Wage Bargaining and Management Opposition in the Presence of Productivity Gains and Organization Costs

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October 1997

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Abstract

Empirical studies have emphasized three important factors in firm-labor relationships: (a) organization costs of workers, (b) management opposition against workers' organizing drives, (c) the possibility of productivity enhancing effects due to "voice/response" reasons. In this paper the interplay of all three issues is simultaneously analyzed. The possibility of forgone productivity gains puts an upper bound on management opposition against organizing drives of the workers, even if management opposition is cost-less. Strategic gift exchange - less opposition for higher productivity - plays a crucial role. Decreasing productivity gains and increasing the firm's bargaining power lowers management opposition. The equilibrium wage is above the workers' reservation wage.

1 Introduction

Several empirical studies have pointed out that (a) organization costs of workers, (b) management opposition against workers' organizing drives, and (c) the possibility of productivity enhancing effects due to "voice/response" reasons are three important factors in firm-labor relations. Despite these stylized facts no model of wage bargaining has incorporated all three ingredients. In this paper a first step is made to analyze the interplay of organization costs, management opposition, and productivity improving effects of organization. It is also explored how wages, firm's profit, and the optimal level of management opposition are influenced if all three factors are in force.

Arguments that a union or more general organized interest groups can have positive effects on workers' productivity have been put forward by Freeman (1980) and Freeman and Medoff (1984). The reason for these positive effects is the so called "voice/response function" of organizations. Since unions give workers a "voice" in the firm, they can induce higher productivity (by, e.g., lowering quit rates). The idea that "voice" can create "loyalty" and hence a long term affiliation to an organization goes back to an influential book by Hirschman (1970).

Empirical evidence reported by, e.g., Blau and Kahn (1983), Block (1978), Farber (1980), and Freeman (1980), suggests that unionism is indeed a major force in the creation of a permanent relationship. Long-term relations can increase investments in firm-specific human capital. In terms of productivity, the increase in job tenure and reduction in quit rates can raise efficiency by lowering turnover costs, like hiring, training and firing expenses. The empirical results of productivity effects of unions suggest that in most industries there is at least no negative effect. Freeman and Medoff (1984) report the results of production function analysis and conclude that "... most studies of productivity find that unionized establishments are more productive than otherwise comparable non-union establishments". Clark (1980) found that in the U.S. cement industry the positive union effects on productivity are of the order of 6-8 percent. For a more detailed discussion of the empirical literature of union effects on economic performance, see e.g. Addison and Hirsch (1989).

An implication of unionism is that the workers have to bear organization costs. Freeman and Medoff (1984) cite a study by Voos which "suggests that resources spent to organize the unorganized (...) is, indeed, a major determinant of unionization". The organization of workers' meetings to demonstrate power, the organization of ballots and advertising activities in general, as well as the salaries of the union's representatives are immediate organization costs.

In general there are several ways how the management of a firm can make it harder for workers to organize. Freeman and Kleiner (1990) analyzed survey data concerning the opposing behavior of management as a reaction to the organizing drive on the workers' side. They found that the strategies used by firms to deter organization ranges from hiring outside consultants and lawyers, using unfair labor practices to various other activities like distributing company leaflets and letters, captive audience speeches and small meetings between workers and supervisors. Also Freeman (1986) and Freeman and Pelletier (1990) found strong empirical evidence that employer opposition plays an important role for unionization.

Despite these empirical observations wage bargaining models do not take into account that the mechanisms of management opposition, organization costs, and voice/response-driven productivity effects, may be present simultaneously. In this paper I develop a model taking account of all these features of employer-labor relations. The situation is modeled as a two stage game. To capture the idea that the firm can make it harder for workers to organize, management can impose costs on them in case of organizing drives. That is, management opposition directly translates into disutility. The management is assumed to oppose against workers as long as no agreement is reached (if they choose to oppose at all). For simplicity, management opposition is assumed to be cost-less for the firm. Qualitatively, this assumption does not change the results and introducing such costs would in fact even strengthen the implications derived. In the second stage wage bargaining takes place. A modified version of Rubinstein's (1982) bargaining model - in the spirit of Shaked and Sutton (1984), Shaked (1994), Avery and Zemsky (1994) and Henton et al. (1994) - is developed. As in these models, the two agents - here a firm and identical workers, represented by one agent - are assumed to bargain sequentially over discrete time and a potentially infinite horizon. In every time period the workers have to decide if they want to organize. If they decide not to organize they have to accept an ultimatum offer by the firm. In this case the productivity gains of organization are not available. However, if they decide to organize their bargaining position is strengthened and a bargaining round begins. An accepted offer terminates the play. In this case the productivity gains are available. After a rejection the next period begins, again with the organization decision by workers. Furthermore, it is assumed that an old contract exists, where workers receive their reservation wage and the possible productivity gains are not exploited.

In traditional labor economics (see, e.g., Layard et al. (1991)) the possible effect of an organization on the economic performance of a firm is usually subsumed under the term "threat effect". It is argued that a firm always wishes to keep out unions. In order to prevent organization firms pay wages not smaller than the union wage minus the cost of organization. However, if the firm has the possibility to increase workers' organization costs directly it should use this instrument instead of preventing organization by paying higher wages. If this cost increasing activity is not costly for the firm one would expect that the firm will set these costs as high as possible or at least raise it up to a level such that the union wage minus these costs are equal to the non-union wage level. It is an undisputed empirical fact that unionized firms pay higher wages than their non-unionized competitors. Moreover, within many firms some kind of a "social partnership" - in the sense that firms do not try to prevent workers from organizing with all possible means - can be observed. In the presented framework these empirical facts can be explained.

The main results are: If management opposition is not too large multiplicity of equilibria in the bargaining stage of the game arises. The negotiated wage depends crucially on the costs the management imposes on the workers. In general the agreed upon wage is strictly greater than the workers' reservation wage. There is also the possibility of inefficient outcomes where the workers decide not to organize, although both parties could be better off if they would. It is shown that too much opposition can hurt the firm. This puts an upper bound on the optimal level of management

opposition, even though opposition is cost-less. This can be interpreted as a strategic social partnership. It is supported by strategic gift exchange, where higher productivity is exchanged with less opposition. Furthermore, reducing productivity gains lowers optimal management opposition. Increasing the bargaining power of the workers tends to increase management opposition, whereas improving the bargaining position of the management works in the opposite direction.

Related literature

Most wage bargaining models do not take into account the important features of employer-labor relations mentioned above. There are some exceptions which at least deal with the possibility of management opposition explicitly. The two most recent ones are Corneo (1995) and Naylor and Raaum (1993). They study a model of social costum in the line of Akerlof (1980), and analyze how management opposition affects union density. Freeman (1986) and Freeman and Kleiner (1990) deal with the question of the impact of management opposition on union organizing success and its interplay with union wage premiums. All cited papers differ from the presented model not only in the aim of investigation but they also do not take into account the possibility of voice/response effects on productivity. Furthermore, the first two have applied the Nash bargaining solution to determine the outcome of the wage bargaining stage. By the nature of this bargaining solution disagreement never takes place. Since in the model presented in this paper two different disagreement outcomes are possible the Nash solution is not an appropriate concept here (see e.g. Rubinstein et al. (1986)).

The rest of the paper is organized as follows. In Section 2 the model is set up. The equilibria of the bargaining stage, the negotiated wages, the impact of management opposition on profits, and optimal firm behavior on the first stage are analyzed in Sections 3.1 and 3.2. In Section 4 changes in productivity gains and bargaining power and their effect on optimal management opposition is analyzed. An extension of the model - where the firm is allowed to choose the level of management opposition in every period - is presented in Section 5. Section 6 concludes the paper.

2 The Model

Consider the following situation: Two parties - identical workers (for simplicity represented by one player) and a firm - have a contract that specifies the wage that a worker is entitled to per day of work. It is assumed, that with this old contract the workers receive their (exogenously given) reservation wage, denoted by b. The productivity of the workers is given by a production function f_0. At some point in time ($t = 0$) this contract has come up for renegotiation. The workers may feel unhappy with their current situation and therefore think about the possibility of trying to organize, thereby improving their bargaining position. Since the point in time when renegotiation will take place is commonly known the management of the firm may take measures to prevent organization of the workers or at least may try to render it more difficult. For simplicity, it is assumed that management opposition has no direct costs for the firm.[1]

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[1]One may argue that this is not a very realistic assumption. However, as will be shown introducing such costs will not change the qualitative results but will even reinforce the main conclusions.

However there are indirect costs if the management succeeds in its effort to prevent workers from organizing. These costs are due to forgone productivity gains because of the "voice/response function" (VRF) of organizations. If the workers are able to organize the VRF leads to higher productivity.[2]

The institutional design of contract renegotiation is as follows: At time $t = 0$ the management of the firm has to decide about the level of management opposition it will choose in case of worker's organizing drives. Management opposition makes it harder for the workers to organize. This is reflected by the costs they have to bear in case they organize. Therefore the decision problem for the firm on this stage boils down to the problem of choosing a parameter $c \geq 0$ which directly influences the workers' utility in a negative way. The management can commit itself to use this level in every period throughout the whole bargaining process as long as no agreement is reached (later this assumption is relaxed to allow the management to decide on it any number of times). Immediately after that decision the bargaining part of the game begins. The potential periods of play evolve in a discrete manner from 0 to ∞. In each period (as long as no agreement is reached) the workers have to decide if they want to put effort into organizing drives - denoted by $e_t = $ ORG - thereby bearing the costs c chosen by the firm or not ($e_t = $ NOTORG). If the workers decide not to organize the old contract is confirmed. This means that the workers will get their reservation wage and that productivity is "low" (which is reflected by the production function f_0). It is also assumed that the old contract holds thereafter. Another possible interpretation is that in this case the workers are facing an ultimatum wage offer by the firm, which they will surely accept as long as the wage offered is not lower than their reservation wage. If the workers, however, choose $e_t = $ ORG, then on the one hand they have to bear the costs c but on the other hand their bargaining position is improved and a *bargaining round* begins. In this case, firstly nature decides with equal probability who will be the proposer (responder resp.). Secondly, the selected proposer makes a wage proposal which the responder may accept or not. If the responder accepts, an agreement is reached and the new contract is implemented. Now the VRF ensures higher productivity, which is reflected by the production function f. After a rejection the game proceeds to the next period where the workers again have the choice between organizing or not. Depending on this decision the process stops (with low productivity and the reservation wage paid) or a new bargaining round begins, and so on. As long as negotiations take place the old contract applies. Figure 1 depicts the first stage and the beginning of the second stage of the game (In Figure 1, F stands for firm, W for workers, w_f for a wage offer of the firm, w_u for a wage demand of the workers, $(\Pi^u(b,t), U^u(b,t))$ denotes the payoff pair if the old contract is reconfirmed in period t, and $(\Pi^a(x,t), U^u(x,t))$ denotes the payoff pair if a new contract with wage x is signed in period t). It is assumed that the representative worker is only interested in wages and therefore no bargaining about employment takes place. This assumption is confirmed by data Oswald (1993) has collected and analyzed. He shows that (at least in the United States and in Great Britain) unions are only interested in wages and do, in general, not bargain about employment level. One may

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[2]The aim of this paper is to investigate the relationship between VRF and management opposition, therefore I do not want to complicate the model with the possibility that wages may influence workers' effort or productivity like it is assumed in some efficiency wage models (see e.g. Akerlof (1982). Therefore there is no relationship between productivity and wages.
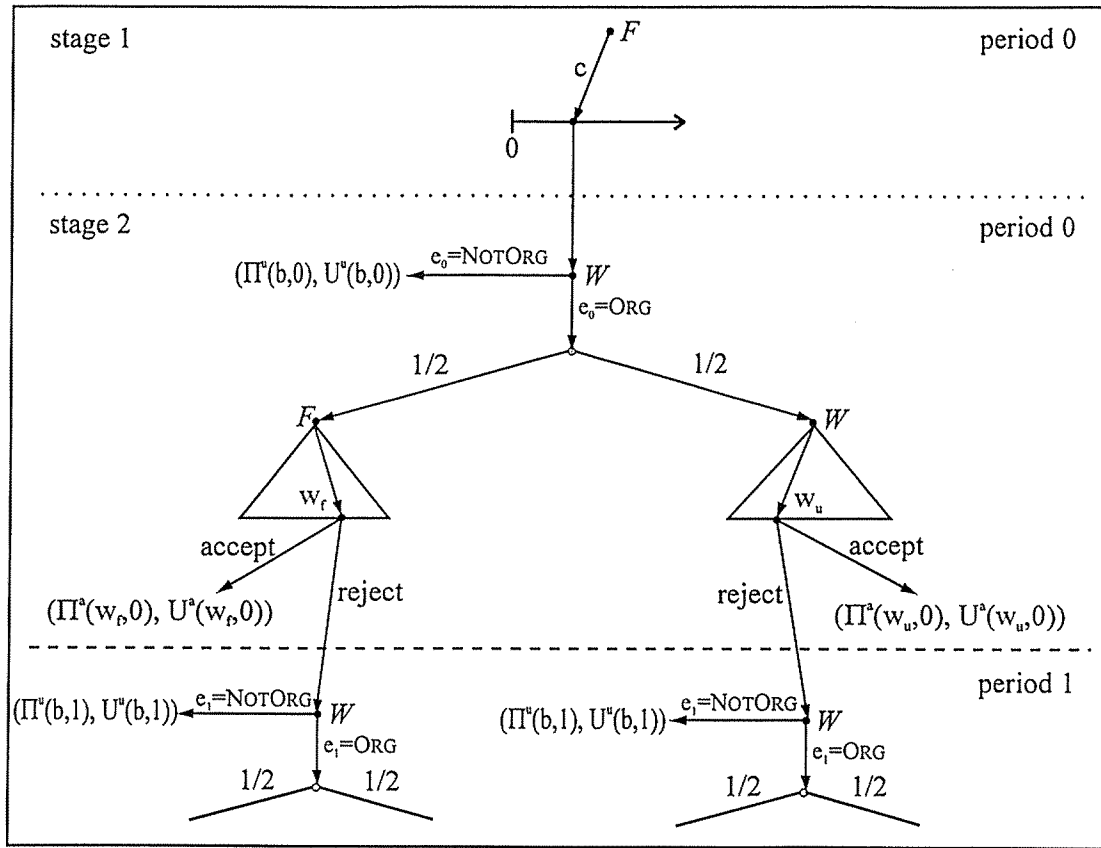
Figure 1: Stage 1 and beginning of stage 2 of the game

also assume that in the past the firm has optimally chosen the employment level - given the wage b and the production function f_0 - but is, because of legal constraints, not able to adjust employment if a new wage agreement is settled. In this case workers have also no incentive to care about the employment level. Lifetime utility is assumed to be separable in time and the instantaneous utility function $u(w; c)$ (where w denotes the wage paid and c the costs imposed by management opposition) of the workers satisfies the following assumptions:

A-1 $u(w; c)$ satisfies the von-Neumann Morgenstern axioms, is continuous, strictly increasing and concave with respect to the wage w. Future utility is discounted with a discount factor $\delta \in]0,1[$. Furthermore, it is strictly decreasing in costs c for any given wage w (i.e. $c_h > c_l \geq 0 \Rightarrow u(w; c_h) < u(w; c_l) \, \forall w$), continuous in a change of the parameter c and $\lim_{c \to \infty} u(b; c) = -\infty$,

NIML Non Increasing Marginal Loss:
Let $c_l < c_h$, then $w \geq v \Rightarrow u(w, c_l) - u(w, c_h) \leq u(v, c_l) - u(v, c_h)$.

