

STRIKE ACTIVITY AND WAGE SETTLEMENTS*

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1. INTRODUCTION

Strikes are recognized as an inevitable product of the conflict of interests between management and union. Paradoxically, strikes occur despite the obvious improvement in welfare for all that could be gained by peaceful settlement.

It has frequently been argued that the inefficiency of strikes implies that some degree of irrationality on the part of either unions or firms must be present. However, this need not be the case — strikes can also arise from lack of information. In this paper we derive a simple model of strike activity and wage settlements in which we assume that both the firm and the union are rational, but that the union is uncertain about the profitability of the firm. Strikes occur when the firm believes that the firm is highly profitable and holds out for a large settlement, when in fact the firm is relatively unprofitable, and cannot afford such a settlement. Our goal is to analyze the forces leading to strikes and to estimate such policy relevant parameters as the premium enjoyed by union labor above the competitive wage.

Our empirical analysis builds on the work of Farber (1978). We analyze the same data, but unlike Farber we model wage negotiations as a non-cooperative game of incomplete information. Each period, the union makes a wage offer that the firm can accept or reject. The union strikes until an offer is accepted. While this negotiation process is special, it has been reported as an institutional fact, for example by Rees (1977). Information is incomplete in that the union does not know how much rent the firm earns on fixed factors.

This game is similar to that studied in Fudenberg-Tirole (1981), except that we take the horizon to be unbounded. We employ a special functional form

for the uncertainty about the firm's rents which allows a closed-form solution sufficiently simple to estimate. This specification was previously used by Sobel-Takahashi (1981) who solved the finite horizon case. From this we are able to give an endogenous derivation of Farber's concession schedule.

We are particularly interested in testing the basic specification of the bargaining model. We do this using techniques due to Hausman (1978) and Ruud (1982). One important alternative hypothesis to the bargaining model we present is to assume that the firm enters the bargaining session with a reputation for being a "tough" negotiator and is able to make the union a take-it-or-leave-it offer. If firms are able to effectively precommit themselves to these strategies they will be able to limit the gains available to the union.

2. THE MODEL

We develop a testable game-theoretic model of wage determination and strike activity. Both unions and firms are assumed to be rational utility maximizers. There are three parts of this section. The first part develops the theoretical model. The second part uses the theoretical model to find the likelihood function for observables. The final part extends the empirical model to allow the possibility of precommitment by firms. Empirical results and specification tests are discussed in the next section.

Theoretical Model: A single union negotiates with a single firm. The representative worker receives the reservation wage \bar{w} if he does not work for the firm, for example, during a strike. Bargaining takes place in successive periods. At time $t = 0$ the union proposes an increment W_0 above the reservation wage. The firm may accept or reject this offer. If it rejects the offer the union goes on strike. It takes the union Δ days to

prepare a second offer w_{Δ} , which again may be accepted or rejected by the firm. In general the union's offer after a strike of length t is w_t . If the offer is accepted the actual wage received is $\bar{w} + w_t$.

The union's objective is to maximize the expected present value of wage payments to the representative worker. Thus it maximizes the expected value of

$$(2.1) \quad \bar{w}/r + \exp(-rt) w_t/r$$

where r is the interest rate at which the worker can borrow and lend.

Notice that we ignore the possibility that the union may be concerned about employment as well as wages and the possibility of capital market imperfections.

If the firm pays a wage increment of w_t its profit is taken to be equal to $\pi - w_t$ where π is the rental the firm receives on fixed factors net of the competitive wage \bar{w} . Notice that employment is assumed independent of the wage rate actually paid and that the size of the labor force is normalized to equal one. The interest rate at which the firm can borrow and lend is s so the firm's objective is to maximize

$$(2.2) \quad \exp(-st)(\pi - w_t)/s.$$

The competitive wage \bar{w} is common knowledge, but the union is uncertain about the profitability of the firm π . Using all available information the union has a prior cdf on π given by

$$(2.3) \quad F(\pi) = \begin{cases} 0 & \pi < 0 \\ (\pi/\bar{\pi})^\lambda & 0 < \pi < \bar{\pi} \\ 1 & \pi > \bar{\pi} \end{cases}$$

where λ and $\bar{\pi}$ are two positive parameters. The distribution (2.3) is chosen for analytic convenience, but represents a fairly flexible functional form.

As Harsanyi (1967) has pointed out, this game of incomplete information may be viewed as a game of imperfect information in which one player (the firm) is drawn at random. In this game a strategy for the union is a function in each period p which determines the wage offer $w_{p\Delta}$ as a function of the past wage offers $w_0, w_\Delta, \dots, w_{(p-1)\Delta}$. A strategy for the firm determines for each value of π which offers will be accepted and which rejected, and when.

A Bayesian equilibrium of this game requires that the firm know the union strategy and choose an optimal strategy for each value of π , and that the union optimize knowing how the firm's strategy depends on π . In addition, as the strike progresses the union must update its prior beliefs (2.3) in accordance with Bayes law. We further require that the equilibrium be perfect: that players believe their opponents will optimize in the future regardless of what has happened in the past. This rules out empty threats. For example, the union might try to set a take-it-or-leave-it offer in period zero. However, the firm shouldn't believe this threat, because ex post if the firm rejects the offer it isn't optimal for the union to stop negotiating.

