fee as a way of extending the incumbent firm's market power over time without any influence on the efficiency of the allocation. In other words, in a world where penalties on quits were forbidden, the incumbent firm would face important restrictions on exploiting its market power. The firm would still set w = 0, but ex-post the allocation would be efficient and moreover the worker would appropriate a larger share of the surplus (instead of 0 the worker would get a payoff equal to the expected value of the second highest valuation).

Similarly, in the common worker case the monopolist firm would offer a contract that maximizes total surplus but that induces zero expected payoff for the worker. Such a contract involves w - s = 1 (efficient separations) and w = [1 - H(1)] (1 - β), which implies s < 0 (the worker is required to pay a positive amount to the incumbent firm if she is fired). If switching costs were forbidden, then the contract would be irrelevant (w = 0). However, in this case the allocation would be inefficient because of the asymmetric information problem; on the other hand, the worker would be better off since, instead of 0, she would have a wage equal to μ > 0, where μ is the solution to $\mu = E\left(q_i | q_I < \mu\right)$.

Summarizing, switching costs may help firms extend their initial market power over time. In this context, anti-slavery laws can be interpreted as useful devices to protect workers from firms' excessive market power, to the extent that they rule out payments to the firm at the moment of separation.

5.5 *More on robustness*

In Appendix C we relax the assumption that renegotiation between the incumbent and the worker are observable in the singular worker case and not in the common worker case. We have also checked that some specific assumptions such as the inability to simultaneously revise wages and quitting fees, the possibility that buy-out fees are not fully enforceable, or the commitment not to rehire the worker after laying her off are simplifications of the model that do not seriously affect the main results. [21]

6. Concluding remarks

This paper presents a theory of switching costs in labor contracting that emphasizes informational issues. In particular, contracts with high separation costs for both parties are predicted to be more likely in the case of "singular" workers, that is, in those segments of the labor market in which potential alternative employers have access to a great deal of information on the worker's performance. In addition, in these market

[21] Formal arguments are available upon request.

segments separations are negotiated, while lay-offs are ex-post undesirable in the common worker case.

We have used a static framework where all payments are obtained at the end of the game. However, our insights carry through dynamic settings provided bonding is ruled out and there are reasons for wage smoothing. It is straightforward to extend our model to a two period model where at the end of the first period the renegotiation process described in the paper takes place. If we allow for bonding (low, or even negative, first period wages) then the contract can include a very high second period wage. In this case, the worker would be reallocated after being compensated for the salary loss. In other words, buy-out fees would still be a useful device but all transfers would go from the firm to the worker (negative buy-out fees). At the other extreme, if we impose an identical wage in both periods, then we would obtain positive buy-out fees with positive probability, as in our benchmark model. Developing a full fledged dynamic model with reasons for wage smoothing (such as uncertainty about the timing of the realization of the variables, and with a risk averse worker) would substantially complicate the analysis, but we would not expect to generate new insights.

Appendix A

<u>Proof of Proposition 1</u>

At stage 2.2 firm I considers three possibilities: (1) retaining the worker; (2) letting the worker go; and (3) firing the worker.

(1) Firm I can retain the worker at the contracted wage w only if it faces no competition, i.e., if $w + b \geq \max\{q_O, 0\}$; otherwise either firm O can make an offer that the worker finds profitable or the worker prefers to leave the market. Therefore, when $w + b < \max\{q_O, 0\}$, then firm I has to offer the worker a higher salary to keep her. Specifically it must offer a salary equal to $\max\{q_O, 0\} - b$, i.e., the firm is forced to renegotiate a higher salary if it intends to keep the worker. Thus, if firm I chooses to retain the worker, then it obtains $q_I - \max\{w, q_O - b, -b\}$. The worker obtains $\max\{w, q_O - b, -b\}$, and outsiders earn zero profit.

(2) Letting the worker go is only viable when the worker is willing to quit. Since by remaining in the firm the worker has guaranteed w, she will not quit unless she earns that much.

Assume $q_O \geq 0$. If firm I offers to reduce the buy-out fee to $q_O - w$, then firm O is willing to pay such a buy-out fee plus the contracted wage w, so that the worker would accept a move to firm O (if $q_O < 0$ the worker will leave the market). Of course, the worker would only accept the revised buy-out fee if it is lower than b (after receiving offers from the outsider, and if she accepts them, the worker does not have any reason to pay more than b in order to quit). Thus, if $b < q_O - w$, letting the worker go implies receiving b. Given our selection criterion, the firm would not raise w, and then $w' = w$ is the equilibrium revision offer.

Thus, by letting the worker go the incumbent makes $\min\{b, q_O - w\}$. The worker makes w. The outsider makes zero rents if $b > q_O - w$ and positive rents $q_O - w$ otherwise.

If $q_O < 0$ the worker quits the market, if she quits the incumbent. The payoffs are straightforward in this case, and $b' = \min\{b, -w\}$.

(3) If it fires the worker, the firm must pay s. Next, rival firms will compete for the worker and if $q_O > 0$, firm O will offer $\max\{q_R, 0\}$, which will be accepted by the worker. Therefore, if firm I fires the worker then it gets $-s$, the worker earns $s + \max\{q_R, 0\}$ and the outside firm $\max\{0, q_O - \max\{q_R, 0\}\}$.

After these preliminary considerations, we can show that conditions (i), (ii) and (iii) are both necessary and sufficient conditions for an equilibrium contract.

I) First, we prove that the three conditions are sufficient for an equilibrium c

I.1) Conditions (ii) and (iii) imply that $b \geq \bar{q} - w$. Hence $b \geq q_O - w$ (and $b \geq 0$) for all q_O. Thus, whenever firm I lets the worker go, then firm O makes zero profits and the worker has no preference between staying and quitting. Moreover, firm I does not have to raise the wage in order to retain the worker.