Assumption A-1 is straightforward and less restrictive than utility functions usually used in (wage) bargaining models. NIML means that for high wages the loss due to

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an increase of the costs is not larger than for low wages (It is a second order condition since for twice differentiable utility functions NIML is equivalent to $\partial^2 u(w; c)/\partial w \partial c$ not being negative). Utility functions commonly used in applied work satisfy this property. For example the functions $u(w, c) := g(w) - k(c)$ and $u(w, c) := g(w - c)$ satisfy NIML. For the first case it is obvious. In the second example NIML is satisfied because of the concavity of the utility function with respect to the wage level. Furthermore, NIML is a sufficient condition for the derived results, but not necessary.

The firm's profit is also assumed to be separable in time and the firm discounts future profits with a discount factor $\gamma \in\ ]0, 1[$. The firm's instantaneous profit is either given by $\pi_0(b)$ when the old contract applies or by $\pi(w)$ when a new contract has been signed. $\pi_0(b)$ is interpreted to be $\max_n f_0(n) - nb = f_0(n_0^*(b)) - n_0^*(b)b$, where f_0 is the *low productivity* production function. The firm receives this profit during the negotiations as long as no new contract is implemented as well as when workers decide *not to organize*. If however workers organize *and* a new contract with a wage w is signed the firm's profit is given by $\pi(w)$. This profit can be derived in two different ways, depending on the institutional design concerning the employment adjustment possibilities. (i) If the firm has the "right-to-manage" $\pi(w)$ is given by $\max_n f(n) - nw$; (ii) If - due to legal constraints - the firm cannot adjust employment this profit is interpreted to be $f(n_0^*(b)) - n_0^*(b)w$. In both cases f is the *high productivity* production function. For the results presented in this paper no particular assumptions on the profit function are necessary as long as it is strictly decreasing and continuous in w. To capture the idea of VRF the following assumption is made:

VRF Voice/Response Function:
   The production functions f_0 and f are such that $\pi_0(b) < \pi(b)$.

It says that the "voice/response function" of organization is effective, such that if the bargaining partners jointly *agree* on the reservation wage the firm's profit is higher than in the situation where the workers face an ultimatum offer (and have therefore no possibility to choose). Since $\pi(w)$ is strictly decreasing this assumption also implies a (unique) "natural" upper bound on the set of wage agreements. It is given by a wage level w^m where $\pi(w^m) = \pi_0(b)$. Since the firm can always ensure $\pi_0(b)$ for itself the set of possible wage agreements is defined to be $\mathcal{W} := [b, w^m] \neq \emptyset$. Without loss of generality, the instantaneous utility and profit functions are normalized such that $u : [b, w^m] \times [0, \infty[\to\ ] - \infty, 1]$ with $u(b; 0) := 0$; $u(w^m; 0) := 1$ and $\pi : [b, w^m] \to [0, 1]$ with $\pi(w^m) := 0$; $\pi(b) := 1$.

With the above assumptions at hand the players' payoffs associated with the various possible paths of play can be defined. Basically, there are three categories of outcomes: (i) *Permanent disagreement*: This is the case when the workers decide to organize (i.e., choose ORG) in every period, but no offer is ever accepted. The firm then receives in every period the profit associated with the old contract, $\pi_0(b)$. The workers get their reservation wage and have to bear the cost induced by management opposition, in each period.
(ii) *Ultimatum offer by the firm in period $T \geq 0$*: Here the workers choose to organize in every period $t \in \{0, 1, \ldots, T - 1\}$ but give up in period T, where they choose NOTORG. Suppose that all offers up to $T - 1$ have been rejected. This means that the old contract

applies in every period and the firm's payoff is as in (i). The workers are paid their reservation wage in every period, but now they have to bear the costs only in periods 0 to $T-1$. Since they gave up and the old contract is newly implemented the management has no more need to oppose from period T onwards.

(iii) *Agreement on a new contract with wage w in period T*: As long as the workers choose ORG and no agreement is made both parties are paid according to the old contract. Hence in periods 0 to $T-1$ the firm receives $\pi_0(b)$ and the workers get utility $u(b;c)$. In period T the workers again decide to organize but now an agreement on a wage $w \in \mathcal{W}$ is made. This leads to a new contract with this wage and high productivity. Therefore, from T onwards the firm receives the profit $\pi(w)$. The workers get forever w. In period T they have - as in the previous periods - to bear the costs c. After the agreement, however, management terminates its opposing behavior and the workers utility from $T+1$ on is given by $u(w;0)$.[3] The payoffs associated with these outcomes are summarized in Table I.

Table I:

Outcome	Firm's profit	Workers utility
Permanent disagreement	$\sum_{t=0}^{\infty} \gamma^t \pi_0(b)$	$\sum_{t=0}^{\infty} \delta^t u(b;c)$
Ultimatum in period T	$\sum_{t=0}^{\infty} \gamma^t \pi_0(b)$	$\sum_{t=0}^{T-1} \delta^t u(b;c) + \sum_{t=T}^{\infty} \delta^t u(b;0)$
Agreement on w in period T	$\sum_{t=0}^{T-1} \gamma^t \pi_0(b) + \sum_{t=T}^{\infty} \gamma^t \pi(w)$	$\sum_{t=0}^{T-1} \delta^t u(b;c) + \delta^T u(w;c) + \sum_{t=T+1}^{\infty} \delta^t u(w;0)$

With the help of the normalizations of the instantaneous utility and profit function these payoffs can be represented as the closed forms in Table II.

Table II:

Outcome	Firm's profit	Workers utility
Permanent disagreement	$\Pi^d(b,\infty) := 0$	$U^d(b,\infty) := \dfrac{1}{1-\delta} u(b;c)$
Ultimatum in period T	$\Pi^u(b,T) := 0$	$U^u(b,T) := \dfrac{1-\delta^T}{1-\delta} u(b;c)$
Agreement on w in period T	$\Pi^a(w,T) := \dfrac{\gamma^T}{1-\gamma}\pi(w)$	$U^a(w,T) := \dfrac{1-\delta^T}{1-\delta} u(b;c) + \delta^T u(w;c) + \dfrac{\delta^{T+1}}{1-\delta} u(w;0)$

Note, that for any given $c \geq 0$ permanent disagreement is the worst outcome, since $0 \leq \pi(w)$ and $u(b;c) \leq (1-\delta)u(w;c) + \delta u(w;0)$ hold for all $w \in \mathcal{W}$.

Since this is a well defined extensive form game with perfect and complete information the solution concept of subgame perfect equilibria (developed by Selten (1965, 1975)) is appropriate.

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[3]That the management terminates its opposition after a new contract is signed is a natural assumption. Introducing only small but positive costs of management opposition would make it unnecessary. For simplicity, however it is assumed that management opposition is cost-less (see also footnote 1).

3 Wages, profits and management opposition

This section is divided into two parts. In the first part the bargaining game and in the second part the management's decision about the costs it wants to impose on the workers in case of organizing drives is analyzed.

3.1 The impact of management opposition on wages and profits

For the analysis of the bargaining part of the game management opposition (i.e., the cost parameter c) is taken as given. It is natural to ask how the equilibria change when this parameter is altered. As it turns out there a three different types of equilibria which are associated with "small", "intermediate", and "large" cost levels. The costs in an interval $[0, \hat{c}]$ are called small, those in $[\hat{c}, \check{c}]$ intermediate, and all other costs large. The definitions of $\hat{c}$ and $\check{c}$ are derived during the discussion of the equilibria.

It is convenient to ask what the bargaining outcome would be if the workers were committed to organize in every period in which no agreement is reached with the firm. As it will be shown this is equivalent to the case where management opposition is such that the organization costs imposed on workers are small. If the workers are forced to organize in every period the strategic situation is similar to the well known Rubinstein (1982) bargaining game. The difference is that the workers have to bear the additional disutility caused by management opposition. From the Rubinstein analysis it is known that the equilibrium strategies are such that the proposer offers a wage which makes the responder indifferent between acceptance and rejection. In equilibrium such an offer will then always be accepted. In the presented model this means that the firm makes a wage offer w_f and the workers demand a wage level w_u such that the following equations hold:

$$U^a(w_f, T) = \frac{U^a(w_f, T+1) + U^a(w_u, T+1)}{2} \tag{3.1}$$

$$\Pi^a(w_u, T) = \frac{\Pi^a(w_u, T+1) + \Pi^a(w_f, T+1)}{2} \tag{3.2}$$

or equivalently

$$(1 - \delta)u(w_f, c) + \delta u(w_f, 0) = \Delta[(1 - \delta)u(w_u, c) + \delta u(w_u, 0)]$$
$$+ 2\frac{1 - \delta}{2 - \delta}u(b, c), \tag{3.3}$$

$$\pi(w_u) = \Gamma\pi(w_f), \tag{3.4}$$

with $\Delta := \delta/(2 - \delta)$ and $\Gamma := \gamma/(2 - \gamma)$. The existence of such a wage pair is shown in the appendix.[4] However, a solution (w_f^*, w_u^*) to 3.1 - 3.2 (3.3 - 3.4, resp.) is not necessarily unique. A sufficient condition for uniqueness would be log-concavity of the profit function. In general this is not the case. For instance, the often used Cobb-Douglas technology with one input never implies log-concavity of the derived profit

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[4]For easiness of exposition only informal arguments concerning equilibrium strategies and all other claims stated are given, here. All statements of this and the next section are rigorously proved in the appendix. The formal description of the equilibrium strategies can also be found there.

function. This non-uniqueness will lead to multiple equilibria for small values of c. It can be shown, however, that the solution is independent of the period T (this is due to the stationarity of the parties' preferences) and that for any pair (w_f^*, w_u^*) the relation $w_f^* < w_u^*$ holds. The latter reflects the advantage of being the proposer.

The best outcome for the management would be if (i) it only had to pay the reservation wage b and (ii) it is able to extract high productivity. So, the question arises if there is an equilibrium where the workers organize and at the same time are satisfied with an agreement which gives them their reservation wage? And, indeed such an equilibrium exists. It can be found when the cost level reaches the upper bound of the small-costs interval, i.e. if management opposition is such that the costs imposed on workers equals $\hat{c}$. Where $\hat{c} > 0$ is such that

$$(1 - \delta)u(\pi^{-1}(\Gamma); \hat{c}) + \delta u(\pi^{-1}(\Gamma); 0) = -(1 - \delta)u(b; \hat{c}) \qquad (3.5)$$

holds. This upper bound for the small costs is derived in the following way. Suppose for a moment that a stationary subgame perfect equilibrium where the firm always offers b exists. From 3.4 and the normalization of π it follows that $w_u^* = \pi^{-1}(\Gamma \pi(b)) = \pi^{-1}(\Gamma)$. The workers can (in any period T) ensure themselves the payoff $U^u(b, T)$ by deciding not to organize. In the proposed equilibrium they will receive $[U^a(\pi^{-1}(\Gamma), T) + U^a(b, T)]/2$. Therefore, he incentive condition for ORG is $U^u(b, T) \leq [U^a(\pi^{-1}(\Gamma), T) + U^a(b, T)]/2$. After some rearrangements it turns out that if this relation holds with equality it leads to the above definition of $\hat{c}$. In short, $\hat{c}$ is such that even if the worst equilibrium for the workers is played, they still have an incentive to organize.

For small cost levels an increase of c will always work in favor of the management, given the stationary equilibrium. Since knowing that workers will always choose ORG an increase in management opposition simply weakens the bargaining position of the workers, by imposing larger bargaining costs. Hence, the best the management can do is to push up organization costs to $\hat{c}$. The firm then gets $\frac{1}{2}[1 + \Gamma]/[1 - \gamma]$ which corresponds to a wage agreement on b if the management makes the offer and to $\pi^{-1}(\Gamma)$ if the workers make the offer. These observations lead to the following proposition.

Proposition 1
If management opposition is such that the costs imposed on workers in case of organizing drives are small, i.e. $c \leq \hat{c}$, then

(i) There are equilibria where the workers always organize, i.e., choose ORG in every period. If the imposed costs are strictly smaller than $\hat{c}$, then the workers will always organize in any equilibrium.

(ii) The maximal and the minimal equilibrium payoffs of the firm are strictly increasing with the costs imposed on the workers.

(iii) The largest payoff the firm can receive is
$$\frac{1 + \Gamma}{2[1 - \gamma]}.$$
This payoff corresponds to the wage pair $(b, \pi^{-1}(\Gamma))$ at organization costs $\hat{c}$.

(iv) In any equilibrium the (expected) wage is strictly greater than the workers reservation wage b.

