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Scab Labor

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ABSTRACT

This paper explores the political economy of unions, and the consequences this has for bargaining and strikes. We develop a very simple model to show that there are circumstances in which everyone, including striking workers, gains when some employees cross the picket line. We detail how strikes can emerge in equilibrium despite the absence of uncertainty, and how this strike outcome can Pareto dominate the outcome when scabbing is illegal, despite the fact that the strike destroys surplus. We also characterize when the firm might prefer to lock out those workers who would be strike breakers.

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"After God had finished the rattlesnake, the toad and the vampire, he had some awful substance left with which he made a scab. A scab is a two-legged animal with a corkscrew soul, a waterlogged brain and a combination backbone made of jelly and glue. Where others have hearts, he carries a tumour of rotten principles ... A strikebreaker is a traitor to his god, his country, his family, and the working class." *Jack London*

1. Introduction.

This paper explores the political economy of unions, and its consequences for bargaining and strikes. We consider an environment in which a union's bargaining position in negotiations reflects that held by the median striker. In the event that a contract offer is rejected, those union members who choose to do so may be able to go back to work for the firm as "scabs". We detail how strikes can emerge in equilibrium even though there is no uncertainty, and characterize when the firm might prefer to lock out those workers who would be strike breakers. Indeed, we document how, in equilibrium, even though strikes destroy surplus, the strike outcome can Pareto dominate the outcome where scabbing is illegal and contract negotiations are settled immediately. Essentially, scabbing allows for a better (intertemporal) allocation of the smaller surplus across the various parties.

This result contrasts with almost all the literature dealing with strikes. Most models perceive strikes as a cost that has to be incurred by both sides in the bargaining to permit credible communication of private information. Either the firm endures a strike to convince the union that it really cannot afford a high wage settlement or the union is signaling that it will not accept a low wage offer. An exception to this view of strikes is *Fernandez and Glazer* (1991) who construct a subgame perfect equilibrium featuring a strike between two perfectly informed agents.

It is an intuitively appealing idea that the existence of strike breakers necessarily weakens the union's negotiating position. It might be argued that the hostility often expressed towards those crossing a picket line is a consequence of other workers' fears that a favorable settlement is less likely if they fail to maintain a united front during bargaining. Yet the evidence is mixed on these fronts. While studies by *Cramton and Tracy* (1995) using U.S. data and *Cramton, Gunderson and Tracy* (1995) using Canadian data find that when there are laws prohibiting the use of replacement workers unions receive more favorable settlements, more direct studies suggest different conclusions. In particular, *Gramm and Schnell* (1994b) find that when employers attempt to circumvent a strike by employing 'scabs', unions receive more favorable settlements than when firms do not employ scabs.

Similar intuition would lead one not to expect firms to lose when the option of hiring

strike breakers exists. If the output of strike breakers does not justify the costs, the firm should just fail to employ replacement workers. Therefore, the option of employing workers during a strike should not be detrimental to the firm. Finally, since strikes necessarily destroy surplus, it would seem that it cannot be the case that a strike of positive duration can make all parties — firm, strikers and scabs — better off.

We show that these seemingly obvious results need not be so. The key feature driving our results is that the union represents those members who remain on strike. This assumption reflects the fact that union officials are elected and bargain with a view to maintaining popularity with striking members.

This distinction we make between the union executive and the rank-and-file is in keeping with *Ashenfelter and Johnson* (1969) who observe that there are many players in wage negotiations. They view strikes as a consequence of unrealistic wage expectations from the workforce; the union leaders call a strike to avoid accusations of 'selling out', aware that during the strike workers will revise their expectations downwards until a realistic settlement can be agreed to by the union leaders without it adversely affecting their tenure as leaders. Our paper also has the feature that union leaders are concerned about retaining their position, but in our model this induces union leaders to take the position that would be adopted by the median member of the union.

We distinguish workers by their discount factors, so that less patient union members are the first to break solidarity. As a consequence, as scabs return to work, the union takes more 'militant' positions, adopting positions reflecting those of the now more patient median striking worker. Consequently, the settlement reached between the union and firm features a higher wage than would have been the case were there no strike breakers (as Gramm and Schnell (1994b) find), and this increase in the settlement wage may more than offset wages foregone during the strike. Whether the firm gains from employing scabs depends on whether increased profits from employing scab workers at relatively low wages exceeds the costs of the higher wage settlement. In turn, this determines whether the firm wants to lock out would–be strike breakers. It may be that while the strike reduces total surplus, it re–allocates the surplus in such a way that everyone is made better off.