I.2) Under conditions (i), (ii) and (iii) firm I always prefers to reduce the buy-out fee to $\max\{q_O - w, -w\}$ to laying the worker off:

$$\max\{q_O, 0\} - w \geq - w \geq -s$$

I.3) Firm I retains the worker if and only if it is efficient:

$$q_I - w \geq \max\{q_O, 0\} - w \text{ , which is equivalent to } q_I \geq \max\{q_O, 0\}.$$

I.4) Given that the allocation is efficient, the expected surplus is equal to Q and in all cases the outsider's rents are zero. Thus, the contract maximizes the expected payoff of the worker subject to non-negative expected profits for the incumbent firm.

II) Second, we show that the three conditions are necessary.

II.1) Suppose that $b < \bar{q} - w$. Then there is a positive probability that $\bar{q} \geq q_O > b + w > q_I > q_R$, in which case the worker is (efficiently) reallocated but the outsider earns $q_O - (b+ w') > 0$ for some w' in the interval $[w, q_O - b]$, so that the worker would not appropriate the entire potential surplus. Increasing b so as to reduce this probability to zero would then increase the profits for the incumbent, and then the contract cannot be an equilibrium one.

II.2) Suppose that $s < w$. Then there is a positive probability that $\max\{q_O, 0\} - w < -s$ (firm I prefers to lay the worker off rather than induce her to quit by reducing the buy-out fee), and $q_I - w < -s$ (firm I prefers to lay the worker off rather retain her). Once the worker is laid off firm O makes profits equal to $q_O - q_R$. Thus, outside firms would make strictly positive expected profits and the worker would not appropriate all the potential surplus. The worker would be happy to decrease the wage slightly in exchange of an increase in s that reduces the probability of being laid off with a loss.

II.3) If $w \neq Q$, then firm I makes either negative expected profits ($w > Q$) or strictly positive profits ($w < Q$). The firm's participation constraint rules the first possibility out, and ex-ante competition between identical firms rules out the second.

Q.E.D.

Proof of Proposition 2.

Sufficiency:

Let (i) (ii) and (iii) be satisfied. Also, let w^e be the equilibrium offer by outsiders at stage 2.3.

1) If $w^e \leq w + b$, then the best reply is to offer the worker $b' \geq w^e - w$, if $q_I - w \geq -s$ (i.e, $q_I \geq 1$) and $q_I - w \geq w^e - w$ (i.e, $q_I > w^e$). If $-s > q_I - w$ and $-s > w^e - w$, then the best reply is to offer the worker, and if $w^e - w > q_I - w$ and $w^e - w > -s$ the best reply is to set b' = w^e -w and let the worker go. Then, for w^e to be an equilibrium offer $w^e = E\ [q_i | q_I \leq y]$, where $y = w + \max\{w^e - w, -s\}$ (Bertrand competition by outsiders plus consistency of beliefs).

2) If w^e > w + b, then whenever $q_I - (w^e - b) > b$, and $q_I - (w^e - b) > -s$, the best reply for the incumbent is to set w' = w^e - b and keep the worker. If -s > q_I - $(w^e - b)$, and -s > b, then the best reply is to fire the worker, and if b > -s and b > q_I - $(w^e - b)$, the best reply is to let the worker go by keeping w' = w and b' = b. Again, for w^e to be an equilibrium, $w^e = E[q_i | q_I \leq y]$, where this time y = $\max\{w^e,\ w^e - b - s\}$.

Notice that, since b > -s, this second region require $w^e = E[q_i | q_I \leq w^e]$, an equation in w^e which has no solution given our assumption A5 on h (Section 2).

On the other hand region 1 has only one candidate w^e. Satisfying $y = E[q_i | q_I \leq y]$ and $y = \max\{w^e, w - s\} = \max\{w^e, 1\}$, which is y =1 and w^e = β. (again, $w^e \leq 1$, since $E\ [q_i | q_I \leq y] \leq 1$). This is indeed an equilibrium provided b'>1-w (<0) when $q_I \geq 1$:

if outsiders bid above β, they obtain workers whose $q_I \leq 1$ only (and expect losses) unless w^e > 1, in which case the outsider firms expects losses too $(E[q_i | q_I \leq 1] = 1)$.

The contract is efficient, all separations take the form of layoffs.

Necessity: In equilibrium, outsiders get zero rents for any contract. If the contract does not implement efficiency it could not be an equilibrium contract. Indeed, notice that, by the reasoning above, and for any w^e offered by outsiders. Q^{w^e} is an interval $[0, y]$ for some y (if the incumbent prefers to keep the worker for some q_I if also prefers to keep her for any $q_I' > q_I$). Then, offering $w^e + \varepsilon$ can only increase $E[q_i | q_I \in Q^x]$, and then, increasing slightly the offer an outsider can always virtually double profits (by breaking ties with other outsiders). But this immediately implies that the equilibrium contract gives all the rents to the worker, and, given that a contract satisfying the proposition is efficient, it also implies that any equilibrium contract is efficient.

Then, in any equilibrium contract, $w^e = \beta$. Now, assume that there are voluntary quits with positive probability in equilibrium. If $b < \beta$ -w, then $b \geq$ - s (i.e., the incumbent can get rid of the worker with a maximum revenue of b). However, for the incumbent to keep the worker if and only if it is efficient to do so, $1 - (\beta - b) = b$, that is, $\beta = 1$, which is a contradiction, since $\beta < 1$.