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Consider now the opposite benchmark case: an equilibrium where it is never optimal for the workers to organize. This has to be the case at some level of management opposition, since, for any given wage, the workers utility tends to $-\infty$ for infinitely high costs. Now suppose that such an equilibrium where the workers never organize is given and that they have deviated in some period T by choosing ORG. If it is the workers' turn to make an offer the management expects that the workers will stick to the equilibrium behavior in the next period $T + 1$. The workers anticipate that and know therefore that the management will accept any wage offer w_u which gives it at least the profit of rejecting the offer and waiting for the next period. Hence, the firm accepts any wage demand w_u such that $\Pi^a(w_u, T) \geq \Pi^u(b, T + 1)$ holds. Since $\Pi^u(b, T + 1) = 0$ and the payoff of accepting the highest possible wage w^m in period T gives also zero payoff to the firm, it will accept any demand in $\mathcal{W}$. Workers will accept only offers which give them a payoff at least as high as the payoff they can ensure by rejecting and waiting for the next period where they then choose NOTORG. Hence, the wage offer w_f made by the management has to satisfy $U^a(w_f, T) \geq U^u(b, T + 1)$. Using the monotonicity of workers' utility it can be shown that any offer which is greater or equal to the reservation wage satisfies this inequality. Both parties now know that the opponent will accept any offer in the set of possible wage agreements $\mathcal{W}$. Hence, the management will propose b and the workers will propose w^m, and both offers will be accepted in equilibrium. From that the incentive condition for not organizing is easily derived. The workers will choose NOTORG in period T if the inequality $U^u(b, T) \geq [U^a(w^m, T) + U^a(b, T)]/2$ is satisfied. Some rearrangements show, that this is equivalent to $-(1 - \delta)u(b; c) \geq (1 - \delta)u(w^m; c) + \delta u(w^m; 0)$. The cost level $\check{c}$, which is the boundary between intermediate and large costs, is therefore defined to be such that

$$-(1 - \delta)u(b; \check{c}) = (1 - \delta)u(w^m; \check{c}) + \delta u(w^m; 0). \tag{3.6}$$

Whenever the costs imposed on the workers are grater than $\check{c}$ they will not organize, and the old contract with wage b and low productivity applies. The following proposition summarizes these arguments.

Proposition 2
If management opposition is such that the costs imposed on workers in case of organizing drives are large, i.e. $c > \check{c}$, then

   (i) The workers never organize in any equilibrium.
   (ii) The payoff the firm receives is zero.
   (iii) Since the old contract applies the workers are paid their reservation wage b.

So far the "extreme" cases of small and large management opposition have been considered. It turned out that conditions on the cost levels can be found such that the workers either always organize, $c < \hat{c}$, or never organize, $c > \check{c}$. By these reasonings about stationary "organization behavior", for intermediate levels of management opposition - i.e., imposing costs c satisfying $\hat{c} < c < \check{c}$ - neither stationary equilibrium is possible. Any equilibrium has to contain non stationary behavior. In such an equilibrium workers must get at least $U^u(b; T)$ in any given period T. This is their security level, which they can guarantee themselves simply by not organizing. The best for the

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firm would be to give the workers an incentive to organize, to extract the productivity gains from organization, and at to pay the lowest possible wages. To find such an equilibrium a wage pair has to be found which gives the workers their security payoff and induces organization. Consider such a pair of wage proposals (w_f, w_u) where the firm makes it highest possible profit. Hence, let the management's wage offer w_f exactly be the reservation wage b. This implies that the wage demand $\tilde{w}_u$ which maximizes the firms' profit must satisfy $U^u(b, T) = [U^a(b, T) + U^a(\tilde{w}_u, T)]/2$, which can be rewritten as

$$(1 - \delta)u(\tilde{w}_u; c) + \delta u(\tilde{w}_u; 0) = -(1 - \delta)u(b; c). \tag{3.7}$$

Such an outcome is supported by punishment strategies. The most important punishment is that the workers now can credibly threaten not to organize when the firm does not accept their offer. This was not possible for small costs. Whenever the management deviates and rejects a wage demand the workers will not organize and equilibrium behavior will change to the strategies supporting the equilibrium for large organization costs. With this punishment strategy the workers can - when they are chosen to make a proposal - force the management to accept the wage w^m. This already shows that in such an equilibrium (i) the wage outcome is not unique and (ii) the negotiated wage is strictly greater than the workers' reservation wage. A further outcome which is sustainable in an equilibrium is one where the workers choose right at the beginning not to organize. In this case the old contract is reinforced (A complete characterization of the equilibrium supporting the described outcomes is given in the appendix.). The above reasoning shows that the smallest payoff the firm can make is zero (when the old contract applies) whereas the maximal payoff for a given level of intermediate management opposition is $[\Pi^a(b, 0) + \Pi^a(\tilde{w}_u, 0)]/2$. Using the definitions and the normalization of the firm's payoff this gives

$$\frac{1 + \pi(\tilde{w}_u)}{2(1 - \gamma)}.$$

Since (because of NIML) the workers utility decreases less at higher wages than at lower ones when c increases it follows from 3.7 that $\tilde{w}_u$ must increase with c. This implies that a higher level of management opposition *decreases* the maximal payoff the firm can make. This somewhat surprising effect is due to the already mentioned threat of the workers not to organize. If the firm wants to extract the productivity gains and if the workers' threat is effective the management has to compensate the workers for higher organization costs by paying higher wages. As will be shown in the next section this is the major force which puts an upper bound on the optimal level of management opposition. From the monotonicity of the firm's maximal profits with respect to c it is clear that the maximum the firm can get is associated with organization costs $\hat{c}$. Denote the wage $\tilde{w}_u$ which corresponds to $\hat{c}$ by $\hat{w}_u$. Then by 3.7 this wage level must satisfy $(1 - \delta)u(\hat{w}_u; \hat{c}) + \delta u(\hat{w}_u; 0) = -(1 - \delta)u(b; \hat{c})$. With the definition of $\hat{c}$ (see 3.5) this holds if and only if $\hat{w}_u = \pi^{-1}(\Gamma)$. Therefore, the following proposition can be stated:

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Proposition 3
If management opposition is such that the costs imposed on workers in case of organizing drives are in the intermediate range, i.e., $c \in [\hat{c}, \check{c}]$, then

(i) *There are (non stationary) equilibria where organization of the workers take place. However, there is also the possibility that they do not organize.*

(ii) *The maximal equilibrium payoff of the firm is strictly decreasing with the costs imposed on workers. The minimal equilibrium payoff of the firm is associated with the old contract and therefore independent of management opposition.*

(iii) *The maximum the firm can receive is*
$$\frac{1 + \Gamma}{2[1 - \gamma]}.$$
This payoff corresponds to the wage pair $(b, \pi^{-1}(\Gamma))$ at organization costs $\hat{c}$.

(iv) *In any equilibrium the (expected) wage is greater or equal than the workers reservation wage b.*

3.2 Too much management opposition hurts the firm

Proposition 1 of the preceding section yields a result one would intuitively expect: as long as management opposition is cost-less, the maximum the firm can get is associated with high organization costs for the workers. However, by Proposition 3, the situation changes when the cost level $\hat{c}$ is reached. From that point on it may hurt the firm if the management increases the costs imposed on workers. What are the forces behind the increase of minimal and maximal profits for small costs and the decrease of the maximal profits for intermediate costs? The workers may threaten the management to impose the opportunity costs of forgone productivity gains on the firm by sticking to the old contract. Since the workers are weak in the sense that their outside option only gives them the reservation wage this threat is not credible as long as the organization costs imposed on them are small. For that reason an increase of management opposition works in favor of the firm. However, at $\hat{c}$ this weakness turns to a *credible* threat. As long as the costs are not too high, i.e., not greater than $\check{c}$, the gains from cooperation are still large enough such that the opponents can reach an agreement where (at least) one of them is better off compared to the alternative where the old contract is reinforced. The management therefore has an incentive to induce organizational effort on the workers' side. For intermediate cost levels, however, the firm has to compensate the workers for these costs. The only possible mean of compensation is to pay higher wages, which lowers profit. As long as the cost are smaller than $\check{c}$ the management can credibly commit itself to pay this compensation.

The maximum the firm can get corresponds to a level of management opposition which imposes costs $\hat{c}$ on the workers. As long as the parties agree to play the equilibria which give the firm the highest possible profit it is clear that the firm has any incentive to choose such a cost level. That is, (i) the firm has no incentive to set the costs prohibitively high and (ii) if the gains from cooperation are exploited the firm has also no incentive to increase management opposition as far as possible (i.e. impose costs of $\check{c}$). However, the equilibria which are best for the management are the worst for the workers. Therefore there is no reason for the opponents to coordinate on them. So

the question arises if it is possible to find (non trivial) upper bounds on management opposition which are independent of the equilibria actually played? To answer this question the minimal equilibrium profits for low cost levels will be compared with the maximum equilibrium profits for intermediate cost levels. That is, the worst equilibria for the firm in case of little management opposition are compared with the best equilibria for the firm in case of intermediate management opposition.[5] To show that management opposition is bounded above by imposing organization costs not larger than $\hat{c}$ it suffices to find conditions which guarantee that the worst the firm can get by imposing costs smaller than this level is still better than the best it can get by imposing costs greater than $\hat{c}$. Two sufficient conditions can be derived which lead to this upper bound.

Theorem 1 OPTIMAL MANAGEMENT OPPOSITION IS BOUNDED ABOVE
Independent of the equilibria actually played in the bargaining part of the game, the following holds.

> *(i) If the firm is patient enough, i.e., if γ is sufficiently nearby 1, then optimal management opposition is bounded above. The management will never impose costs strictly greater than $\hat{c}$ on the workers.*
> *(ii) If the system 3.3 - 3.4 has a unique solution at $\hat{c}$ then,*
>> *(a) management never chooses to impose costs strictly greater than $\hat{c}$ on the workers, and*
>> *(b) never chooses to impose costs of zero, i.e., not to oppose at all.*

The first statement imposes restrictions on the impatience of the firm. For the second statement to be valid restrictions on the curvature of the profit function are necessary. Since in real world negotiations a bargaining round seldom takes longer than some days the assumption of discount factors close to unity nearby one is not implausible. The following simple example explores the second part of the above result. Suppose that the workers are risk neutral and that utility is additive separable with respect to the wage and the organization costs and that the firm possesses a Cobb-Douglas technology of the form $f(n) = n^{0.5}$. The instantaneous utility function and the instantaneous profit function are then given by $u(w; c) = w - c$ and $\pi(w) = (4w)^{-1}$. The equilibrium wages and profits for a given management opposition are easily calculated by using the formulas of the preceding section. Figure 2 below depicts the (normalized) expected payoff for the firm in dependence of the costs imposed on workers. As can be seen, for low cost levels the equilibrium profit increases and is unique. For intermediate costs, i.e. for $c \in [\hat{c}, \check{c}]$, uniqueness is gone since there exist equilibria were the workers decide not to organize. Furthermore, the maximal equilibrium profit decreases with c. In this example the levels of organization costs which cut offs small from intermediate and intermediate from large costs are:

$$\hat{c} = \frac{b(w^m - b)}{\gamma w^m + 2b(1-\gamma)} \frac{1-\gamma}{1-\delta}, \quad \check{c} = \frac{w^m - b}{2(1-\delta)}.$$

For costs larger than $\check{c}$ the workers never decide to organize and the firm's profit is therefore zero. In inspecting the picture one can easily see that the firm will never choose

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[5]The case of large management opposition is not taken into account, because it is clear that imposing such cost levels cannot be optimal if the minimal profits for small costs are strictly greater than zero.
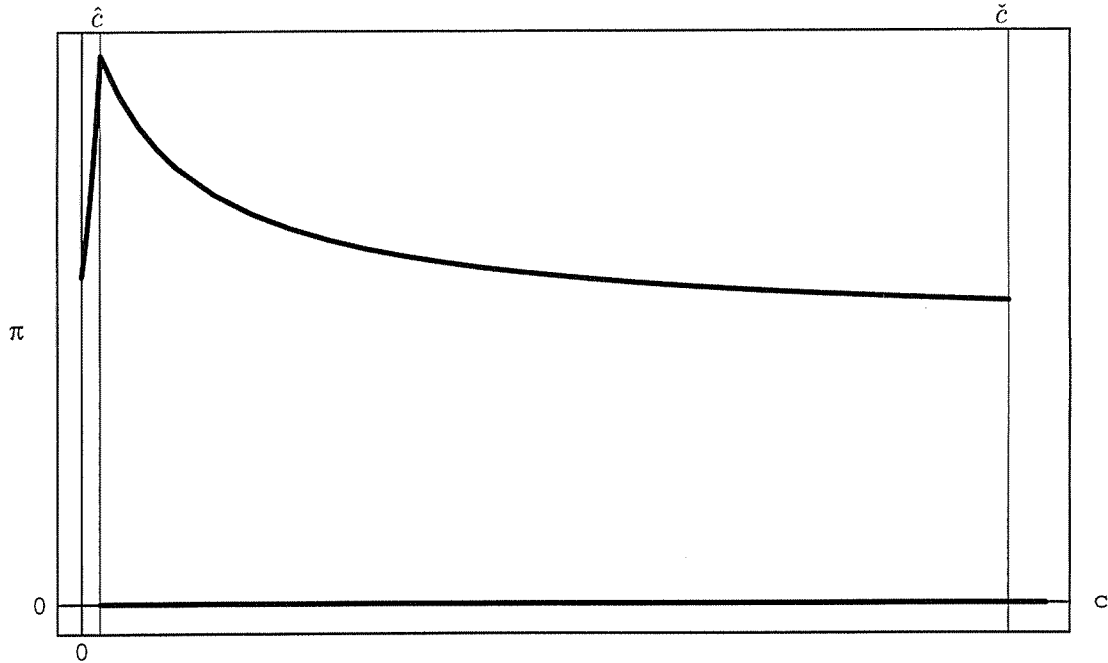
Figure 2: Expected maximal and minimal equilibrium profits as a function of c

a level of management opposition which leads to organization costs strictly larger than $\hat{c}$, as well as it will never choose not to oppose at all (compare part (ii) of Theorem 1). Since there are several equilibria for intermediate costs it is not clear which cost level the firm actually will choose. If, for instance, the parties agree to play an equilibrium where the firm gets the highest possible payoff at $\hat{c}$ then the firm will choose $\hat{c}$ in the first stage. But, on the other hand, if they always play an equilibrium where the firm does not get its best payoff no optimal choice of the firm exists. This non-existence of an optimal c, however, can be overcome if it is assumed that cost levels can only be chosen in a discrete manner. Then the firm will decide to choose either $\hat{c}$ or the largest cost level which is strictly smaller than $\hat{c}$.