The next section sets out the economic environment and describes the bargaining game. Section 3 details the equilibrium analysis and results. Section 4 concludes. All proofs are in the appendix.

2. Model

Assume there is a single firm that maximizes discounted profits, $\sum_{t=0}^{\infty} \delta_f^t (v_t - w_t)\ell_t$, where v_t is the opportunity value of a unit of labor to a firm in period t, w_t is the wage paid to a worker in period t, and ℓ_t is the number of workers employed in t. The firm's discount factor is $\delta_f \in (0,1)$. The risk neutral firm is perfectly informed and rational.

A worker for the firm seeks to maximize lifetime wages, $\sum_{t=0}^{\infty} \delta_i^t w_t$. There are a continuum of workers of measure one. Workers differ in their degrees of patience; for simplicity we suppose that their discount factors are continuously distributed on $[\underline{\delta}, \bar{\delta}]$, where $0 < \underline{\delta} < \bar{\delta} < 1$.

Initially all workers belong to a union that bargains on their behalf in wage negotiations. Once the union and firm reach a wage settlement, that wage prevails in all subsequent periods, and all workers receive that wage.

We look at a variation of the Rubenstein bargaining game, modified to take into account both the political economy features of the union and the effects of strike breakers. We assume that the union's bargaining position in each period t corresponds to that which would be taken by the median voter within its membership in that period, δ_{m_t}. The median voter is myopic only in the sense that he takes the bargaining position that would be chosen were he always decisive.

The motivation underlying this assumption is that union officials are elected, and consequently bargain with a view to remaining popular with their membership. If a split does occur, the position of the median voter changes as it is assumed strike breakers cease to be represented by the union. The position of the union adjusts accordingly. We would argue that even if union officials correctly anticipate a break in union ranks, they cannot act on this information prior to the break occurring because to do so would leave them vulnerable to a leadership challenge since they would not have been representing the median member.

The bargaining between the union and firm proceeds as follows. At the start of period $t = 0$ the firm proposes a new contract. The union can either accept or reject this proposal. If it accepts the game ends and the new wage is that agreed upon. However if the union rejects the offer it strikes for that period and, at the start of period $t = 1$, it makes a counter offer to the firm. This can either be accepted, ending the bargaining, or rejected, causing the strike to continue another period. The bargaining continues with alternating offers, until agreement is reached. The reservation wage of workers is $\underline{w}$.

The difference between this paper and most other papers that deal with labor negotiations is that when the union rejects an offer and strikes, workers have the option of

ignoring the strike call. Workers can choose to strike break and work for the firm at the initial wage offered, w_0. We assume that strike breakers incur a psychic cost c_i each subsequent period. This cost c_i represents the social cost of breaking ranks with fellow workers and is incurred even after the union and firm settle. Anecdotal evidence offers support to our contention that there is a psychic cost to strike breaking; indeed the very term 'scab' is often used derogatively.[1]

Clearly, a union member will break solidarity with fellow strikers if doing so increases his discounted lifetime net wages. In fact, without the cost c_i no worker would honor a strike call in the setting presented here. Instead each atomless agent, perceiving that his strike breaking would not impact on the negotiations leading to a settlement, would choose to ignore the strike call. More generally, this feature holds for any model featuring a continuum of workers; unless strike breaking is ruled out, a strike cannot be supported in equilibrium unless some cost to being a scab is (implicitly) assumed.

In the bargaining between the firm and workers, the union ceases to represent the settlement views of those workers who strike break. However, when the union and firm finally reach an agreement, strike breakers receive the same new wage as their fellow workers although, because former scabs continue to incur the psychic cost of c_i each period, their 'net' wage is lower.