If $b \geq \beta$ -w, then the maximum buy-out fee that the incumbent can obtain is β -w, and for voluntary quits to be as good as firing $\beta -w \geq -s$. But then efficiency requires $1 - w = \beta - w$, which contradicts the fact that $\beta < 1$. Then, voluntary quits cannot be observed in an efficient equilibrium path.

We then look at contracts with only firing in (efficient) equilibrium. In that case, the worker is retained by offering some wage $w' = \max\{\beta\text{-}b, w\}$, and the worker leaves the firm only when she is fired. For an equilibrium to be efficient, $1 - \max\{\beta\text{-}b, w\} = -s$.

Assume $\beta - b > w$. Then, the incumbent should offer $w' = \beta - b$ to keep the worker. But then a deviation by an outside who offers $\beta + \varepsilon$ obtains the worker for any realization of q_I, and then this could not be an equilibrium. Thus, efficient equilibrium requires $w \geq \beta - b$. In this case $1 - w = -s$, which is (i) in Proposition 2. Also, if $1 - b > w$, then an outsider could deviate offering $w + b$, obtain the worker for any q_I, and then a value $1 - (w+b) > 0$. Thus $1 - b < w$, and we obtain (ii) in Proposition 2. Finally, in any contract satisfying (i) and (ii) with only firing $w = \alpha$ for the total surplus to accrue to the workers, and this is (iii) in Proposition 2.

QED

Appendix B

B.1. Ex-post bargaining power

Consider the following model of bargaining among the worker, the incumbent firm, and the outsider after the realizations of q's become common knowledge. In order to simplify the presentation assume that qi's are always non-negative. We envision renegotiation as a process in which the worker is involved in two simultaneous negotiations, one with each of the firms. We take contracts (w, b, s) as given. Then the outcome of renegotiation, as in the benchmark model, is a triple (w_O, w' b').

The solution we propose is in the spirit of the Nash bargaining solution. Specifically, parties will strike agreements that satisfy:

(i) in each negotiation surplus is shared according to the (exogenous) bargaining power of the parties involved: the payoffs of incumbent-worker, and outsider-worker satisfy the (generalized) Nash bargaining solutions for the two negotiations given some threat points.

(ii) the threat point of a party in one negotiation is the outcome of the other negotiation (what the party gets if the current negotiation breaks but the other succeeds).

(iii) the worker chooses where to work, given the outcomes of the two negotiations. Whenever she is indifferent we assume that she goes to the most efficient firm.

(iv) no offer is meaningless, i.e., in a negotiation no party concedes anything that in case it is implemented implies lower payoffs than those the party can ensure for itself.

Condition (iv) implies that $q_O \geq w_O$ and $w' \geq w$. The first inequality states that the outsider makes no wage offers above its reservation level. The second inequality states that the worker never agrees to accept a wage offer below the contract wage.

Then, define δ_I and δ_O respectively as the bargaining power of firm I and firm O vis a vis the worker. We will consider only the two extreme forms of contracts that can be signed by the incumbent and the worker: a "spot" market contract, with $b = s = w = 0$, and our equilibrium contract, $b = s = \infty$, $w > 0$. We analyze the renegotiation of each in turn.

1) Suppose $b = s = w = 0$, and take realizations q_I and q_O. Consider a candidate solution for the renegotiation (w', b', w_O).

The incumbent and the worker can share a surplus equal to $\max \{q_I, w_O\}$. If the negotiation with the incumbent breaks (and $w_O \geq 0$), then the worker chooses to move to the outsider firm and gets the wage w_O, and the incumbent makes zero profits. Thus, the threat point in their negotiation is $(w_O, 0)$. Suppose $w_O \geq q_I$. Then the threat point is in the Pareto frontier, and therefore is itself a solution. Thus, the outcome of bargaining with the incumbent yields $b' = 0$, and $w' \in [0, q_I]$. On the other hand, if $w_O < q_I$, then the incumbent and the worker get the following payoffs:

$$u_I = \delta_I (q_I - w_O)$$

$$u_w^I = w' = (1 - \delta_I) q_I + \delta_I w_O$$

and to be consistent with these payoffs b' must satisfy:

$$b' \geq - (1 - \delta_I)(w_O - q_I).$$

Consider now the bargaining problem between the outsider and the worker. They can share a surplus equal to $q_O - b'$. If their negotiation breaks, then the worker has only the possibility of working for the incumbent, with a payoff of w', and the outsider gets zero. This is the threat point in the negotiation. If $q_O - b' \geq w'$, then the solution should also satisfy:

$$u_O = \delta_O (q_O - b' - w')$$

$$u_w^O = w_O = (1 - \delta_O)(q_O - b') + \delta_O w'$$

If q_O - b' < w', the threat point is outside the bargaining set and therefore $u_O = 0$. Then condition (iv) requires that $w_O \in [0, q_O]$.

Therefore, if $q_I > q_O$, any solution satisfies $w' > q_O$, the worker stays at firm I and firm O makes zero profits. If $q_I < q_O$, w_O can be any number in the interval $[(1-\delta_O)\, q_O, (1-\delta_O)\, q_O + \delta_O\, q_I\,]$ and hence, the outsider profits are any number in the interval $[\delta_O\,(q_O - q_I), \delta_O q_O]$.