Theorem 1 shows that even if management opposition is cost-less the firm has no incentive to deter workers from organizing. The upper bound on management opposition can be interpreted as some kind of social partnership, a phenomenon which is observed in the real world. With the possibility of productivity gains due to organizations (the VRF) this result shows that *strategic* gift exchange may play a crucial role in wage bargaining situations. The gifts exchanged are: Higher productivity on the workers side and less management opposition on the side of the firm. The result that the management will always choose to oppose follows from the assumption that the there are no costs of management opposition. If such costs are introduced it could well happen that the management does not react at all to organizing drives by the workers. This of course strengthens the result that there will be a kind of social partnership within the firm.

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4 The impact of bargaining power and productivity gains on optimal management opposition

The upper bound on the level of management opposition predicted by the model is affected in various ways by parameters influencing the outcome of the wage negotiation stage. In particular, the size of the productivity gains and the discount factors play an important role. To be able to analyze the impact of these exogenous parameters it is assumed that one of the two conditions assumed in Theorem 1 holds, in this section.

4.1 Decreasing productivity gains lowers management opposition

The major driving force for the result that the firm does not try to increase the workers' organization costs above a certain level is that there are forgone productivity gains when workers decide not to organize. This guarantees that the management has no incentive to prevent workers from organizing with all possible means (i.e., to set c above $\check{c}$). The disadvantage of the workers of bearing the organization costs turns out to be an effective threat against the firm if the costs are raised above some certain level. This threat is given by the possibility of forgone productivity gains, which imposes opportunity costs on the firm. This has led to the observation that the firm will never choose a c strictly larger than $\hat{c}$. It is therefore natural to look more closely at the impact of a change in the productivity gains on the level of management opposition. Consider a reduction in these gains. The effect of course is that the (additional) surplus the workers and the management can negotiate upon will be reduced. This means that for a given level of c the firm's profit will be decreased. The optimally chosen level of management opposition lies in the region where the organization costs of the workers work in favor of the firm. The management has, therefore, c.p. an incentive to increase these costs in order to maintain it's profit level. On the other hand, however, the bargaining position of the workers is weakened in the sense that the forgone productivity gains are getting smaller and the firm can get the same profit level with less opposition. The next proposition shows that the second effect dominates the first, which gives the firm an incentive to lower the workers' organization costs. Before stating result the "reduction of productivity gains" has to be defined: The productivity gains due to the VRF of organization are lower if, for every given wage, the profit of the firm is lower than in the original situation. That is, if π is the profit function in the original situation and π_l the profit function in the less productive situation then, $\pi_l(w) < \pi(w)$ for all $w \in]b, w^m[$.

Theorem 2
Optimal management opposition decreases with decreasing productivity gains. More formally, let $\hat{c}_l$ and $\hat{c}$ be defined as in the previous section, then $\pi_l(w) < \pi(w) \ \forall w \in]b, w^m[$ implies $\hat{c}_l < \hat{c}$.

This says that a decrease in the productivity gains shifts the upper bound $\hat{c}$ of optimal organization costs to the left, i.e. towards smaller levels of management opposition. The result that a strategic social partnership exists is therefore strengthened.

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4.2 Increasing the firm's bargaining power decreases management opposition

In this section the impact of the player's discount factors on the optimal level of management opposition is analyzed. The discount factors can be interpreted as a measure of the bargaining power of the players. In the original bargaining game of Rubinstein (1982), for instance, the payoff of the player who becomes more patient (i.e. who's discount factor increases while leaving the discount factor of the opponent constant) increases. Furthermore, as the discount factor approaches one this player receives the whole surplus in the limit. The firm has two sources of bargaining power: the exogenously given discount factor and the endogenously determined organization costs imposed on workers. Since management opposition is assumed to be cost-less there seems to be no reason for the management to change its strategy when the exogenous bargaining power is increased. It should simply lead to a higher payoff at the expense of workers. However, the definition of $\hat{c}$ (see 3.5) shows that this upper bound of the optimal level of management opposition depends on the firm's discount factor γ (as well as on the discount factor δ of the workers). The following statement can be proved.

Theorem 3
An increase in the firm's discount factor γ leads to a decrease of $\hat{c}$. That is, an increase in the firm's bargaining power lowers (the upper bound of) optimal management opposition. Furthermore, in the limit (i.e. $\gamma \to 1$) optimal management opposition vanishes completely.

This is a rather surprising result, since it holds although there are no costs of management opposition. The intuition behind it is that whenever cost levels at or above $\hat{c}$ are reached the workers' threat not to organize becomes effective. By increasing the firm's bargaining power this point is reached earlier, since it is defined to be such that there is an equilibrium where the firm can extract almost all of the gains from cooperation. This, in turn, implies that the workers have to threaten not to organize already at lower levels of management opposition.

A similar result holds when the workers' bargaining power is changed. An increase of the worker's patience works against the firm. The bargaining position of the workers is strengthened and the firm becomes relatively weaker. Therefore, an increase in the worker's *impatience* should lead to a decrease of opposition by the management. This is indeed the case as the following result shows.

Theorem 4
Decreasing the worker's bargaining power decreases management opposition.

For the limit case of $\delta \to 0$ the management's opposition decision is completely undetermined. The reason is that the workers will accept any offer no matter how high or low the organization costs imposed by the firm are. Therefore the firm will propose a wage b, which the worker will accept, and gets the highest possible payoff. If the firm would have some (small) costs of management opposition, then of course the firm will always choose c equal to zero.

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5 An extension

So far it has been assumed that the firm has to choose the level of management opposition at the very first stage and has to stick to it as long as no agreement is reached. This of course may lead do a commitment problem on the firm's side, since the management may want to change c in some later period. The model can be is extended to allow the management to choose the opposition level in every period in which no agreement is reached. It will be shown that there is an equilibrium where the results concerning the level of management opposition derived in the previous sections are still valid.

Consider those equilibria of the unextended game where the play ends in every period with an immediate agreement or with the ultimatum offer made by the firm. Propositions 1 - 3 show that such equilibria exist for any given level of c. Assume that c^* is an optimal level given these equilibria in the unextended version of the model. That means, given an equilibrium agreement (w_f^*, w_u^*) of the bargaining stage, c^* maximizes the firm's profit. It will be shown that if the firm chooses $c_t = c^*$ in every period t, and both the firm and the workers apart from that behave like prescribed by the equilibrium strategies of the unextended game, this is an equilibrium of the extended model. To prove that consider an arbitrary period T. Suppose that the firm chooses in this period a cost level $c_T \neq c^*$ but, thereafter, immediately returns to the proposed strategy. Since there will be an immediate agreement or the ultimatum case the firm will get at most $\max\{\frac{\gamma^T}{2(1-\gamma)}[\pi(w_f^*(c)) + \pi(w_u^*(c))], 0\}$. But, choosing c^* as prescribed leads to the payoff $\frac{\gamma^T}{2(1-\gamma)}[\pi(w_f^*(c^*)) + \pi(w_u^*(c^*))]$ which is by the definition of c^* not smaller than the above deviation payoff. Hence, such a deviation does not pay. By the one-shot deviation principle and the construction of the proposing/responding behavior this is an equilibrium, and the firm always chooses the same level of management opposition which coincides with the optimal level in the unextended model. This implies that all results concerning the level of management opposition established in the previous sections are still valid in this equilibrium.

6 Conclusions

This paper has shown that even if management opposition against organizing drives by workers is cost-less the management has, in general, no incentive to deter workers from organizing by all possible means. Both parties are completely rational and fully informed. Hence, this result is solely driven by strategic considerations. The upper bound on the level of management opposition can be interpreted as some kind of (strategic) social partnership between management and the workers, an institution which can actually be observed in the real world. With the assumption that the "voice/response function" allows for productivity gains this result shows that a strategic gift exchange may play a crucial role in wage bargaining situations. This holds even if both parties are solely driven by selfish and egoistic behavior. The gifts exchanged here are more productivity on the workers' side and less opposition on the employer's side. The driving force for this result is that in the wage bargaining stage of the game the management prefers on the one hand to pay low wages, but is on the other hand also interested in

high productivity. Management opposition weakens the bargaining power of the workers and leads, therefore, c.p. to lower wages. Since the workers have to be compensated for the costs imposed by that opposition if they try do organize, the firm has to pay higher wages if it wants to extract the productivity gains induced by the voice/response function of organization. It is this trade-off which drives the result. At some level of opposition the second effect dominates the first and too much opposition hurts the firm.

Reducing productivity gains lowers the optimal level of management opposition. The reason is that if these gains are reduced the opportunity costs for the firm in case of no cooperation are also reduced. These opportunity costs, however, directly influence the bargaining power of workers and weakens their bargaining position. Therefore, the management can lower the costs imposed on the workers in case of organizing drives and still maintain its profits. These effects, lead to the straightforward extension of endogenizing productivity decisions. In the light of the above described result workers may have an incentive to be more productive because this strengthens their bargaining position. On the other hand, however, management opposition may also be increased. It would be interesting to analyze under which conditions the first effect dominates the second. This then may explain why in some sectors unionized firms are more productive than non-unionized ones; and why in other sectors the opposite is true.

The bargaining power of the two parties work in opposite directions. If the workers become more patient the level of management opposition tends to be increased, whereas if the firm's discount factor increases management opposition is reduced. For almost completely patient firms the rather strong result that management opposition vanishes holds.

It has also been shown that in general the negotiated wages are higher than the reservation wage of the workers. This is consistent with the stylized fact that unionized firms pay in general higher wages than non-unionized ones.

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Appendix

A Proofs of Proposition 1 - 3 of Section 3.1

The proofs are given in a sequence of lemmas.

A.1 Proof of Proposition 1

For Proposition 1 it is first proved that the system of equations 3.1 - 3.2 has a solution for all $c \leq \hat{c}$, and that any solution is independent of the period T. Furthermore, it is shown that any solution (w_f^*, w_u^*) satisfies $w_f^* < w_u^*$. Thereafter the existence of $\hat{c}$ and some properties in connection with this cost level are proved. Then the existence of a subgame perfect equilibrium with the desired properties is stated and proved. This then proves part (i) of Proposition 1.

Define $\pi_i := \pi(w_i)$ for $w_i \in \mathcal{W}$ and the function $h : [0,1] \times [0, \infty[\rightarrow] - \infty, 1]$, where $h(\pi_i; c) := u(\pi^{-1}(\pi_i); c)$. This means that an agreement on a wage w_i assigns a profit $\pi_i = \pi(w_i)$ to the firm and a utility $h(\pi_i; c) = u(\pi^{-1}(\pi_i); c) = u(w_i; c)$ to the workers. $i \in \{f, u\}$ indicates if w_i is a proposal made by the firm (f) or by the workers (u). Since π^{-1} is strictly decreasing and u is strictly increasing in its first argument it follows that $h(\pi_i; c)$ is strictly decreasing in π_i. Also because of these monotonicity properties the functions are well defined and to every profit/utility pair corresponds a unique wage level. Furthermore define

$$
\begin{aligned}
H(\pi_f, c) := \ & (1 - \delta)h(\pi_f, c) + \delta h(\pi_f, 0) \\
& - \Delta[(1 - \delta)h(\Gamma \pi_f, c) + \delta h(\Gamma \pi_f, 0)] - 2\frac{1 - \delta}{2 - \delta}u(b, c) \qquad \text{(A.1)}
\end{aligned}
$$

where $\Delta := \frac{\delta}{2 - \delta} \in]0, 1[$ and $\Gamma := \frac{\gamma}{2 - \gamma} \in]0, 1[$. This function will be very helpful in what follows. The following result helps to identify potential candidates for SPEs if the cost level is small.

Lemma 1 Solution(s) of the "Fundamental Equations"
There exists a $\tilde{c} > 0$ such that for any T the following system of equations has for all $c \in [0, \tilde{c}]$ a solution $(w_f(c), w_u(c)) := (w_f^*, w_u^*) \in \mathcal{W} \times \mathcal{W}$, which is independent of T.

$$
U^a(w_f, T) = \frac{U^a(w_f, T+1) + U^a(w_u, T+1)}{2} \qquad \text{(A.2)}
$$

$$
\Pi^a(w_u, T) = \frac{\Pi^a(w_u, T+1) + \Pi^a(w_f, T+1)}{2} \qquad \text{(A.3)}
$$

For every solution the relation $w_f^* < w_u^*$ holds.

Proof: The system of equations in the above Lemma is 3.1 - 3.2 of section 3.1 which is by the definitions of $U^a(w_f, T)$ and $\Pi^a(w_u, T)$ equivalent to 3.3 - 3.4 of section 3.1,

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which are stated below, once more.

$$(1 - \delta)u(w_f, c) + \delta u(w_f, 0) = \Delta[(1 - \delta)u(w_u, c) + \delta u(w_u, 0)]$$

$$+ 2\frac{1 - \delta}{2 - \delta}u(b, c) \qquad (A.4)$$

$$\pi(w_u) = \Gamma\pi(w_f) \qquad (A.5)$$

Hence a solution (if one exists) is independent of T. Note that - using the definitions preceding the Lemma - the above system A.4 - A.5 has a solution if and only if the equation

$$(1 - \delta)h(\pi_f; c) + \delta h(\pi_f; 0) - \Delta[(1 - \delta)h(\Gamma\pi_f; c) + \delta h(\Gamma\pi_f; 0)]$$

$$- 2\frac{1 - \delta}{2 - \delta}u(b; c) = 0, \qquad (A.6)$$

has a solution, or equivalent if $H(\pi_f, c)$ has a root. This function is a composition of continuous functions and therefore also continuous (in its first argument). What has to be shown is that there exists a $\tilde{c} > 0$ such that this function has a root for all $c \in [0, \tilde{c}]$.

Case 1: $c = 0$

In this case H becomes

$$H(\pi_f; 0) = h(\pi_f; 0) - \Delta h(\Gamma\pi_f; 0) \qquad (A.7)$$

For $\pi_f = 0$ and $\pi_f = 1$ one gets

$$H(0; 0) = h(0; 0) - \Delta h(0; 0) = 1 - \Delta > 0 \qquad (A.8)$$

$$H(1; 0) = h(1; 0) - \Delta h(\Gamma; 0) = -\Delta h(\Gamma; 0) < 0 \qquad (A.9)$$

Hence, since H is continuous the existence of a root is assured in this case.