The opportunity value of labor to the firm is

$$v_t = \begin{cases} v(s_t, t), & \text{if } t < T; \\ v, & \text{otherwise.} \end{cases}$$

where s_t is the proportion of strikebreakers at time t. We assume that $v_t(0,t) = 0$, $v_t(1,t) = v$ and $\frac{\partial v_t}{\partial s_t} \geq 0$. That is, the firm requires workers to produce and output is increasing with its workforce. Furthermore, to ensure that a strike cannot be surplus creating, we require that $\frac{\partial(v_t - s_t w)}{\partial s_t} \geq 0$.

In our analysis we suppose that $v_t(s_t, t) = 0$ $(s_t < 1)$ for all $t \geq 1$, so that scabs are only productive for one period — and hence the equilibrium strike is only one period — but the qualitative features extend to less extreme formulations in which $v(s^*, t) \geq v(s^*, t+i)$ $i = 1, 2, ...,$ $\lim_{i \to \infty} v(s^*, t+i) = 0$, $\forall s^* < 1$. The economic rationale for this assumption is that in the short–run the firm may be able to operate with scabs, but that it is difficult to continue over the long–run. For instance, the firm may have an inventory to run down, so the strike breakers can be used to serve this purpose, but over time it becomes necessary to produce more stock. Alternatively, strikebreakers may not have the spare labor necessary to maintain machinery, so that in the long run problems

[1] As an example of the hostility strike breakers face, recall our introductory quote by Jack London.

on the production line develop and productivity declines. The modeling purpose of this assumption is that we need to ensure that the firm does not prefer to operate with scabs forever.

We assume that the firm can lock out would be strike breakers if it is optimal for it do so. Let w_T^a be the wage that the union and firm eventually agree to, where T is the period in which they reach agreement. Then:

For as long as a worker remains loyal to the union the worker's net wage is given by

$$w_t = \begin{cases} 0, & \text{if } t < T; \\ w_T^a, & \text{otherwise,} \end{cases}$$

The possibility of outside sources of income for striking workers, such as a strike fund, could be easily incorporated into the model, but would not alter the results.

For a strike breaker the net wage will be

$$w_t = \begin{cases} w_0 - c_i, & \text{if } t = 1; \\ -c_i, & \text{if } 1 < t < T; \\ w_T^a - c_i, & \text{otherwise,} \end{cases}$$

although the cost to the firm in wages is w_0, 0, or w_T^a. Given the extreme production function assumed, it is clear that the firm will lock out scabs after a single period. To keep the model simple we assume $c_i = c$ for all workers, so that workers differ only in their discount factors. Allowing for heterogeneity among workers in the psychic costs to strike breaking would not affect the qualitative findings.

3. Results

Having specified the game we now detail conditions under which in equilibrium everyone (firm, strike breakers and striking workers) is better off from a strike occurring that is not honored by all workers.

In the equilibrium we consider, the strike lasts at most a single period. After one period the firm would lay off any strike breakers, and receive a payoff of zero until a settlement was reached, while the union's members would be foregoing a wage in each period. Since there are no informational asymmetries neither side has an incentive to prolong the strike beyond one period. Consequently workers, when deciding whether to strike break in the event of a strike, form beliefs consistent with the equilibrium outcome that the strike's duration will be a single period.

We now detail the set of workers who would like to scab:

LEMMA 1: A worker becomes a strike breaker if and only if his discount factor is less than δ^*, where $\delta^* = \frac{w_0 - c}{w_0}$. Provided $c > w_0(1 - \delta_{m_0})$ the proportion of strike breakers is less than 50% of all workers.

Observe that the decision about whether or not to scab is independent of the expected settlement wage. This is because each worker does not anticipate that his decision to break ranks with the union will affect the wage settlement. Of course, since all workers with discount factors $[\underline{\delta}, \delta^*]$ scab, the median discount factor of striking union members increases from δ_{m_0} to δ_{m_1}, and this affects the bargaining between the union and the firm.

The firm's initial offer has to be more carefully considered than merely setting it high enough to be accepted by the median voter or not high enough. If the offer is rejected by the union, the possibility remains that some workers will break ranks with the union if w_0 is sufficiently high. The firm must consider exactly how many workers it wants to break the strike before setting w_0, aware that the gains from the productivity of any scabs has the detrimental effect of increasing the union's "militancy," as its new median member's discount factor is an increasing function of the number of scabs.