2) Assume b = s = ∞, w > 0. Again, the incumbent and the worker can share a surplus equal to $\max\{q_I, w_O\}$. Now, however, their threat points are respectively, q_I - w and w, since in case their negotiation breaks they are locked-in by their contract (b = s = ∞). Also by condition (iv) w' = w, since the worker's reservation utility is now w and the incumbent can guarantee for itself q_I -w. If $q_I \geq w_O$, then the threat point is in the Pareto frontier, and therefore itself a solution. In this case, $b' \geq w_O - w$. If $q_I < w_O$, then the outcome of their negotiation yields the following payoffs:

$$u_I = b' = \delta_I\, w_O + (1 - \delta_I)\, q_I - w$$

$$u_w^I = w + (1 - \delta_I)(w_O - q_I).$$

The outsider and the worker can share a surplus equal to q_O - b', and their threat points are respectively 0 and w. If $q_O - b' - w < 0$, then the threat point dominates any point in the feasible set and the outcome of the negotiation is $u_O = 0$, and $w_O \in [0, q_O]$. Instead, if $q_O - b' - w \geq 0$ then:

$$u_O = \delta_O (q_O - b' - w)$$

$$u_w^O = w_O - b' = \delta_O\, w + (1 - \delta_O)(q_O - b').$$

Therefore, if $q_I > q_O$, $w_O < q_I$ the worker stays at firm I and firm O makes zero profits. If $q_I < q_O$, then

$$b' = -w + \frac{\delta_I (1 - \delta_O)}{1 - \delta_I\, \delta_O}\, q_O + \frac{1 - \delta_I}{1 - \delta_I\, \delta_O}\, q_I$$

which implies that:

$$u_O = \frac{\delta_O (1 - \delta_I)}{1 - \delta_I \delta_O} (q_O - q_I)$$

Notice that the outsider makes lower expected profits with infinite switching costs than with spot market contracts, for any distribution of bargaining power, except if δ_0 = 1. In this case with infinite switching costs b' = q_I - w and the outsider makes in both cases $u_O = q_O - q_I$, i.e., contracts with infinite switching costs are redundant. The same result would be obtained if we revert the order of moves between the outsider and the incumbent in the benchmark model, at the renegotiation stage. Also note that in the limit case of $\delta_I = 1$, with infinite switching costs then b' = q_O - w and $u_O = 0$, like in our benchmark model.

That is, unless $\delta_0 = 1$, or $\delta_O = 0$ switching costs are useful in extracting rents from outsiders, and hence must be part of equilibrium contracts.

B.2. Information Structure

Assume $q_i = q + \varepsilon_i$, where ε_i is private information to firm i at the renegotiation stage, and they are i.i.d. with distribution *F*. In particular, we will assume that *F* is the uniform distribution. The realization of q, however, is common knowledge at the renegotiation stage. For economy of notation, assume for now that *q = 0*. That is, assume the realization of *q* is such that $q_i = \varepsilon_i$. We will compare two extreme contracts, one where the incumbent and the worker are not tied by quitting costs and one where they set sufficiently high quitting costs

<u>Contract b = s = 0</u>.

Once the incumbent learns q_I, it makes positive profits only when keeping the worker. Thus, it chooses a contract revision that solves

$$\underset{w' \geq 0}{\mathrm{Max}}[q_I - w']\ F(w')^2 = [q_I - w']w'^2,$$

whose solution is implicitly given by

$$w' + \frac{F(w')}{2f(w')} = q_I$$

$$\Rightarrow w' = \frac{2}{3}q_I = w'(q_I).$$

The rents of an outsider[22], after w' has been announced, and knowing $q_i > w'$, are

$$\int_{w'(q_I)}^{q_i} F(x)\ dx.$$

Thus, the expected rent of an outsider (before knowing q_i) once q_I is determined, are

$$\int_{w'(q_I)}^{1}\left(\int_{w'(q_I)}^{q_i} F(x)dx\right)\ f(q_i)\ dq_i = \int_{\frac{2}{3}q_I}^{1}(1-x)\ xdx.$$

Also, we can compute the inefficiency created by reallocation, given q_I, as

[22] Once the contract revision by the incumbent has been announced, outside firms face a simple auction with reserve price w'+b'. We use revenue equivalence results to compute outsiders' rents.

$$\int_{w'(q_I)}^{q_I} 2(q_I - x)f(x)F(x)dx = \int_{\frac{2}{3}q_I}^{q_I} (q_I - x)\ xdx$$

Indeed, when $(q_I) < x < q_I$, where x is the maximum of the outsiders' productivities (an went with probability density 2f(x)F(x)), the worker leaves the incumbent and is employed at an outsider where her productivity is x instead of staying at the incumbent where her productivity is q_I. In any other case, the worker is efficiently employed.

Contract $\underline{w > 0,\ \ b = s = \infty}$

Now, the incumbent obtains profits b' when the worker quits. Then, the incumbent chooses w', b' at the renegotiation stage so as to

$$\underset{\substack{w' \geq w \\ b' \leq b}}{\mathrm{Max}}\left[q_I - w'\right]\ F\left(w' + b'\right)^2 + \left[1 - F\left(w' + b'\right)^2\right]b' \equiv \left[q_I - \left(w' + b'\right)\right]F\left(w' + b'\right)^2 + b'$$

The solution satisfies $w' = w$, and

$$1 - F\left(w + b'\right)^2 + 2f\left(w + b'\right)\ F\left(w + b'\right)\ \left[q_I - \left(w + b'\right)\right] = 0$$

$$\Rightarrow w' + b' = q_I + \frac{1 - \left(w + b'\right)^2}{2\left(w + b'\right)}$$

with solution $w' + b' = \dfrac{q_I + \sqrt{3 + q_I^2}}{3}$

Again, we can compute the rents for an outsider in expected terms (for each q_I) as

$$\int_{w+b'(q_I)}^{1}\left(\int_{w+b'(q_I)}^{q_i} F(x)\ dx\right)f(q_i)\ dq_i = \int_{w+b'(q_I)}^{1}\left[1 - F(q_i)\right]\ F(q_i)dq_i =$$

$$\int_{\frac{q_I + \sqrt{3+q_I^2}}{3}}^{1}(1 - x)\ xdx$$

Notice that, for any q_I, these are smaller than before, since $w + b'(q_I) > q_I > w'(q_I)$.