Case 2: $c > 0$

The function H shifts continuously with c and the values $H(0; 0)$ and $H(1; 0)$ are strictly bounded away from zero, it follows that there exists a $\tilde{c} > 0$ such that $H(0; \tilde{c}) > 0$ and $H(1; \tilde{c}) < 0$ holds. Therefore, again because of the smoothness of H in π_f and c, it follows, that $H(\pi_f; c)$ has a root for any $c \in [0, \tilde{c}]$.

$w_f^* < w_u^*$ holds since it is a necessary condition for $\pi(w_u^*) = \Gamma\pi(w_f^*)$ ($\pi(.)$ is decreasing and $\Gamma < 1$). $\qquad \square$

Lemma 2 THE H-FUNCTION SHIFTS UPWARD WITH c

For any $\pi_f \in [0, 1]$ the statement $c_l < c_h \Rightarrow H(\pi_f; c_l) < H(\pi_f; c_h)$ holds.

Proof: Let π_f be in $[0, 1]$. Then after some tedious manipulations it follows that

$$H(\pi_f; c_l) < H(\pi_f; c_h)$$

$$\Leftrightarrow$$

$$(2 - \delta)[h(\pi_f; c_l) - h(\pi_f; c_h)] < \delta[h(\Gamma\pi_f; c_l) - h(\Gamma\pi_f; c_h)] + 2[u(b; c_l) - u(b; c_h)]$$

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Since the term on the r.h.s. is largest for $\delta = 0$ and the terms on the l.h.s. are smallest for $\delta = 0$ (h is strictly decreasing in it's second argument) it suffices to show that

$$h(\pi_f; c_l) - h(\pi_f; c_h) \leq u(b; c_l) - u(b; c_h)$$

holds. By definition of h this is equivalent to

$$u(\pi^{-1}(\pi_f); c_l) - u(\pi^{-1}(\pi_f); c_h) \leq u(b; c_l) - u(b; c_h).$$

By assumption is π_f in $[0, 1]$ and therefore $\pi^{-1}(\pi_f) \in [b, w^m]$. The property NIML of the utility function now ensures that the inequality holds. $\square$

The following Lemma states that there is some cost level for which the boundary point $\pi_f = 1$ is a root of the above defined function $H(\pi_f; c)$. Since it is shown that the cost level in question is exactly $\hat{c}$ this also proves that $\tilde{c}$ in the Lemma above can be replaced by $\hat{c}$.

Lemma 3 EXISTENCE OF A ROOT OF H AT $\pi_f = 1$

Let $\hat{c} > 0$ be s.th. $(1 - \delta)h(\Gamma; \hat{c}) + \delta h(\Gamma; 0) = -(1 - \delta)u(b; \hat{c})$, then

(i)
$$H(1; \hat{c}) = 0,$$

(ii)
$$c < \hat{c} \Leftrightarrow (1 - \delta)h(\Gamma; \hat{c}) + \delta h(\Gamma; 0) > -(1 - \delta)u(b; \hat{c}),$$

(iii)
$$c \in [0, \hat{c}[\text{ and } \tilde{\pi}_f \in [0, 1] \Rightarrow (1 - \delta)h(\Gamma\pi_f; c) + \delta h(\Gamma\pi_f; 0) > -(1 - \delta)u(b; c)$$

Proof: Define $F(c) := (1-\delta)h(\Gamma; c)+\delta h(\Gamma; 0)+(1-\delta)u(b; c)$. This function is continuous, strictly decreasing, diverges to $-\infty$ for $c \to \infty$ and $F(0) = h(\Gamma; 0) > 0$. Hence $\hat{c} > 0$ exists and is unique. (i) Is found by setting $\pi_f = 1$ in $H(\pi_f; \hat{c})$ and using the equation which determines $\hat{c}$. (ii) Follows from the existence of $\hat{c}$ and the monotonicity of F. The third statement follows from (ii) and $[\pi_f \leq 1 \Rightarrow (1 - \delta)h(\Gamma\pi_f; c) + \delta h(\Gamma\pi_f; 0) \geq (1 - \delta)h(\Gamma; c) + \delta h(\Gamma; 0)]$. $\square$

Lemma 4 EXISTENCE OF A SUBGAME PERFECT EQUILIBRIUM WHERE THE WORKERS ALWAYS ORGANIZE

(i) If $c \in [0, \hat{c}]$ then the strategy combination (σ_1^*, ω_1^*) described in Table A.I below is a (stationary) subgame perfect equilibrium.

Table A.I: Equilibrium strategies for $c \in [0, \hat{c}]$

		S_1
Firm	propose	w_f^*
	accept	$w_u \leq w_u^*$
Workers	e	ORG
	demand	w_u^*
	accept	$w_f \geq w_f^*$
Transition		*absorbing*

where the indices f and u refer to an offer made by the firm (the workers, resp.) and (w_u^*, w_f^*) denotes a particular solution of the system of equations A.2 - A.3.

(ii) In any SPE the workers choose $e_t = $ ORG $\forall t$ as long as $c \in [0, \hat{c}[$.

Proof: (i) Since it is assumed that $0 \leq c \leq \hat{c}$ a solution (w_u^*, w_f^*) of the system of equations A.2 - A.3, with $w_u^* \geq w_f^*$, exists for every c. To see that the above described pair of strategies form a subgame perfect equilibrium (SPE) it suffices to check for one-shot-deviations, only (see Fudenberg and Tirole (1991), and Harris (1986)).

Consider an arbitrary period $T \geq 0$. If the firm proposes a $w > w_f^*$ this will be accepted and the firm will be worse off. If the firm proposes a wage less than w_f^* it will be rejected and the firm can expect to get at most $\Pi^a(w_u^*, T)$ which is smaller than $\Pi^a(w_f^*, T)$. If it rejects the proposal w_u^*, it can again expect to get at most $\Pi^a(w_u^*, T)$ which is exactly that what it will get if it follows the proposed strategy. Hence, there is no profitable deviation from the proposed strategy, given the workers stick to their proposed strategy.

For the workers the arguments concerning the demand/acceptance behavior are similar. The more interesting part is the opting in behavior. If the workers decide to choose $e_T = $ NOTORG they will get the payoff $U^u(b, T)$. If they follow the proposed strategy they will get the expected payoff $\frac{1}{2}[U^a(w_u^*, T) + U^a(w_f^*, T)]$. Hence it has to be shown that $U^u(b, T) \leq \frac{1}{2}[U^a(w_u^*, T) + U^a(w_f^*, T)]$ holds. Using the definitions of the payoffs and rearranging it, it can be shown that this inequality is equivalent to

$$0 \leq (1 - \delta)u(w_u^*; c) + \delta u(w_u^*; 0) + (1 - \delta)u(w_f^*; c) + \delta u(w_f^*; 0).$$

Using the fact that (w_u^*, w_f^*) is a solution of the system A.2 - A.3 one gets that this is equivalent to

$$(1 - \delta)u(w_u^*; c) + \delta u(w_u^*; 0) \geq -(1 - \delta)u(b; c)$$

which is in turn (by definition of h and the fact that $w_u^* = \pi^{-1}(\pi(w_f^*))$) equivalent to

$$(1 - \delta)h(\Gamma\pi(w_f^*); c) + \delta h(\Gamma\pi(w_f^*); 0) \geq -(1 - \delta)u(b; c).$$

This statement is true since $c \in [0, \hat{c}]$ and $\pi(w_f^*) \in [0, 1]$ (see Lemma 3). Hence a deviation is not profitable and the strategy combination described in Table A.I is subgame perfect.

(ii) It will be shown that in each SPE, after any history, it is optimal for the workers to organize, i.e. to choose $e_t = $ ORG instead of $e_t = $ NOTORG, as long as $0 \leq c < \hat{c}$ holds. Write $u_u^f(T)$ and $u_u^u(T)$ for the minimal utility the workers can expect to get in any SPE where the firm (workers resp.) makes a wage offer in period T, and define $u_u(T) := \frac{1}{2}[u_u^u(T) + u_u^f(T)]$. Analogously write $\Pi_f^f(T)$ and $\Pi_f^u(T)$ for the maximal profit the firm can expect to get in any SPE where the firm (workers resp.) makes a wage offer in period T, and define $\Pi_f(T) := \frac{1}{2}[\Pi_f^u(T) + \Pi_f^f(T)]$. (For notational simplicity we assume that these minima and maxima actually exist. All arguments given also hold if infima and suprema would be used, instead.) The equilibrium wage offers associated with the minimal equilibrium payoff of the workers (which in turn give the maximal payoff for the firm) are denoted by $\underline{w}_u$ and $\underline{w}_f$ if the workers (the firm resp.) make the offer.

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Claim 1: $u_u^f(T) \geq \max\{U^u(b, T+1), u_u(T+1)\}$ where $U^u(b, T+1)$ is the payoff the workers get if they decide to choose $e_{T+1} = \text{NotOrg}$, and this inequality is equivalent to

$$-(1-\delta)u(b; c) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0) \geq$$
$$\max\{0, \tfrac{1}{2}\delta[(1-\delta)u(\underline{w}_u; c) + \delta u(\underline{w}_u; 0) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0)]\}.$$

Proof of Claim 1: Consider a subgame starting in period T with a wage offer of the firm. In any SPE the firm has to propose a wage w_f s.th. the utility of the workers is at least the maximum of $U^u(b, T+1)$ and $u_u(T+1)$, since otherwise the workers would be strictly better off in rejecting the offer and waiting for the next period. But then the wage offer made by the firm would not be an equilibrium offer. Since this has to be true for any equilibrium wage offer it has to be true for the offer which give the workers the minimal payoff, too. Hence, the above inequality holds. The equivalence of the two inequalities follows from the definition of the payoff and the fact that there is a one-to-one relationship between utility and wage. □

Claim 2: $\underline{w}_u$ is s.th. $\Pi^a(\underline{w}_u, T) \leq \max\{\Pi^u(b, T+1), \Pi_f(T+1)\}$ or, which is equivalent, s.th. $\pi(\underline{w}_u) \leq \gamma \max\{0, \tfrac{1}{2}[\pi(\underline{w}_u) + \pi(\underline{w}_f)]\}$.

Proof of Claim 2: Consider now a subgame starting in period T after the workers have made a wage offer. If the firm rejects an offer it can expect to get at most the maximum of $\Pi^u(b, T+1)$ and $\Pi_f(T+1)$. Hence, the firm will accept any wage offer w_u for which the inequality $\Pi^a(w_u, T) > \max\{\Pi^u(b, T+1), \Pi_f(T+1)\}$ holds. Since $\Pi^a(w, T)$ is continuous and strictly decreasing, there exists an $\epsilon > 0$ s.th. a wage offer $w_u + \epsilon$ is still accepted. But in this case the workers would be better off and therefore no w_u with $\Pi^a(w_u, T) > \max\{\Pi^u(b, T+1), \Pi_f(T+1)\}$ can be an equilibrium wage offer. Hence, the stated inequality holds. The second inequality follows again from the definition of the payoffs. □

What has to be shown is that, for any T, it is always better for the workers to organize than to do it not, i.e. that the inequality $U^u(b, T) < u_u(t)$ holds. Suppose not, i.e. $U^u(b, T) \geq u_u(T)$, or equivalent

$$0 \geq (1-\delta)u(\underline{w}_u; c) + \delta u(\underline{w}_u; 0) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0). \tag{A.10}$$

Furthermore,

$$-(1-\delta)u(b; c) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0) \geq$$
$$\max\{0, \tfrac{1}{2}\delta[(1-\delta)u(\underline{w}_u; c) + \delta u(\underline{w}_u; 0) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0)]\}.$$

For

$$0 \geq (1-\delta)u(\underline{w}_u; c) + \delta u(\underline{w}_u; 0) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0).$$

the last inequality reduces to

$$-(1-\delta)u(b; c) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0) \geq 0. \tag{A.11}$$

To possible case have to be distinguished.

Case 1: $\Pi_f(T+1) > \Pi^u(b, T+1)$, hence $\underline{w}_u$ is s.th. $\Pi^a(\underline{w}_u, T) \leq \Pi_f(T+1)$ or, which is equivalent, s. th. $\pi(\underline{w}_u) \leq \gamma \tfrac{1}{2}[\pi(\underline{w}_u) + \pi(\underline{w}_f)]$, which is in turn equivalent

to $\pi(\underline{w}_u) \leq \Gamma\pi(\underline{w}_f)$. This implies $h(\pi(\underline{w}_u); c) \geq h(\Gamma\pi(\underline{w}_f); c)$. Together with A.10 it follows

$$0 \geq (1-\delta)h(\Gamma\pi(\underline{w}_f); c) + \delta h(\Gamma\pi(\underline{w}_f); 0) + (1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0).$$

This, in turn, together with A.11 implies

$$(1-\delta)h(\Gamma\pi(\underline{w}_f); c) + \delta h(\Gamma\pi(\underline{w}_f); 0) \leq -(1-\delta)u(b; c).$$

But since $0 \leq \pi(\underline{w}_f) \leq 1$ this is a contradiction to $c \in [0, \hat{c}[$.

Case 2: $\Pi_f(T+1) \leq \Pi^u(b, T+1)$, hence $\underline{w}_u$ is s.th. $\Pi^a(\underline{w}_u, T) \leq \Pi^u(b, T+1)$ or, which is equivalent, s.th. $\pi(\underline{w}_u) \leq 0$. This implies $h(\pi(\underline{w}_u); c) \geq h(0; c)$. Together with A.10 and A.11 this implies

$$(1-\delta)h(0; c) + \delta h(0; 0) \leq -(1-\delta)u(b; c),$$

which again contradicts $c \in [0, \hat{c}[$. Therefore $U^u(b, T) < u_u(T)$ indeed holds and thus it is always better for the workers to organize. $\square$

Next parts (ii) - (iv) of Proposition 1 are proved.