LEMMA 2: At time $t = 0$, the union will accept any wage offer, w_0^a, such that

$$w_0^a \geq \frac{(1 - \delta_{m_0})\underline{w} + \delta_{m_0}(1 - \delta_f)v}{1 - \delta_f \delta_{m_0}}.$$

In period 0, the union takes a position that would correspond to the one that its current median union member would take, were the median union member to decide whether to accept future offers and to make future counter offers in the bargaining game. Consequently, the union will accept the wage that corresponds to the solution of the standard infinite–horizon, alternating–offer bargaining game between the firm and the median union member.

If the firm's offer is rejected by the union and a strike is called, then some workers will not honor the strike call. In this case, the union would adopt a more "militant" bargaining position. The firm recognizes this when making its initial wage offer; it knows that should the union make it an offer in period one, the offer, p_1, will have to satisfy

$$v - p_1 \geq \delta_f(v - q_2), \tag{1}$$

for the firm to accept.

The value of the offer the union can expect in period two, q_2, is also different. This is because the union's median member, δ_{m_1}, changes, so that the union's membership is more 'militant.' Therefore, the firm would have to make an offer that satisfies

$$q_2 - \underline{w} \geq \delta_{m_1}(p_3 - \underline{w}). \tag{2}$$

The game from period one on is a standard, alternating–offer, infinite–horizon bargaining game. If a worker was going to break ranks with the union, along the equilibrium path he would have done so at the beginning of the strike. Hence the union's median discount factor will be δ_{m_1} for the remainder of the bargaining. Therefore, the problem faced by a party in an even period will be the same, whether it is period t or period $t+2$. Similarly the problem at time $t+1$ corresponds to the problem at $t+3$.

Because the game does not change after period 0, the offer the union makes in period one should be the same as the one it makes in all odd periods in which bargaining takes place. Equating p_1 with p_3 we can solve for p_1 from equations (1) and (2). The offer the union will make in period one,

$$w_1^a = \frac{(1-\delta_f)v + \delta_f(1-\delta_{m_1})\underline{w}}{1-\delta_{m_1}\delta_f}, \tag{3}$$

will be accepted by the firm.

If the firm makes an initial wage offer less than

$$w_0^a = \frac{(1-\delta_{m_0})\underline{w} + \delta_{m_0}(1-\delta_f)v}{(1-\delta_{m_0}\delta_f)},$$

the offer will be rejected. The firm's profits if there is a strike are given by

$$v_0(s_0, 0) - s_0 w_0 + \frac{\delta_f}{1-\delta_f}(v - w_1^a),$$

so that the optimal first period wage, w_0^*, is given by the solution to

$$[\frac{\partial v_0}{\partial s_0} - w_0]\frac{\partial s_0}{\partial w_0} - s_0 - \frac{\delta_f}{1-\delta_f}\frac{\partial w_1^a}{\partial \delta_{m_1}}\frac{\partial \delta_{m_1}}{\partial s_0}\frac{\partial s_0}{\partial w_0} \leq 0$$

$$\left[[\frac{\partial v_0}{\partial s_0} - w_0]\frac{\partial s_0}{\partial w_0} - s_0 - \frac{\delta_f}{1-\delta_f}\frac{\partial w_1^a}{\partial \delta_{m_1}}\frac{\partial \delta_{m_1}}{\partial s_0}\frac{\partial s_0}{\partial w_0}\right][w_0 - w_0^a] = 0$$

Having calculated the settlement wage that follows a one–period strike, w_1^a, as a function of the initial wage offer, w_0, we can now detail when a strike will occur:

PROPOSITION 1: A strike occurs in equilibrium if and only if

$$argmax_{w_0 < w_0^a}\ v_0(s_0, 0) - s_0 w_0 + \frac{\delta_f}{1-\delta_f}(v - w_1^a) > \frac{1}{1-\delta_f}(v - w_0^a).$$

Otherwise, bargaining is resolved immediately, with the firm's offer of

$$w_0^a = \frac{(1-\delta_{m_0})\underline{w} + \delta_{m_0}(1-\delta_f)v}{(1-\delta_{m_0}\delta_f)}$$

being accepted by the union. The strike outcome occurs if and only if δ_f is sufficiently small.