The inefficiency in reallocation is given by

$$\int_{q_I}^{w+b'(q_I)} 2\left(x - q_I\right)\ f(x)\ F(x)\ dx = \int_{q_I}^{\frac{q_I + \sqrt{3+q_I^2}}{3}} 2\left(x - q_I\right)\ xdx$$

This time the inefficiency comes from the possibility that the worker stays with the incumbent when an outsider values her more: $w'+b'(q_I) > x > q_I$).

In expected terms, we obtain that the efficiency loss in case $w > 0$ and $b = s = \infty$ are higher than those when w = b = s = 0. Indeed, the difference of the second and the first is

$$\int_0^1\left(\int_{\frac{2}{3}q_I}^{\frac{q_I + \sqrt{3+q_I^2}}{3}} 2\left(q_I - x\right)\ xdx\right)\ dq_I\ .$$

However, the rents given up to outsiders more than compensate this difference. In fact, the difference in rents when w = b = s = 0 and when $w > 0,\ b = s = \infty$ is

$$\int_0^1 \int_{\frac{2}{3}q_I}^{\frac{q_I + \sqrt{3+q_I^2}}{3}} 2(1-x)\ \ x dx\,,$$

and then, the difference in surplus obtained by the pair worker-incumbent when they sing a contract with $b = s = \infty$ instead of that with b = s = w = 0 is

$$\int_0^1 \int_{\frac{2}{3}q_I}^{\frac{q_I\sqrt{3+q_I^2}}{3}} 2x\left[1 + q_I - 2x\right]\ dx\ \ dq_I = \frac{109}{162} - \frac{2}{3\sqrt{3}} - \frac{1}{4}\arcsin\ \frac{1}{\sqrt{3}} > 0\,.$$

One can repeat the above computations for any q > 0 with no change in the results. That means that quitting penalties are to be expected in equilibrium.

B.3. Ruling out switching costs

B.3.a. *Singular workers*

A contract with w > 0 will be offered in equilibrium only if the firm who attracts the worker makes at least as much expected profits as the others.

Let q_H, q_M, q_L be the highest, middle and lowest realizations, respectively. If $0 < w \le q_M$ then the value of w is irrelevant for the continuation game, as the worker goes to the firm with the highest valuation and receives q_M.

If $q_M \le w \le q_H$ then the worker still goes to the firm that values her most. If it is the incumbent firm the one with the highest valuation then it makes $q_H - w$, but if it is an outside firm then it makes at least $q_H - q_M \ge q_H - w$.

Similarly, if $w \ge q_H$, the incumbent firm always fires the worker (and makes zero profits) and the outside firm with the relatively higher valuation makes positive profits.

Because of the symmetry of firms (assumption A1, permutation invariance of h), for any w > 0 the incumbent firm makes strictly lower expected profits than the outside firms. Hence, the only possible equilibrium contract includes w = 0. From the above argument it follows that no firm wishes to deviate from such a contract. Hence, firms earn positive expected profits. This type of reasoning does not change if we restrict b = 0 but allow for s > 0, i.e., apply antislavery laws only.

B.3..b *Common workers*

Again, the worker will be laid off if and only if q_I - w < 0. Given that such behavior is anticipated by outside firms, whenever the worker is laid off she gets a wage equal to $E\left(q_i | q_I\ \le\ w\right)$, $i \neq$ I. Thus, the worker's expected payoff as a function of w is given by U_W. This can be written as a function of w:

$$U_w = \int_{\underline{q}}^{\bar{q}} \int_{\underline{q}}^{w} q_i \, h'(q_i, q_I) \, dq_I \, dq_i + \int_{\underline{q}}^{\bar{q}} \int_{\underline{w}}^{\bar{q}} w \, h'(q_i, q_I) \, dq_I \, dq_i$$

where $h'(q_i, q_I) \equiv \int_{\underline{q}}^{\bar{q}} h(x, q_i, q_I) \, dx$.

This is a concave function of w, under some regularity conditions:

$$\frac{d^2 U_w}{dw^2} = -2 \int_{\underline{q}}^{\bar{q}} h'(q_i, w) \, dq_i + \int_{\underline{q}}^{\bar{q}} (q_i - w) \frac{\partial h'}{\partial q_I}(q_i, w) \, dq_i < 0$$

and since

$$\frac{dU_w}{dw}(w = 1) = \int_{\underline{q}}^{\bar{q}} \int_{1}^{\bar{q}} h'(q_i, q_I) \, dq_I \, dq_i > 0$$

the optimal wage is higher than 1.

Appendix C. Information on renegotiation

C.a. Singular workers

We first show that when performance is public but renegotiation is secret (i.e., the incumbent's action in stage 2.2 is not observable to outsiders) the main features of Proposition 1 still hold.

When renegotiation is secret, virtually all contracts will have a continuum of continuation equilibria even without considering "dominated bids". Thus, in order to compare different contracts, when they are offered to the worker, we will have to specify a more stringent equilibrium selection. That is, for each contract we will have to specify what equilibrium agents choose in each subgame starting in the node corresponding to each realization of the qs. These subgames are complete information subgames of imperfect information (simultaneous offers by all parties). To give some economic content to the analysis, we will restrict our attention to monotone selections. The monotonicity refers to the choices across contracts and for the same realization of the qs. Thus, we say that a selection (for all contracts) is monotone if for any two contracts A and B so that w+b is higher in contract A, then the offers of all firms in contract A are not lower than the offers in contract B for the same realization of the q vector. In particular, assume that $q_I < q_O$ and consider two contracts with the same wage w but different bs. Then, if the incumbent offers to revise down the buy-out fee it will not be to a higher value in the contract with a lower stipulated buy-out fee. That means that higher buy-out fees do not mean lower protection for the incumbent against outside competition (may mean just the same protection).