Lemma 5 PROPERTIES OF THE MINIMAL AND THE MAXIMAL PAYOFFS OF THE FIRM FOR $c \in [0, \hat{c}[$

Let $(\overline{w}_f^*, \overline{w}_u^*)$ be the maximal and $(\underline{w}_f^*, \underline{w}_u^*)$ be the minimal wage pair which are solutions to the system A.2 - A.3.

(i) For $c \in [0, \hat{c}[$ the minimal expected subgame perfect equilibrium payoffs are given by $(\overline{w}_f^*, \overline{w}_u^*)$ and the maximal expected subgame perfect equilibrium payoffs are given by $(\underline{w}_f^*, \underline{w}_u^*)$, i.e. the minimal (resp. maximal) expected payoffs for the firm in any SPE coincide with the minimal (resp. maximal) expected payoffs given by the (stationary) equilibria stated in Lemma 4.

(ii) If $c \in [0, \hat{c}[$ then the minimal and the maximal payoffs of the firm are strictly increasing with the workers' organization costs c.

Proof: Consider the minimal profits first. (i) For $c \in [0, \hat{c}[$ the workers decides to choose $e_t = \text{ORG}$ in any subgame perfect equilibrium (Lemma 4). In other words the alternative payoffs do not play a role in determining the equilibrium payoffs. Knowing this and using the notation $\overline{w}_f$ and $\overline{w}_u$ for the equilibrium wage agreements which give the firm the minimal payoff in a subgame where the firm (workers resp.) has to make an offer one gets that in any period t the firm will reject any wage offer w_u where $\Pi^a(w_u, T) < \frac{1}{2}[\Pi^a(\overline{w}_u, T+1) + \Pi^a(\overline{w}_f, T+1)]$, since it would be better off then. Hence such an offer cannot be an equilibrium offer and therefore the inequality $\Pi^a(\overline{w}_u, T) \geq \frac{1}{2}[\Pi^a(\overline{w}_u, T+1) + \Pi^a(\overline{w}_f, T+1)]$, which is equivalent to $\pi(\overline{w}_u) \geq \Gamma\pi(\overline{w}_f)$ must hold. The workers, on the other hand, will accept any offer w_f with $U^a(w_f, T) > \frac{1}{2}[U^a(\overline{w}_u, T+1) + U^a(\overline{w}_f, T+1)]$. In this case, because of the continuity and monotonicity of the utility function and the profit function, the firm could slightly decrease the wage offer such that it is still accepted and makes the firm better off. Therefore such an offer can also not be an equilibrium offer and the inequality $U^a(\overline{w}_f, T) \leq \frac{1}{2}[U^a(\overline{w}_u, T+1) + U^a(\overline{w}_f, T+1)]$ which

is equivalent to $(1-\delta)u(\overline{w}_f,c)+\delta u(\overline{w}_f,0) \le \Delta[(1-\delta)u(\overline{w}_u,c)+\delta u(\overline{w}_u,0)]+\frac{2(1-\delta)}{2-\delta}u(b,c)$ must hold, too. By definition of the minimal (expected) equilibrium payoffs of the firm the inequality $\Pi^a(\overline{w}_u,T)+\Pi^a(\overline{w}_f,T) \le \Pi^a(\overline{w}_u^*,T)+\Pi^a(\overline{w}_f^*,T) \Leftrightarrow \pi(\overline{w}_u)+\pi(\overline{w}_f) \le (1+\Gamma)\pi(\overline{w}_f^*)$ must also hold. Using $\pi^{-1}(\overline{\pi}_f) := \pi^{-1}(\pi(\overline{w}_f)) = \overline{w}_f$ and $\pi^{-1}(\overline{\pi}_u) := \pi^{-1}(\pi(\overline{w}_u)) = \overline{w}_u$ the above inequalities become

$$\Gamma\underline{\pi}_f \;\le\; \underline{\pi}_u \tag{A.12}$$

$$(1-\delta)h(\underline{\pi}_f;c)+\delta h(\underline{\pi}_f;0) \;\le\; \Delta[(1-\delta)h(\underline{\pi}_u;c)+\delta h(\underline{\pi}_u;0)]$$
$$+\frac{2(1-\delta)}{2-\delta}u(b;c) \tag{A.13}$$

$$\underline{\pi}_u+\underline{\pi}_f \;\le\; (1-\Gamma)\underline{\pi}_f^* \tag{A.14}$$

It will be shown now that these inequalities hold with equality. Consider the second inequality first and suppose that the inequality is strict. Since the first inequality implies that $h(\underline{\pi}_u;c) \le h(\Gamma\underline{\pi}_f;c)$ for all c one gets

$$(1-\delta)h(\underline{\pi}_f;c)+\delta h(\underline{\pi}_f;0) \;<\; \Delta[(1-\delta)h(\Gamma\underline{\pi}_f;c)+\delta h(\Gamma\underline{\pi}_f;0)]$$
$$+\frac{2(1-\delta)}{2-\delta}u(b;c)$$

which is equivalent to $H(\underline{\pi}_f;c) < 0$. Since $\underline{\pi}_f^*$ is the smallest root of $H(\underline{\pi}_f;c)$ and $H(0,c) > 0$, it follows that $H(\pi_f;c,.) > 0$, $\forall \pi_f \in [0,\pi_f^*[$. Furthermore $H(\underline{\pi}_f^*;c) = 0$, hence $\underline{\pi}_f > \underline{\pi}_f^*$, which implies that $\underline{\pi}_u + \underline{\pi}_f > (1-\Gamma)\underline{\pi}_f^*$; a contradiction. Hence A.13 holds with equality. A.12 also holds with equality, because again suppose not, i.e. $\Gamma\underline{\pi}_f < \underline{\pi}_u$ this again implies that $H(\underline{\pi}_f,c) < 0$, and therefore leads to a contradiction. It follows that $(\overline{w}_f,\overline{w}_u)$ are determined by the same system of equations as $(\overline{w}_f^*,\overline{w}_u^*)$ and therefore coincide.

(ii) Consider the minimal equilibrium payoff when it is the firms turn to propose an offer. Let $\underline{\pi}_f^l$ be the payoff associated with cost level c_l and $\underline{\pi}_f^h$ associated with cost level c_h. If $0 \le c_l < c_h < \hat{c}$ then, by the "upward shift property" of the H-function and the definition of $\underline{\pi}_f^h$ and $\underline{\pi}_f^l$, it follows that $H(\underline{\pi}_f^h,c_l) < H(\underline{\pi}_f^h,c_h) = H(\underline{\pi}_f^l,c_l) = 0$. Since $H(\pi_f,c_l) > 0 \;\forall \pi_f \in [0,\underline{\pi}_f^l[$, $H(\underline{\pi}_f^h,c_l) < 0$ implies that $\underline{\pi}_f^h > \underline{\pi}_f^l$. Since $\underline{\pi}_u = \Gamma\underline{\pi}_f$, $\underline{\pi}_u$ is also increasing with c.

The proof for the maximal payoffs is very similar. Again using the fact that in any SPE the workers will choose $e_t = \text{ORG}$ in every period. Denote the equilibrium wage agreements which give the firm the maximal payoff in a subgame where the firm (resp. the workers) has to make an offer by $\underline{w}_f$ (resp. $\underline{w}_u$). Let T be an arbitrary period. If w_u is such that $\Pi^a(w_u,T) > \frac{1}{2}[\Pi^a(\underline{w}_u,T+1)+\Pi^a(\underline{w}_f,T+1)]$, then this offer will always be accepted by the firm, since it cannot expect to get more than the value on the r.h.s. of this equation. But then the workers could slightly decrease the offer. This offer will still be accepted and the workers would be better off. Therefore such an offer cannot be an equilibrium offer and one gets $\Pi^a(\underline{w}_u,T) \le \frac{1}{2}[\Pi^a(\underline{w}_u,T+1)+\Pi^a(\underline{w}_f,T+1)]$, which is equivalent to $\pi(\underline{w}_u) \le \Gamma\pi(\underline{w}_f)$. Using the same notation as in the proof for the minimal payoffs this is

$$\Gamma\overline{\pi}_f \;\ge\; \overline{\pi}_u. \tag{A.15}$$

Furthermore, an offer w_f for which the inequality $U^a(w_f, T) < \frac{1}{2}[U^a(\underline{w}_u, T+1) + U^a(\underline{w}_f, T+1)]$ holds cannot be an equilibrium offer, too. The workers would be better off in rejecting such an offer and just waiting for the next period. Hence, $U^a(\underline{w}_f, T) \geq \frac{1}{2}[U^a(\underline{w}_u, T+1) + U^a(\underline{w}_f, T+1)]$, which is equivalent to $(1-\delta)u(\underline{w}_f; c) + \delta u(\underline{w}_f; 0) \geq \Delta[(1-\delta)u(\underline{w}_u; c) + \delta u(\underline{w}_u; 0)] + 2\frac{1-\delta}{2-\delta}u(b; c)$. That is,

$$(1-\delta)h(\overline{\pi}_f; c) + \delta h(\overline{\pi}_f; 0) \geq \Delta[(1-\delta)h(\overline{\pi}_u; c) + \delta h(\overline{\pi}_u; 0)] \quad (A.16)$$
$$+ 2\frac{1-\delta}{2-\delta}u(b; c).$$

Again by the definition of the maximal expected equilibrium payoffs the inequality

$$\overline{\pi}_u + \overline{\pi}_f \geq (1+\Gamma)\overline{\pi}_f^* \quad (A.17)$$

must also hold. Suppose that A.16 is strict. A.15 implies $h(\overline{\pi}_u; c) \geq h(\Gamma\overline{\pi}_f; c)$ and therefore

$$(1-\delta)h(\overline{\pi}_f; c) + \delta h(\overline{\pi}_f; 0) > \Delta[(1-\delta)h(\Gamma\overline{\pi}_f; c) + \delta h(\Gamma\overline{\pi}_f; 0)] \quad (A.18)$$
$$+ 2\frac{1-\delta}{2-\delta}u(b; c).$$

which is equivalent to $H(\overline{\pi}_f; c) > 0$ must hold. By definition is $\overline{\pi}_f^*$ the largest root of $H(\pi_f; c)$ and furthermore $H(1; c, .) < 0$ for all c in $[0, \hat{c}[$. Hence, $H(\pi_f; c, .) < 0$ for all π_f in $]\overline{\pi}_f^*, 1]$ and therefore $\overline{\pi}_f < \overline{\pi}_f^*$. Together with A.15 this implies $\overline{\pi}_u + \overline{\pi}_f < (1+\Gamma)\overline{\pi}_f^*$, which contradicts A.17. Hence, A.16 holds with equality. A.15 also holds with equality since if not, $h(\overline{\pi}_u; c) > h(\Gamma\overline{\pi}_f; c)$ and therefore $H(\overline{\pi}_f; c) > 0$ again. Which leads to a contradiction as just established. Hence, the pair $(\underline{w}_f, \underline{w}_u)$ is determined by the same system of equations as $(\underline{w}_f^*, \underline{w}_u^*)$ and therefore coincide.

The proof that the maximal expected equilibrium payoffs of the firm are strictly increasing in c is almost the same as for the minimal payoffs and therefore omitted here.

This proves part (ii) of Proposition 1. Parts (iii) and (iv) are easily verified using the fact that the maximal payoff of the firm is strictly increasing with c, that b is an equilibrium offer of the firm, and the definition of the payoff function.

A.2 Proof of Proposition 2

First the existence of $\check{c}$ - the lower bound for large costs - and some properties are proved.

Lemma 6 EXISTENCE AND PROPERTIES OF $\check{c}$

Let $\check{c} > 0$ be s.th. $(1-\delta)h(0; \check{c}) + \delta h(0; 0) = -(1-\delta)u(b; \check{c})$ then,

(i)

$$c > \check{c} \Leftrightarrow (1-\delta)h(0; c) + \delta h(0; 0) < -(1-\delta)u(b; c)$$

(ii)

$$\hat{c} < \check{c}$$

Proof: Define $G(c) := (1-\delta)h(0;c)+\delta h(0;0)+(1-\delta)u(b;c)$. This function is continuous, strictly decreasing, diverges to $-\infty$ if $c \to \infty$ and $G(0) = h(0;0) = 1$. Hence $\check{c} > 0$ exists and is unique. (i) Follows straightforward from the existence of $\check{c}$ and the monotonicity of G. (ii) Suppose not, i.e. $\check{c} \leq \hat{c}$. This implies $u(b;\check{c}) \geq u(b;\hat{c})$ which is equivalent to (see definitions of $\check{c}$ and $\hat{c}$)

$$(1-\delta)h(0;\check{c}) + \delta h(0;0) \leq (1-\delta)h(\Gamma;\hat{c}) + \delta h(\Gamma;0).$$

$[0 < \Gamma \Rightarrow h(0;c) > h(\Gamma;c)]$ leads to

$$(1-\delta)h(\Gamma;\hat{c}) + \delta h(\Gamma;0) < (1-\delta)h(0;\hat{c}) + \delta h(0;0)$$

hence $h(0;\check{c}) < h(0;\hat{c})$ which is a contradiction to the fact that h is strictly decreasing in c. $\qquad\square$

Lemma 7 EXISTENCE OF A SUBGAME PERFECT EQUILIBRIUM WHERE THE WORKERS ALWAYS DECIDE NOT TO ORGANIZE

(i) If $c \in [\check{c}, \infty[$ then the strategy combination (σ_2^*, ω_2^*) described in Table A.II below is a subgame perfect equilibrium.

Table A.II: Equilibrium strategies for $c \in [\check{c}, \infty[$

		S_1
Firm	propose	b
	accept	$w_u \leq w^m$
Workers	e	NOTORG
	demand	w^m
	accept	$w_f \geq b$
Transition		*absorbing*

(ii) In any SPE the workers choose $e_t = \text{NOTORG} \, \forall t$ as long as $c \in]\check{c}, \infty[$.

Proof: (i) This strategies will also be used to prove the existence of an equilibrium for intermediate cost levels, and are proved there. The only difference is that the state is absorbing here whereas it is not for intermediate costs. It remains to show that $e = \text{NOTORG}$ is optimal. If the workers deviate in some period T they can expect to get $\frac{1}{2}[U^a(w^m, T) + U^a(b, T)]$. This is not greater than $U^u(b, T)$, since after some calculations it turns out that $\frac{1}{2}[U^a(w^m, T) + U^a(b, T)] \leq U^u(b, T)$ is equivalent to $(1-\delta)h(0;c) + \delta h(0;0) \leq -(1-\delta)u(b;c)$ which is exactly the condition for $c \geq \check{c}$.