The settlement wage is higher if bargaining is resolved after a one–period strike than it would be if settlement were immediate, *i.e.* $w_1^a > w_0^a$. This result, which accords with the empirical findings of Gramm and Schnell (1994b), is driven by two factors that work in the same direction. Firstly, at date 1 the union has the first mover advantage in the continuation bargaining game, and secondly, the median member of the union is now more patient/militant, and this strengthens the union's ability to reach a favorable settlement.

When the inequality in proposition 1 holds, the firm benefits from the strike. It can earn revenues at time 0 while only paying a fraction of the settlement wage to the scab workers, and the resulting profits more than offset the discounted future extra costs it will have to incur because of the higher settlement wage that it will have to pay. If the firm does not desire an immediate settlement, preferring to operate with only strike breakers for

a period, then its offer will be less than w_0^a. The exact value depends on the productivity of the scab labor force, $v_t(\cdot)$.

A firm with a low discount factor finds it more attractive to employ scabs than a more patient firm. To see this re–write the condition characterizing when a strike occurs

$$(1-\delta_f)[v_0(s_0,0)-s_0w_0]+\delta_f[v-w_1^a] > (v-w_0^a).$$

That is, the discount–weighted average of scab and post–scab firm profits must exceed the profits from immediate settlement. If the weight on immediate profits is high enough (δ_f is low enough), then the firm optimally incurs a strike. In effect, a firm that employs strike breakers is borrowing from its workers, earning extra initial profits but then having to pay its entire workforce a higher wage in future periods than would be the case if it settled immediately. Consequently, firms that place a greater weight on their future stream of profits are more inclined to settle immediately.

Clearly, if scab labor is not sufficiently productive, or if the return of the scabs dramatically increases the militancy of the union, the firm will not gain from delaying settlement. In such an instance, since the environment is one of perfect information, so no signaling or reputational effects need to be considered, settlement is immediate.

Hence, it follows directly that should the firm choose to use strike breakers, the firm must necessarily benefit from this option. If it did not, then it would settle immediately at a wage rate w_0^a, the outcome that would also result if the possibility of strike breaking did not exist. Proposition two addresses the issue of whether there are circumstances in which workers also benefit because of the presence of strike breakers.

PROPOSITION 2: All workers are made better off by the fact that some are willing to break the strike if and only if

$$\delta^* > \frac{1-\delta_{m_1}\delta_f}{1-\delta_{m_0}\delta_f} \quad \frac{(1-\delta_{m_0})\underline{w}+\delta_{m_0}(1-\delta_f)v}{(1-\delta_f)(v+s_0w_0)+\delta_f(1-\delta_{m_1})\underline{w}}.$$

Since strike breakers and the firm choose to work through a strike it is perhaps not surprising that they should benefit from the possibility to do so. However, under the conditions in proposition 2, the striking workers also benefit because some former union members broke ranks and returned to work. This result arises because of the change in the union's composition. The union now represents a more patient, or "militant," striking constituency. This means that in the equilibrium to the bargaining game, the

union extracts a larger wage than it would have been able to were it also to bargain for the most impatient workers. This high wage more than offsets the wages foregone during the one–period strike.

Essentially, while strikes destroy surplus, all parties are made better off because the division of the surplus is improved. The firm receives greater immediate profits, the patient strikers go without wages for a period, but then receive higher wages that more than compensate them, and the scabs free–ride on the wage settlement driven by the union's more militant members.

From the union's perspective, there is an optimal value of the psychic cost, c, associated with strike breaking, which is neither zero, nor arbitrarily large. If c is too small, all workers will break any strike call, each perceiving that she will not affect the bargaining, and keen not to forego a wage when the cost to breaking the strike is small. Conversely, if c is too large, no worker will break the strike and the outcome is a settlement of w_0^a.

Although the firm can gain from a strike that is broken, followed by a higher wage settlement, and chooses this course of action in such cases, it is possible that it is unprofitable for the firm to employ strike breakers. There is a gain to the firm of having 'doves' — workers keen to settle — represented by the union, and it is possible that this gain more than offsets any benefits to be had from employing them during a strike. In such cases the firm will be keen to settle immediately and avoid a strike.