Under this restriction, the following proposition extends the results of Proposition 1.

Proposition 3

Assume that all qs become common knowledge once the contract is signed, and that renegotiation of the contract is secret. Then :

a) For almost all monotone equilibrium selections Z, an equilibrium contract requires:

(i) $s \geq w$

(ii) $b \geq \bar{q} - w$

(iii) $w = S(Z)$, and $S(Z) = Q - 1.5\, E\,\pi_o(w = S(Z))$, where

$E\,\pi_o(w = S(Z))$ are the expected profits of the outsider when $w = S(Z)$

b) For almost all monotone equilibrium selections, the equilibrium contracts induce an efficient allocation of the worker and there are no layoffs along the equilibrium path. Moreover, whenever the worker quits she pays a revised down buy-out fee, which is positive with positive probability.

Proof of Proposition 3

We follow the following strategy for proving the result. We look at the renegotiation stage, once the qs are realized, and divide the analysis in those cases for which the incumbent has a higher valuation and those in which the outsider has a higher valuation for the worker. We show that the allocation of the worker will be efficient for any contract unless the worker is fired. Among all contracts without firing we then look for the contract that mimimizes outsider's rents: as usual, that would be the equilibrium contract unless distorting the allocation (i.e., designing the contract so that firing occurs in equilibrium) can help reducing outsider's rents. We finally argue, for each case, that firing can only increase these rents, and therefore the equilibrium contract is obtained.

Thus, consider any contract (w,b,s). After both q_O and q_I are known, and if $q_I > q_O$, the incumbent will "bid" the maximum between w + b and q_O. That is, if w + b is higher than q_O then the outsider will (may) bid up to her valuation, but the incumbent prefers not to lower b and keep the worker paying w (unless it is more interesting to fire flat out). (If $w + b < q_0 < q_I$ then I prefers to increase the wage to $w' = q_0 - b$ and keep the worker unless $-s > q_I - (q_o - b)$). The important thing here is that the allocation will be efficient and the outsider makes no profits. However, if the worker is fired, then the outsider does make a profit. Thus, the severance payment that minimizes the outsider's rents in this region satisfies $s \geq w$.

Now assume that $q_R < q_I < q_O$. Here we will have multiplicity of continuation equilibria:

i) If $\max\{w+b, q_R\} < q_I < q_O$, the only equilibrium (with undominated bids) is for both the incumbent and the outsider to bid q_I (offer a wage $w' = q_I - b$) and the same for the outsider. The worker works for the outsider, who makes $q_O - q_I$ profits. The incumbent makes b.

ii) If $b+w > q_I$, let $K \in [q_I, \min\{q_O, b+w\}]$. Then, for any such K there exists an equilibrium where both firms bid K (the incumbent offers b' = K-w), the outsider gets the worker and makes q_O - K, and the incumbent makes K-w.

Now assume that $q_I < q_R < q_O$. Then:

iii) If $q_R > \max\{q_I, b+w\}$, the only equilibrium in undominated strategies is for both the outsider and the residual firms to bid q_R. Then the outsider gets the worker with a profit of $q_O - q_R$, and the incumbent makes a profit of b.

iv) If $q_R < b+w$, again for any $K \in [q_R, \min\{q_O, b+w\}]$ there is an equilibrium in which both the residual, the outsider, and the incumbent bid K (the incumbent sets b' = K-w), the outsider gets the worker and makes q_0 - K, and the incumbent makes K-w. The wages obtained by the worker can easily be computed from the above.

Notice that both in (ii) and (iv) the wage is always w and that the allocation is efficient in (i) through (iv). Also, we have multiplicity, and then need to define an equilibrium selection for each contract, in (ii) and (iv). A such monotone (as defined above) equilibrium selection has K = q_O in (ii) and K = q_R in (iv) in all contracts. With such equilibrium selection neither the allocation nor the outsider's rents depend on w or b, since then rents and allocation are the same in (i) and (ii), and in (iii) and (iv). However, any other monotone equilibrium selection (that is, any in which the outsider does not get the entire income when renegotiating) makes rents in (ii) lower than in (i) and in (iv) lower than in (iii). But notice that whether we are in (i) or (ii), in (iii) or in (iv) for a given realization of the qs depends on w+b. In particular, if $w+b \geq \bar{q}$. then the probability of being in (i) or (iii) is driven down to zero. Thus, for all but one monotone equilibrium selections the contract that minimizes an outsider's rents for an efficient allocation of the worker has $w+b \geq \bar{q}$.

Of course, it may be in the interest of the pair incumbent-worker to introduce distortions in the allocation of the worker if that helps to reduce an outsider's rents. However, notice that the only possibility of introducing distortions is by firing the worker (setting s low enough so that for some realizations of q_I it is in the incumbent's interest to fire the worker). But this distortion, not only reduces total surplus, but also increases the outsider's rents.

We now argue that an equilibrium contract has to be efficient. Indeed, assume otherwise. As we have seen, that only means that the worker is fired for some realizations of the q_s. That is, $q_I - \max\{w, q_O - b\} < -s$ for some q_I , q_O with $q_I > q_O$. Consider increasing b so that $q_I - q_O + b > -s$ for any $q_O < q_I$ for instance, $b \geq \bar{q}$. Consider also increasing s so that $s \geq \bar{q} - w$. Then firing is also eliminated when $w > q_O - b$. This reduces outsiders' rents whenever $q_I > q_O$ (no firing), increases efficiency for those cases of firing, and does not increase rents for outsiders for realizations $q_O > q_I$ (equilibrium selection). Thus, the pair worker-incumbent obtains extra rents, which they can share via w (so that w + b is not reduced).