(ii) This is proved in a similar way as the result that the workers always organize if $c \in [0, \hat{c}[$ holds. $\qquad\square$

This proves part (i) of Proposition 2. Parts (ii)-(iii) follow straightforwardly.

A.3 Proof of Proposition 3

Lemma 8 EXISTENCE OF A SUBGAME PERFECT EQUILIBRIUM FOR INTERMEDIATE COST LEVELS

If $c \in [\hat{c}, \check{c}]$ then the strategy combination (σ_3^*, ω_3^*) described in Table A.II below is a subgame perfect equilibrium.

Table A.III: Equilibrium strategies for $c \in [\hat{c}, \check{c}]$

		S_1	S_2	S_3
Firm	propose	b	b	b
	accept	$w_u \leq w^m$	$w_u \leq \tilde{w}_u$	$w_u \leq w^m$
Workers	e	ORG	ORG	NOTORG
	demand	w^m	$\tilde{w}_u$	w^m
	accept	$w_f \geq b$	$w_f \geq b$	$w_f \geq b$
Transition		if *firm* rejects $w_u \leq w^m \to S_3$	if *firm* rejects $w_u \leq \tilde{w}_u \to S_3$	if *workers* choose $e = \text{ORG} \to S_2$
		if *workers* reject $w \geq b \to S_2$		

$\tilde{w}_u$ *is given by the equation*

$$(1 - \delta)u(\tilde{w}_u; c) + \delta u(\tilde{w}_u; 0) = -(1 - \delta)u(b; c).$$

Proof: First it is shown that for $c \in [\hat{c}, \check{c}]$ a unique $\tilde{w}_u \in [b, w^m]$ satisfying the above equation exists. This is equivalent to the existence of a unique $\tilde{\pi} \in [0, 1]$ satisfying the equation

$$(1 - \delta)h(\tilde{\pi}; c) + \delta h(\tilde{\pi}; 0) = -(1 - \delta)u(b; c).$$

Define the continuous and strictly decreasing function $A(\tilde{\pi}) := (1-\delta)h(\tilde{\pi}; c) + \delta h(\tilde{\pi}; 0) + (1 - \delta)u(b; c)$. $A(0) = (1 - \delta)h(0; c) + \delta h(0; 0) + (1 - \delta)u(b; c) \geq 0$ because c is assumed not to be greater than $\check{c}$ (see Lemma 6 part (i) above). For $\tilde{\pi} = 1$ the inequality $A(1) \leq 0$ holds. Since, suppose not, i.e. $(1 - \delta)h(1; c) + \delta h(1; 0) > -(1 - \delta)u(b; c)$. $1 > \Gamma$ implies $h(1; c) < h(\Gamma; c)$ for all $c \geq 0$ and therefore, $(1 - \delta)h(\Gamma; c) + \delta h(\Gamma; 0) > (1 - \delta)h(1; c) + \delta h(1; 0)$, hence

$$(1 - \delta)h(\Gamma, c) + \delta h(\Gamma, 0) > -(1 - \delta)u(b, c),$$

which is equivalent to $c < \hat{c}$ and therefore a contradiction.

Before checking for possible deviations the following claim is proved.

Claim: For any $T \geq 0$ the following holds:

(i) $U^a(b, T) \geq \frac{1}{2}[U^a(\tilde{w}_u, T + 1) + U^a(b, T + 1)]$,   (iii) $U^a(\tilde{w}_u, T) \geq U^a(b, T)$,

(ii) $U^u(b, T) = \frac{1}{2}[U^a(\tilde{w}_u, T) + U^a(b, T)]$,   (iv) $U^a(b, T) = U^u(b, T + 1)$.

Proof of the claim: (i) Suppose not, i.e. $U^a(b, T) < \frac{1}{2}[U^a(\tilde{w}_u, T + 1) + U^a(b, T + 1)] \Leftrightarrow -(1 - \delta)u(b; c) < (1 - \delta)u(\tilde{w}_u; c) + \delta u(\tilde{w}_u; 0)$. By definition of $\tilde{w}_u$ this is equivalent to $-(1 - \delta)u(b; c) < -(1 - \delta)u(b; c)$ which is a contradiction. (ii) $U^u(b, T) = \frac{1}{2}[U^a(\tilde{w}_u, T) + U^a(b, T)] \Leftrightarrow (1 - \delta)u(\tilde{w}_u, c) + \delta u(\tilde{w}_u, 0) = -(1 - \delta)u(b, c)$ which is true by definition of $\tilde{w}_u$. (iii) Is obvious

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since $\tilde{w}_u \in [b, w^m]$ and $U^a(w, T)$ is strictly increasing with w. (iv) $U^a(b, T) = U^u(b, T+1) \Leftrightarrow$ $(1 - \delta^{T+1})u(b, c) = (1 - \delta^T)u(b, c) + \delta^T(1 - \delta)u(b, c) = (1 - \delta^{T+1})u(b, c)$. $\qquad \square$

To check that the proposed strategy combination is indeed subgame perfect it has to be shown that no player, in any state, can increase his payoff by a one-shot deviation. Consider an arbitrary period $T > 0$.

State S_1:

Firm:
1. To propose a wage greater than b is obviously worse than proposing b.

2. If the wage offer w^m is rejected, then the state changes immediately to S_3. The workers will choose $e = \text{NotOrg}$ and the profit of the firm therefore will be $\Pi^a(b, T+1) = 0$. Hence this kind of deviation is not payoff increasing, too.

Workers:
1. To demand less than w^m is worse than demanding w^m as prescribed.

2. If the wage offer b is rejected, than the state changes immediately to S_2. In this case the workers can expect to get the payoff $\frac{1}{2}[U^a(\tilde{w}_u, T+1) + U^a(b, T+1)]$, which is not greater than $U^a(b, T+1)$ (see Claim part (i)), the payoff they would get in following the proposed strategy.

3. Choosing $e = \text{NotOrg}$ gives $U^u(b, T)$, whereas in sticking to the prescribed strategy they will get $\frac{1}{2}[U^a(w^m, T) + U^a(b, T)]$ which is not smaller than $\frac{1}{2}[U^a(\tilde{w}_u, T) + U^a(b, T)] = U^u(b, T)$ (see Claim part (ii)). This deviation is therefore also not profitable.

State S_2:

Firm:
1. As above.

2. If the firm rejects $\tilde{w}_u$ the state will change to S_3 where it gets a payoff of zero. But since $\tilde{w}_u \in [b, w^m)$ it follows that $\pi(\tilde{w}_u) \in [0, 1)$. The deviation is again not profitable.

Workers:
1. To demand less than $\tilde{w}_u$ is worse than to demand $\tilde{w}_u$, as prescribed.

2. To demand more than $\tilde{w}_u$ leads to an expected payoff of $\frac{1}{2}[U^a(\tilde{w}_u, T+1) + U^a(b, T+1)]$. Following the prescribed strategy gives $U^a(\tilde{w}_u, T)$. Combining $U^a(\tilde{w}_u, T) \geq U^a(b, T)$ (see Claim part (iii)) with $U^a(b, T) \geq \frac{1}{2}[U^a(\tilde{w}_u, T+1) + U^a(b, T+1)]$ (see Claim part (i)) it follows that this kind of deviation is not profitable.

3. Rejecting b leads again to the payoff $\frac{1}{2}[U^a(\tilde{w}_u, T+1) + U^a(b, T+1)]$ which is again not greater than $U^a(b, T)$, the payoff the workers will get in following the prescribed strategy.

4. Choosing $e = \text{NotOrg}$ gives $U^u(b, T)$. Choosing $e = \text{Org}$ gives $\frac{1}{2}[U^a(\tilde{w}_u, T) + U^a(b, T)]$ which is equal to $U^u(b, T)$ (see Claim part (ii)).

State S_3:

Firm:
1. As above.

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2. If the firm rejects w^m it will get a profit of zero, since the workers choose $e = \text{NotOrg}$. Hence, the deviation is not profitable.

Workers: 1. As in state S_1.

2. Rejecting b leads to the payoff $U^u(b, T+1)$. Accepting b gives $U^a(b, T)$, which is equal to the deviation payoff, by the Claim part (iv).

3. If the workers decide to choose $e = \text{Org}$ the state changes to S_2 where they will get $\frac{1}{2}[U^a(\tilde{w}_u, T) + U^a(b, T)]$ which is (again by Claim part (ii)) the same as $U^u(b, T)$, the payoff they get in choosing $e = \text{NotOrg}$ as prescribed.

All in all no one-shot deviation, in any state, is profitable for any player and the strategy combination (σ_3^*, ω_3^*) described by Table A.III is indeed subgame perfect. $\square$

The outcome depends on the initial state. If it is either S_1 or S_2 then the workers organize. If it is S_3 then they don't. This proves part (i) of Proposition 3.

Lemma 9 Maximal and Minimal SPE-Payoffs of the firm for $c \in [\hat{c}, \check{c}]$

(i) If $c \in [\hat{c}, \check{c}]$ then the maximal expected payoff the firm can get in any subgame perfect equilibrium of the bargaining game is

$$\frac{\Pi^a(b, 0) + \Pi^a(\tilde{w}_u, 0)}{2}$$

or equivalent

$$\frac{\pi(b) + \pi(\tilde{w}_u)}{2(1 - \gamma)} = \frac{1 + \pi(\tilde{w}_u)}{2(1 - \gamma)}.$$

where $\tilde{w}_u$ is given by

$$(1 - \delta)u(\tilde{w}_u; c) + \delta u(\tilde{w}_u; 0) = -(1 - \delta)u(b; c).$$

(ii) This maximal expected payoff is strictly decreasing with c.

(iii) If $c \in [\hat{c}, \check{c}]$ then the minimal expected payoff the firm can get is

$$\frac{\pi_0(b)}{1 - \gamma} = 0.$$

Proof: (i) Observe first that in any SPE where the workers decide not to organize in some period T the payoff of the firm is given by $\Pi^u(b, T) = 0$. On the other hand there exist SPEs where the workers decide to organize and the firm gets an expected payoff strictly greater than 0. Therefore the maximal payoff of the firm has to be associated with organizing behavior of the workers. Denote the smallest equilibrium wage agreements by $\underline{w}_u$ and $\underline{w}_f$ if the workers (firm resp.) make an offer. Since $(b, \tilde{w}_u)$ is an equilibrium agreement, $\underline{w}_f = b$ holds. For $\underline{w}_u$ the inequality $U^u(b, T) \leq \frac{1}{2}[U^a(b, T) + U^a(\underline{w}_u, T)]$ or equivalent $-(1 - \delta)u(b, c) \leq (1 - \delta)u(\underline{w}_u, c) + \delta u(\underline{w}_u, 0)$ must hold, because otherwise the workers would get a strictly greater payoff in deciding not to organize, but then $\underline{w}_u$

would not be an equilibrium agreement. Using the last inequality and the definition of $\tilde{w}_u$ one gets

$$(1 - \delta)u(\tilde{w}_u; c) + \delta u(\tilde{w}_u; 0) \leq (1 - \delta)u(\underline{w}_u; c) + \delta u(\underline{w}_u; 0),$$

which implies (by strong monotonicity of u) that $\tilde{w}_u \leq \underline{w}_u$. Therefore, since $\tilde{w}_u \geq \underline{w}_u$ (by definition of $\underline{w}_u$) one gets $\tilde{w}_u = \underline{w}_u$. The statement holds therefore, because the firms profit is decreasing in wage and in time.

(ii) It is sufficient to show that the agreed upon wage $\tilde{w}_u$ is strictly increasing with costs. Let $c_h > c_l$ and denote the associated equilibrium wage agreements by $\tilde{w}_u^h$ and $\tilde{w}_u^l$. $c_h > c_l \Rightarrow [-(1 - \delta)u(b, c_h) > -(1 - \delta)u(b, c_l)$ and $(1 - \delta)u(\tilde{w}_u^h, c_l) + \delta u(\tilde{w}_u^h, 0) > (1 - \delta)u(\tilde{w}_u^h, c_h) + \delta u(\tilde{w}_u^h, 0)]$. Combining these inequalities and using the equations which determines $\tilde{w}_u^h$ and $\tilde{w}_u^l$ one gets $(1 - \delta)u(\tilde{w}_u^h, c_l) + \delta u(\tilde{w}_u^h, 0) > (1 - \delta)u(\tilde{w}_u^l, c_l) + \delta u(\tilde{w}_u^l, 0)$ which implies $\tilde{w}_u^h > \tilde{w}_u^l$.

(iii) That $\frac{\pi_0(b)}{1-\gamma} = 0$ is the smallest payoff the firm can get follows from the existence of an equilibrium path where the workers decide not to organize. (See Table A.III, state S_3). $\qquad\square$

The following Lemma is an immediate consequence of the Lemma just proved.

Lemma 10 MAXIMUM OF MAXIMAL SPE-PAYOFFS OF THE FIRM FOR $c \in [\hat{c}, \check{c}]$

If $c \in [\hat{c}, \check{c}]$ then the largest maximal expected SPE-payoff of the firm is given by

$$\frac{\pi(b) + \pi(\hat{w}_u)}{2(1 - \gamma)} \quad with \ \hat{w}_u = \pi^{-1}(\Gamma),$$

i.e.

$$\frac{1 + \Gamma}{2(1 - \gamma)}$$

Proof: By the Lemma above the maximum of the maximal payoffs is reached at $\hat{c}$. Hence $\hat{w}_u$ has to be such that $(1 - \delta)u(\hat{w}_u, \hat{c}) + \delta u(\hat{w}_u, 0) = -(1 - \delta)u(b, \hat{c}) = (1 - \delta)u(\pi^{-1}(\Gamma), \hat{c}) + \delta u(\pi^{-1}(\Gamma), 0)$, which holds if and only if $\hat{w}_u = \pi^{-1}(\Gamma)$. $\qquad\square$

The above two Lemmas prove parts (ii) and (iii) of Proposition 3. Part (iv) is obvious since π^{-1} is strictly grater than zero.