If we alter the model so that the union's bargaining representatives correctly perceive the implications of a split in the union ranks during a strike, and are able to exploit this knowledge, they will want to wait until period one before reaching a settlement. To overcome this problem, the firm could preempt the union by threatening a lockout if its initial offer is rejected.

PROPOSITION 3: The firm can credibly commit to a lockout when making its initial offer if there is no $w_0 < w_1^a$ such that

$$v_0(s_0, 0) - s_0 w_0 + \frac{\delta_f}{1-\delta_f}(v - w_1^a) > \frac{\delta_f}{1-\delta_f}\left(v - \frac{(1-\delta_f)v + \delta_f(1-\delta_{m_0})\underline{w}}{1-\delta_f\delta_{m_0}}\right).$$

When this condition holds, the union will accept a wage offer of w_0^a. If the condition does not hold, the firm will have to offer

$$w^* = (1-\delta_f)v - (1-\delta_f)(v_0 - s_0 w_0) + \delta_f w_1^a$$

to achieve an immediate settlement.

Proposition three shows that there are circumstances where the firm will want to preempt a strike call by locking out its workforce. The lockout minimizes the militancy of the union negotiators with which it must bargain.

When the conditions stated in proposition three do not hold, the threat of a lockout is not credible. Although the firm would prefer to settle in period 0 at a wage w_0^a, if the union strikes, the firm's best response is to earn some profits during the strike by hiring strike breakers. When this is true, the firm either makes an initial offer, w^*, that is high enough to persuade the union to settle immediately, or a strike occurs during which the firm employs strike breakers.

4. Conclusion

This paper develops a very simple model to make two points. First, it is shown that there are circumstances in which everyone, including striking workers, gains when some employees cross the picket line. Second, we derive conditions under which a firm will threaten a lockout.

The introduction of asymmetric information concerning the profitability of the firm, so often necessary in papers considering strikes, would not alter our results substantively. With asymmetric information, longer strikes may occur. So too, equilibrium may feature lockouts. In our formulation, the credible threat of a lockout is sufficient to persuade the union to accept the firm's initial wage offer.

Equilibrium strikes may also occur if workers differed not by their discount factors, but by their preferences over an n-dimensional issue space. For example, suppose that workers and the firm care about wages, pensions and working conditions. Suppose further that improved working conditions are cheap to provide, so that the firm would prefer to substitute along this dimension. Finally, suppose that there is a strong correlation between the value a worker attaches to the size of the wage in any settlement and the weight she gives pensions when assessing an offer by the firm. By offering a high initial wage, the firm may lure a preponderance of those who place greater weights on pensions than on working conditions, skewing the ultimate settlement toward lower pensions and better working conditions.

In this instance, workers who observe the strike call and the firm benefit. Interestingly, scabs may lose, because although they correctly anticipate the psychic cost to being a scab, they fail to internalize the subsequent effect of their actions on the bargaining position taken by the union. Consequently they will be unhappy ex post with a settlement that features good working conditions, but relatively low pensions, an offer that was acceptable to the majority of workers who honored the strike.

In a broader context, this paper gives some insight into the conditions in which a firm will prefer workers to either bargain as a single entity, or divide up into various unions of differing degrees of 'militancy'. In the latter case we would expect to find industries that can profitably run for a period of time with only a fraction of the profit–maximizing labor input. Conversely, those industries where the entire workforce is needed for the firm to function effectively offer firms an incentive to reach a closed–shop arrangement with a single union.

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APPENDIX

Proof of Lemma 1

By assumption, workers believe the strike will end after one period. Let w^a be the wage settlement the worker anticipates when the bargaining is resolved. Since the worker is atomless, her decision on whether or not to honor the strike call does not affect the value of w^a. The worker strictly prefers to scab if and only if

$$[w_0 - c] + \sum_{t=1}^{\infty} \delta^t [w^a - c] > \sum_{t=1}^{\infty} \delta^t w^a.$$

Simplifying

$$w_0 > \frac{1}{1-\delta} c,$$

which rearranges to leave

$$\delta < \frac{w_0 - c}{w_0} = \delta^*.$$

Provided $\delta_{m_0} > \delta^*$ then fifty per cent of workers will not break the strike. Given the value of δ^*, simple algebra derives the condition for c stated in the lemma. ■