Then, an equilibrium contract is efficient with no layoffs, and then Proposition 3 follows.

Q.E.D.

C.b. Common workers

We next show that when performance is not public but renegotiation is (i.e., the incumbent's actions at stage 2.2 are observable to outsiders), in all second best efficient equilibria the main qualitative features of the equilibrium described in Proposition 2 hold.

Given that outside firms are able to perfectly observe the revision of the contract, they can update their beliefs about the value of the worker by using the information contained in the actions taken by the incumbent firm (and given that qs are positively correlated). This is a signalling game. Our goal here is to characterize the set of contracts for which there exist second best efficient equilibria. That is, we are only searching for Pareto efficient equilibria of the entire game.

Given the contract parameters (w, b, s), and given the realization of q_I, the choice of the incumbent firm consists of either firing the worker (and paying s), offering an alternative salary w', or a buy-out fee b' .[23] Outside firms make conjectures about the realization of q_I, and about the strategy played by the incumbent firm which imply beliefs about the expected value of their own qs conditional on different actions taken by the incumbent firm. We summarize beliefs in the expected value of the worker for an outsider in the different information sets, that is:

$E(q_i|\text{ firing})$

$E(q_i|\text{ b'})$

$E(q_i|\text{ w'})$

[23] Of course, the option of neither firing the worker nor revising the terms of the contract is a particular case of the above options, where w' = w and b' = b.

Given the conjectures held by outsiders, firm I chooses an action, outside firms offer to employ the worker at a certain wage, and the worker chooses a particular firm in order to maximize her expected utility. In equilibrium these conjectures must be compatible with firm I's strategy. (In particular, $E(q_i| b' = b) = E(q_i| w' = w)$).

Let us define $\gamma \equiv E(q_i|q_I \geq 1)$. The next result characterizes the set of contracts that implement a second best efficient equilibrium.

Proposition 4

Assume that the only information revealed at the beginning of stage 2 is q_I which is observed by the incumbent firm only. Also, assume that renegotiation of the contract is public. Then:

a) A contract (w, b, s) is offered in a second best efficient equilibrium if and only if the following conditions hold:

(i) $s = w - 1$

(ii) $b \geq \gamma - w$

(iii) $w = \alpha$

b) In a second best efficient equilibrium all separations take place through layoffs. Despite the existence of a positive severance payment, if the worker is laid off her utility drops. Firms make zero expected profits.

Condition (ii) guarantees that the worker does not quit, that is, that buy-out fees are sufficiently high. Now, the signalling aspect of contract revision increases competitive pressures from outsiders and, as a result, the contract requires a higher lower bound on buy-out fees (although the minimum lower bound may still be negative). Conditions (i) and (iii) are identical to those in Proposition 2.

<u>Proof of Proposition 4</u>

(I) Suppose that conditions (i), (ii) and (iii) hold; then there exist an equilibrium that is second best efficient, i.e., the worker remains with the incumbent firm if and only if $q_I \geq 1$.

Consider the following strategy for firm I once q_I is revealed:

If $q_I \geq 1$ then $b' = b$ and $w' = w$ (stay put)

If $q_I < 1$ then fire the worker and pay s

Suppose that outsiders' beliefs are such that:

$E(q_i| \text{firing}) = \beta$

$E(q_i | b') < 1$ for all $b' \neq b$

$E(q_i | w') = E(q_i | b' = b) = \gamma$ for all w'

Notice that these beliefs are consistent with the proposed strategy for firm I.

Given that outside firms have the same information and the same beliefs they will offer a wage equal to the expected value of the worker (Bertrand competition). Thus, if the worker is fired she will accept the wage β. If she is not fired she will decide not to quit, since in this case the outsiders' offer is equal to γ, and the gains from staying are greater than the gains from quitting: $\gamma - b \leq w$ (condition (i)).

Let us now consider firm I's action in the second period. Quitting will only take place if firm I reduces the buy-out fee. Given the outside firms´ beliefs, the revisions of the buy-out fee that the worker could accept (so that she leaves the firm with a net wage above w) satisfy $b' < E(q_i | b') - w < 1 - w$. Thus, from condition (ii), firm I strictly prefers firing to letting the worker quit:

$- s = 1 - w \geq b'$.

Hence, in the proposed equilibrium there is never quitting. Also, firm I prefers retaining the worker to firing her if and only if:

$q_I - w \geq - s$

which by condition (ii) holds if and only if $q_I \geq 1$. Thus, given the strategies played by outside firms and the worker, the proposed strategy for firm I in the second period is optimal.

Finally, at the beginning of the game all firms are identical, and thus have incentives to offer such a contract, since this maximizes the expected surplus of the worker subject to the incumbent firm making non-negative profits.

(II) Next we show that if in a second best efficient equilibrium a contract (w, b, s) is offered, then conditions (i), (ii) and (iii) must hold.