B Proof of Theorem 1

Proof of Part (i): What has to be shown is that independent of the actually played equilibria the management never has an incentive to choose a c which is strictly greater than $\hat{c}$, when γ is sufficiently nearby 1. Since the maximal payoff for $c > \hat{c}$ is strictly smaller than $[1 - \Gamma]/[2[1 - \gamma]]$ and the minimal payoffs for $c < \hat{c}$ are strictly increasing with c it is sufficient to show that the minimal payoff at $c = 0$ is not smaller than $[1 - \Gamma - \alpha]/[2[1 - \gamma]$ for any $\alpha \in]0, 1[$. Let $\underline{\pi}_f^*$ and $\underline{\pi}_u^*$ be the minimal profits at $c = 0$ when the firm and the workers make the offer, resp. Hence, the (expected) minimal payoff in this case is $[\underline{\pi}_f^* + \underline{\pi}_u^*]/[2[1 - \gamma]]$. In equilibrium $\underline{\pi}_u^* = \Gamma \underline{\pi}_f^*$ holds. Hence, what has to be

shown is, that if γ is large enough $\underline{\pi}_f^* \geq [1 + \Gamma - \alpha]/[1 + \Gamma]$ holds for any $\alpha \in]0, 1[$. Note that $\underline{\pi}_f^*$ is the smallest root of $H(\pi_f; 0)$ (cf. A.7). Define $\tilde{H}(\pi_f; 0) := h(\pi_f; 0) - \Delta h(\pi_f; 0)$ and observe that this function is strictly positive for $0 \leq \pi_f < 1$, strictly decreasing with π_f and has a unique root at $\pi_f = 1$. For $\Gamma_n < 1$, $n \in \{1, 2, \ldots\}$, with $\Gamma_n < \Gamma_{n+1}$ and $\lim_{n \to \infty} \Gamma_n = 1$, define $H_n(\pi_f; 0) := h(\pi_f; 0) - \Delta h(\Gamma_n \pi_f; 0)$.

Claim: $H_n \uparrow H_1$.

Proof of the claim: (i) Let $\pi_f \in [0, 1]$ be given. $\Gamma_h > \Gamma_l \Rightarrow h(\Gamma_h \pi_f, 0) < h(\Gamma_l \pi_f, 0) \Rightarrow$ $H_h(\pi_f, 0) := h(\pi_f, 0) - \Delta h(\Gamma_h \pi_f, 0) > h(\pi_f, 0) - \Delta h(\Gamma_l \pi_f, 0) =: H_l(\pi_f, 0)$, i.e. the sequence (H_n) is monotonically increasing. (ii) Since $h(\Gamma \pi_f, 0)$ is continuous one gets $\lim_{n \to \infty} H_n(\pi_f, 0) = h(\pi_f, 0) - \Delta h(\pi_f, 0) = \tilde{H}(\pi_f, 0)$ for any $\pi_f \in [0, 1]$.

That is, (H_n) is a monotonically converging sequence of continuous functions on the compact interval $[0, 1]$ with the limit $\tilde{H}$ which is also continuous, and therefore (by the Theorem of Dini), the sequence (H_n) is converging uniformly. Let $\alpha \in]0, 1[$ be given and define $a := [2 - \alpha]/2 \in]1/2, 1[$. Since a is strictly smaller than 1, $\tilde{H}(a; 0) > 0$ holds, and let $\epsilon := \tilde{H}(a; 0)/2$. From the uniform convergence of (H_n) to $\tilde{H}$ follows that there exist $\Gamma_k, \Gamma_{k+1}, \ldots$, such that $\tilde{H} - H_j < \epsilon$ for all $j \geq k$. This implies that $H_j(x; 0) > 0$ for all $x \leq a$. Therefore the smallest roots of these functions are all strictly greater than a. What remains to be shown is that $a \geq [1 + \Gamma - \alpha]/[1 + \Gamma]$. Using the definition of a and rearranging terms leads to $\Gamma \leq 1$, which is true by definition. Using the definition of Γ_k, a γ_k has been found such that for all $\gamma \in [\gamma_k, 1[$ the minimal payoff at $c = 0$ is greater than any of the maximal payoffs for $c > \hat{c}$. $\square$

Proof of Part (ii): If the system 3.1 - 3.2 has a unique solution for $\hat{c}$ then the only root of $H(\pi_f, \hat{c})$ is at $\pi_f = 1$ (see Lemma 3).

Claim: If $H(\pi_f, \hat{c})$ has a unique root then all roots of $H(\pi_f, c)$ with $c \in [0, \hat{c}[$ converge to 1 for $c \to \hat{c}$.

Proof of the claim: Suppose not, i.e. it exists an open ball $\mathcal{U}$ of $(1, \hat{c})$ s.th. $H(x; c) \neq 0$ for all $(x, c) \in \mathcal{U}$. Take an arbitrary point $(\tilde{x}, \tilde{c}) \in \mathcal{U}$ which is not equal to $(1, \hat{c})$. For all $(\tilde{x}, c)$ with $c \in [\tilde{c}, \hat{c}]$, $(\tilde{x}, c) \in \mathcal{U}$ and therefore $H(\tilde{x}, c) \neq 0$. Since $H(x, c)$ is continuous in x either $H(\tilde{x}, c) < 0 \, \forall c \in [\tilde{c}, \hat{c}]$ or $H(\tilde{x}, c) > 0 \, \forall c \in [\tilde{c}, \hat{c}]$ holds (because otherwise a zero point in $\mathcal{U}$ would exist). Case 1: $H(\tilde{x}, c) < 0 \, \forall c \in [\tilde{c}, \hat{c}]$, in particular $H(\tilde{x}, \hat{c}) < 0$. With $H(0, \hat{c}) > 0$ and the continuity of H with respect to x this implies that there exists a $x^* \in]0, \tilde{x}[$ with $H(x^*, \hat{c}) = 0$. But this is a contradiction to the uniqueness of the root for $c = \hat{c}$. Case 2: $H(\tilde{x}, c) > 0 \, \forall c \in [\tilde{c}, \hat{c}]$. In particular $H(\tilde{x}, \tilde{c}) > 0$ and $(x, \tilde{c}) \in \mathcal{U}$ for all $x \in [\tilde{x}, 1]$. By the upward shift property of H, $H(1, \tilde{c}) < 0$ holds. Hence by continuity of H with respect to x, there exists a $x^* \in]\tilde{x}, 1[$ with $H(x^*, \tilde{c}) = 0$ and $(x^*, \tilde{c}) \in \mathcal{U}$, which is again a contradiction. $\square$

The fact that all roots of $H(\pi_f; c)$ converge to 1 for $c \to \hat{c}$ implies that the minimal payoffs converge to $[1 + \Gamma][2[1 - \gamma]]^{-1}$. But this means that since the maximal payoff for $c > \hat{c}$ is strictly smaller than $[1 + \Gamma][2[1 - \gamma]]^{-1}$, a $c_l < \hat{c}$, which is sufficiently nearby $\hat{c}$ such that the minimal payoff in this case is strictly greater than the maximal payoff for $c_h > \hat{c}$, can be found. Hence the firm will never choose such a c_h. This proves (a).

To prove (b) it is sufficient to show that there exists some $\tilde{c}$ with $0 < \tilde{c} < \hat{c}$ such that the maximal equilibrium profit at $c = 0$ (denoted by $\overline{\pi}_0$) is strictly smaller than the minimal profit at $c = \tilde{c}$ (denoted by $\underline{\pi}_{\tilde{c}}$). This is equivalent to the statement that $\exists \rho > 0$ s.th. $H(\pi_f; \hat{c} - \rho) > 0$, $\forall \pi_f \in [0, \overline{\pi}_0[$ since then *all* roots of $H(\pi_f; \hat{c} - \rho)$ have to be to the

right of $\overline{\pi}_0$. Which then implies that the smallest equilibrium payoff at $\hat{c}-\rho$ is larger than the maximal payoff at $c = 0$. Suppose, to the contrary that this statement is not true, i.e. $\forall \rho > 0 \ \exists \pi'_f \in [0, \overline{\pi}_0[$ with $H(\pi'_f; \hat{c} - \rho) \leq 0$. $\pi'_f = 0$ cannot happen because $H(0; c) > 0$ for all c in the relevant range. Since the only root at $\hat{c}$ is given by 1, $H(\pi'_f; \hat{c}) > 0$ cannot happen, too. Therefore, for all $\rho > 0$, $\overline{\epsilon} := H(\pi'_f; \hat{c}) - H(\pi'_f; \hat{c} - \rho) > 0$ holds. Define $\tau := k\rho \ (k > 1)$. Take $\overline{\epsilon}$ as defined above and $\hat{c} > \hat{c} - \rho$, then for all $\tau > 0$, $0 < \hat{c} - (\hat{c} - \rho) = \rho < k\rho = \tau$ and $H(\pi'_f; \hat{c}) - H(\pi'_f; \hat{c} - \rho) = \overline{\epsilon} > 0$ holds. But this means that $H(\pi'_f; c)$ is not continuous at $c = \hat{c} - \rho$, which is a contradiction. $\square$

C Proofs of Theorems 2 - 4 of Section 4

C.1 Proof of Theorem 2

By the definition of the profit function for any given profit level y the relation $\pi_l^{-1}(y) < \pi^{-1}(y)$ holds. From the definition of $\hat{c}_l$ and $\hat{c}$ the equalities

$$(1 - \delta)u(\pi_l^{-1}(\Gamma); \hat{c}_l) + \delta u(\pi_l^{-1}(\Gamma); 0) = -(1 - \delta)u(b; \hat{c}_l)$$
$$(1 - \delta)u(\pi^{-1}(\Gamma); \hat{c}) + \delta u(\pi^{-1}(\Gamma); 0) = -(1 - \delta)u(b; \hat{c})$$

must also hold. Suppose to the contrary that $\hat{c}_l \geq \hat{c}$. From the monotonicity of the utility function with respect to c it follows that $-(1 - \delta)u(b; \hat{c}_l) \geq -(1 - \delta)u(b; \hat{c}_l)$. Hence, by the two equations above and the fact that the utility function is decreasing with c it follows that

$$(1 - \delta)u(\pi_l^{-1}(\Gamma); \hat{c}_l) + \delta u(\pi_l^{-1}(\Gamma); 0) \geq (1 - \delta)u(\pi^{-1}(\Gamma); \hat{c}) + \delta u(\pi^{-1}(\Gamma); 0)$$
$$\geq (1 - \delta)u(\pi^{-1}(\Gamma); \hat{c}_l) + \delta u(\pi^{-1}(\Gamma); 0).$$

But this is (since $\pi_l^{-1}(\Gamma) < \pi^{-1}(\Gamma)$) a contradiction to the assumption that the utility function is strictly increasing in wages. Hence, $\hat{c}_l < \hat{c}$ indeed holds. $\square$

C.2 Proofs of Theorem 3 and 4

Proof of Theorem 3: Let $\gamma_h > \gamma$ (i.e. also $\Gamma_h > \Gamma$) and $\hat{c}_h$ and $\hat{c}$ be the cost levels which correspond to γ_h and γ, resp.. Using the definition of this cost levels one gets that they have to be such that,

$$(1 - \delta)h(\Gamma; \hat{c}) + \delta h(\Gamma; 0) = -(1 - \delta)u(b; \hat{c})$$
$$(1 - \delta)h(\Gamma_h; \hat{c}_h) + \delta h(\Gamma_h; 0) = -(1 - \delta)u(b; \hat{c}_h).$$

Assume now that $\hat{c}_h \geq \hat{c}$. Since the utility function is strictly decreasing in costs, the function $h(\pi, c)$ strictly decreases in its first argument and with the above equations this implies that

$$(1 - \delta)h(\Gamma; \hat{c}) + \delta h(\Gamma; 0) \leq (1 - \delta)h(\Gamma_h; \hat{c}_h) + \delta h(\Gamma_h; 0)$$
$$< (1 - \delta)h(\Gamma; \hat{c}_h) + \delta h(\Gamma; 0).$$

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Hence, the inequality $h(\Gamma; \hat{c}) < h(\Gamma; \hat{c}_h)$ is implied, but this is a contradiction, and therefore $\hat{c}_h < \hat{c}$.

For $\gamma \to 1$ the r.h.s. of the equation which defines $\hat{c}$ becomes $(1-\delta)h(1; \hat{c}) + \delta h(1; 0)$, which is by definition of h the same as $(1-\delta)u(b; \hat{c})$. At the same time the l.h.s. of the equation stays constant at $-(1-\delta)u(b; \hat{c})$. This two values converge to the same limit iff $\hat{c}$ converges to zero. Therefore since the firm never chooses a cost level above $\hat{c}$ management opposition vanishes in the limit. □

Proof of Theorem 4: Let $\delta_h > \delta$ (i.e. also $\frac{\delta_h}{1-\delta_h} > \frac{\delta}{1-\delta}$). Now rearrange the equations which define $\hat{c}_h$ and $\hat{c}$ corresponding to the two different discount factors δ_h (δ resp.) to get the equations

$$h(\Gamma; \hat{c}_h) + \frac{\delta_h}{1-\delta_h}h(\Gamma; 0) = -u(b; \hat{c}_h)$$

$$h(\Gamma; \hat{c}) + \frac{\delta}{1-\delta}h(\Gamma; 0) = -u(b; \hat{c}).$$

Assume to the contrary that $\hat{c} \geq \hat{c}_h$. This implies since the utility function is strictly decreasing with c that $-u(b; \hat{c}) \geq -u(b; \hat{c}_h)$. It follows with the above equations and from $h(\Gamma; 0) > 0$ that

$$h(\Gamma; \hat{c}_h) + \frac{\delta_h}{1-\delta_h}h(\Gamma; 0) \leq h(\Gamma; \hat{c}) + \frac{\delta}{1-\delta}h(\Gamma; 0)$$

$$\leq h(\Gamma; \hat{c}) + \frac{\delta_h}{1-\delta_h}h(\Gamma; 0).$$

Hence, $h(\Gamma; \hat{c}_h) \leq h(\Gamma; \hat{c})$ which is a contradiction to the strict monotonicity property of h with respect to c. Therefore $\hat{c} < \hat{c}_h$ must hold. □