Proof of Lemma 2

The union anticipates the largest acceptable offer it could make in period one, p_1, satisfies

$$v - p_1 = \delta_f (v - q_2).$$

Therefore the firm's initial offer, q_0, need only satisfy

$$q_0 - \underline{w} = \delta_{m_0} (p_1 - \underline{w}).$$

Since the union is unable to anticipate that the bargaining environment will change if settlement is not reached immediately, it is possible to equate q_0 with q_2, and solve as though the game were a standard infinite horizon, bargaining game. Consequently the union will accept any offer greater than or equal to

$$\frac{(1 - \delta_{m_0})\underline{w} + \delta_{m_0}(1 - \delta_f) v}{1 - \delta_f \delta_{m_0}}. \quad ■$$

Proof of Proposition 1

The offer required for immediate settlement, w_0^a, is derived in lemma two.

For a firm to be better off because of a strike it must be that

$$v_0(s_0,0) - s_0 w_0 + \sum_{t=1}^{\infty} \delta_f^t (v - w_1^a) \geq \sum_{t=0}^{\infty} \delta_f^t (v - w_1^a), \qquad (A1)$$

which rearranges to the inequality given in the proposition.

We now show that a strike occurs if and only if δ_f is less than some critical value. Let $K = v_0(s_0,0) - s_0 w_0$. Rearranging (A1), substituting in for K, w_0^a and w_1^a, yields:

$$(1-\delta_f)K + \left[\frac{\delta_f^2(1-\delta_{m_1})}{1-\delta_{m_1}\delta_f} - \frac{1-\delta_{m_0}}{1-\delta_{m_0}\delta_f}\right](v - \underline{w}) \geq 0. \qquad (A2)$$

The left hand side is a continuous, differentiable function of δ_f. We now argue that (A2) satisfies a single crossing property, so that if the left hand side is zero then an increase in δ_f implies that the inequality does not hold, and a decrease implies that it does hold. Differentiating, substituting for K from (A2) and simplifying, we require that

$$\frac{1}{1-\delta_f}\left[\frac{\delta_f^2(1-\delta_{m_1})}{(1-\delta_{m_1}\delta_f)} - \frac{1-\delta_{m_0}}{(1-\delta_{m_0}\delta_f)}\right] + \frac{2\delta_f(1-\delta_{m_1})}{(1-\delta_{m_1}\delta_f)} + \frac{\delta_f^2(1-\delta_{m_1})\delta_{m_1}}{(1-\delta_{m_1}\delta_f)^2} - \frac{(1-\delta_{m_0})\delta_{m_0}}{(1-\delta_{m_0}\delta_f)^2} < 0.$$

Simplifying yields

$$\frac{(1-\delta_{m_1})\delta_f(2-\delta_{m_1}\delta_f-\delta_f)}{(1-\delta_{m_1}\delta_f)^2} - \frac{1-\delta_{m_0}}{(1-\delta_{m_0}\delta_f)^2}(1-2\delta_{m_0}\delta_f+\delta_{m_0}) < 0.$$

Numerical solution reveals that for feasible values of δ_f, δ_{m_0}, and δ_{m_1} (i.e. $0 < \delta_f < 1$, $0 < \delta_{m_0} \leq \delta_{m_1} < 1$), the inequality is always satisfied. ■

Proof of Proposition 2

A striker is better off because of the existence of strike breakers if

$$\sum_{t=0}^{\infty} \delta^t w_0^a < \sum_{t=1}^{\infty} \delta^t w_1^a,$$

which simplifies to $w_0^a < \delta w_1^a$. Substituting in for w_0^a and w_1^a and rearranging produces the expression in the proposition. If the inequality holds for δ^* it holds for the discount factor of all striking workers.

The firm is necessarily no worse off by the presence of strike breakers, since were there no benefit to be had from their use it could settle in period 0 and avoid a strike altogether.

Strike breakers are also better off. Their strike breaking increases the settlement wage, a bonus they did not even consider when deciding to ignore the strike call. ■

Proof of Proposition 3.

The inequality simply states the condition which would leave the firm worse off if it hired strike breakers. The left hand side is its payoff when it does not lock workers out, and the right hand side is its payoff when it does. ■