In a second best efficient equilibrium, the following must hold

If $q_I \geq 1$ the worker stays at the incumbent firm and works at $w'(q_I)$

If $q_I < 1$ the worker either quits or is fired

First we prove that the probability of quitting along the equilibrium path is zero. Suppose not, i.e., $\exists \Omega \subseteq \{q_I | q_I < 1\}$ with a positive measure, so that $\forall q_I \in \Omega$ firm I offers a buy-out fee $b'(q_I)$ and the worker accepts. First, it has to be the case that $\forall q_I \in \Omega$, $b'(q_I) = b'$, i.e., whenever the worker quits she pays the same revised buy-out fee. Otherwise firm I always chooses the highest of these b' values, since by construction it is always accepted, and then beliefs would be inconsistent with I's strategy. Notice, on the other hand, that $E(q_i| q_{I\in\Omega}) < 1$. That is, similarly as in Proposition 2, $w+b' < 1$, and then for q_I smaller but very close to 1, the equilibrium must involve firing since the incumbent is better off keeping the worker than letting her go ($1-w > b'$). Thus, if there is voluntary quitting with revision of b, then $- s = 1 - w$. This again means no quitting by revising the buy-out fee, since we have $- s > b'$.

With respect to revising w, assume that in equilibrium the worker quits for some wage $w' \geq w$. Then if the equilibrium is efficient, $E(q_i| w') < 1$ and so $w'+b < 1$ too. Let w^s be the smallest of all wages for which the worker stays. Then, for all $q_I \geq 1$, $w'(q_I) = w^s$ (all firms that keep the worker offer her the smallest wage that allows them so). Then outsider's beliefs when observing w^s must be that $q_I \geq 1$, and then their offer to the worker should be $\gamma > 1$. Thus, if firm I manages to keep the worker offering w^s it should be because $w^s + b \geq \gamma > 1$. Thus, $w^s > w' \geq w$. But for efficiency, the firm should be willing to keep the worker for $q_I = 1$, i.e., $1 - w^s \geq b$, which contradicts the fact that $w^s + b > 1$. This contradiction shows that the worker cannot be willing to leave the firm for any wage offer $w' \geq w$. Then voluntary quits cannot occur by revising wages either. The only possibility left is that the worker is fired whenever $q_I < 1$, and kept with $w^s = w$ in an efficient equilibrium. Thus, in any second best efficient contract we will have quitting through firing in equilibrium, and $s = w - 1$. Also, $b \geq \gamma - w$, and for the worker to get the entire surplus, $w = \alpha$.

QED

References

Akerlof, G (1970), The Market for Lemmons: Qualitative Uncertainty and the Market Mechanism, *Quaterly Journal of Economics,* 84, 488-500.

Akerlof, G. and L. Katz (1989), Workers' Trust Funds and the Logic of Wage Profiles, *Quarterly Journal of Economics*, 104, 525-536.

Aghion, P. and P. Bolton (1987), Contracts as a Barrier to Entry, *American Economic Review*, vol. 77, 388-401.

Banerjee, A. and L. Summers (1987), On Frequent Flyer Programs and other Loyalty-Inducing Arrangements, H.I.E.R. No.1337.

Caminal, R. and C. Matutes (1990), Endogenous Switching Costs in a Duopoly Model, *International Journal of Industrial Organization* 8, 353-373.

Cooter, R. and M.A. Einsenberg (1985), Damages for Breach of Contract, *California Law Review*, vol. 73, 1432-1489.

Craswell, R. (1989), Performance, Reliance, and One-Sided Information, *Journal of Legal Studies*, vol. 18, 365-401.

Che,Y.-K. and T.-Y. Chung (1999), Contract Damages and Cooperative Investments, *RAND Journal of Economics*, vol. 30, 84-105.

Chung T.-Y. (1992), On the Social Optimality of Liquidated Damage Clauses: An Economic Analysis, *Journal of Law, Economics and Organization*, vol. 8, 280-305.

Fort R. and Quirk J. (1995), Cross Subsidization, Incentives and Outcomes in Professional Team Sports Leagues, *Journal of Economic Literature*, XXXIII, 3, 1265-1299.

Gibbons, R. and L. Katz (1991), Layoffs and Lemmons, *Journal of Labor Economics*, vol. 9, nº 4, 351-380.

Gilbert R. and C. Shapiro (1997), Antitrust Issues in the Licensing of Intellectual Property: The Nine No-No's Meet the Nineties, *Brooking papers: Microeconomics*, 283-349.

Gordon, D. F. (1974), A Neo-Classical Theory of Keynesian Unemployment, *Economic Inquiry* , 12, 431-459.

Greenwald, B. (1986), Adverse Selection in the Labor Market, *Review of Economic Studies*, 325-347.

Hart, O. (1983), Optimal Labour Contracts under Asymmetric Information: An Introduction, *Review of Economic Studies* 50, 3-35.

Hashimoto, M. (1981), Firm-Specific Human Capital as a Shared Investment, *American Economic Review*, 71, 475-482.

Kahn, Ch. (1985), Optimal Severance Pay with Incomplete Information, *Journal of Political Economy* , 93, 435-450.

Kirman, A. and R. Waldmann (1992), I quit, mimeo European University Institute.

Klemperer, P. (1995), Competition When Consumers Have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics, and International Trade, *Review of Economic Studies*, 62 (4), 515-39.

Laing, D. (1994), Involuntary Layoffs in a Model with Asymmetric Information Concerning Worker Ability, *Review of Economic Studies*, 61, 375-392.

Leitzel, J. (1989), Damage Measures and Incomplete Contracts, *RAND Journal of Economics*, vol. 20, 92-101.

Rogerson, W. (1984), Liquidated Damages and Efficient Reliance and Breach, Mimeo, Department of Economics Northwestern University.

Shavell, S. (1980), Damage Measures for Breach of Contract, *Bell Journal of Economics*, vol. 11, 466-490.

Spier K. E. and M. D. Whinston (1995), On the efficiency of privately stipulated damages for breach of contract: entry barriers, reliance, and renegotiation, *RAND Journal of Economics*, vol. 26, nº 2, Summer 1995, 180-202.