We now solve to find the unique stationary reservation price Bayesian perfect equilibrium. By a reservation price equilibrium we mean that the firm chooses a function $\tilde{w}(\pi)$ and accepts the first offer $w_t < \tilde{w}(\pi)$. We have shown in Fudenberg/Levine/Tirole (1982) that \tilde{w} is necessarily a strictly decreasing function. Thus if the lowest wage previously offered by the union is \tilde{w}_t the union now knows that $\pi < \tilde{w}^{-1}(\tilde{w}_t)$, and thus its posterior is

$$(2.4) \quad F(\pi | \tilde{w}_t) = \begin{cases} 0 & \pi < 0 \\ (\pi / \tilde{w}^{-1}(\tilde{w}_t))^\lambda & 0 < \pi < \tilde{w}^{-1}(\tilde{w}_t) \\ 1 & \pi > \tilde{w}^{-1}(\tilde{w}_t). \end{cases}$$

This is equivalent to measuring π in new units $\tilde{\pi} \equiv [\tilde{w}^{-1}(\tilde{w}_t) / \bar{\pi}] \pi$: only the scale of the posterior is changed. By a stationary equilibrium we mean that if the union found it optimal to offer w_0 when it had prior (2.3) then it should find it optimal to offer

$$(2.5) \quad [\tilde{w}^{-1}(\tilde{w}_t) / \bar{\pi}] w_0$$

when its previous lowest offer is \tilde{w}_t . By finite induction it follows that

$$(2.6) \quad w_{t+\Delta} = \gamma w_t$$

for some $1 > \gamma > 0$.

Assuming (2.6) let us now examine the reservation price function \tilde{w} . If the firm accepts w_t it gets $\pi - w_t$ now. If it waits one period it gets instead $\exp(-s\Delta)[\pi - \gamma w_t]$. The reservation price $\tilde{w}(\pi)$ is the value of w_t that makes the firm indifferent between these values

$$(2.7) \quad \begin{aligned} \tilde{w}(\pi) &= \eta \pi \\ \eta &\equiv \frac{1 - \exp(-s\Delta)}{1 - \gamma \exp(-s\Delta)}. \end{aligned}$$

This characterizes the optimal strategy of the firm.

To find the optimal strategy of the union let η be given and suppose the firm rejected an offer of $w_{t-\Delta}$ last period. If the union charges

$\gamma w_{t-\Delta}$ now the probability that this offer is accepted is $1 - \gamma^\lambda$. Let J be the expected present value to the union of charging w_t . By stationarity it gets γJ next period if the firm rejects w_t . Thus

$$(2.8) \quad J = (1 - \gamma^\lambda) \gamma w_{t-\Delta} + \exp(-r\Delta) \gamma J$$

$$J = (1 - \gamma \exp(-r\Delta))^{-1} (1 - \gamma^\lambda) \gamma w_{t-\Delta}$$

We can then find the first order condition for a maximum of J to be

$$(2.9) \quad \exp(-r\Delta) \lambda \gamma + \gamma^{-\lambda} = \lambda + 1.$$

This equation implicitly defines γ . Note that when the union's last offer was $w_{t-\Delta}$ it knows $\eta\pi < w_{t-\Delta}$ and sets $w_t = \gamma w_{t-\Delta}$. Since it initially knows $\pi < \bar{\pi}$ by stationarity it should set $w_0 = \gamma \eta \bar{\pi}$. This completes characterization of the equilibrium.

We have found the unique stationary reservation price equilibrium. That this is also a Bayesian perfect equilibrium follows from the fact that it is the limit of the finite horizon Bayesian perfect equilibria derived by Sobel/Takahashi (1981) and from the limit theorem of Fudenberg/Levine (1982).

Empirical Model: We observe for firm/union i in the n th contract negotiation the wage w^* , the revenue of the firm R^* and the length of the strike t^* . (For notational simplicity subscripts (i,n) are omitted.) We wish to make inferences about the unknown parameters $\lambda, \bar{\pi}, \Delta, r, s$ and also \bar{w} . These depend on exogenous random variables and random disturbances in a manner specified below. Note from (2.7) and (2.9) that we can replace r with γ , which we choose to do for computational reasons.

From (2.6) we can compute a relation between the incremental demand of

the union w and the length of the strike

$$(2.9) \quad w = \gamma^{(t^* + \Delta)/\Delta} \bar{\eta}.$$

The probability the strike lasts less than or equal to t^* is

$$(2.10) \quad \text{pr}(\eta\pi > w) = 1 - \gamma^{\lambda(t^* + \Delta)/\Delta}.$$

Thus if there is no strike we take the likelihood to be

$$(2.11) \quad p = 1 - \gamma^\lambda$$

which is the probability $t^* = 0$, while if $t^* > 0$ we take

$$(2.12) \quad p = (\lambda \log \gamma^{-1}/\Delta) \gamma^{\lambda(t^* + \Delta)/\Delta}$$

which would be the density corresponding to (2.10) if we approximate t^* as being a continuous rather than discrete random variable.

Next we observe that $w^* = w + \bar{w}$. Since we don't actually observe the reservation wage \bar{w} let us assume it has the log-normal density

$$(2.13) \quad f(\bar{w} | \bar{\mu}, \bar{\sigma}^2) = \frac{\exp[-(\log \bar{w} - \bar{\mu})^2 / 2\bar{\sigma}^2]}{\sqrt{2\pi\bar{\sigma}^2} \bar{w}}.$$

Then the joint likelihood of w^* and t^* is given by

$$(2.14) \quad f(\bar{w} | \bar{\mu}, \bar{\sigma}^2) p$$

where $\bar{w} \equiv w^* - w$ and w is from (2.9).

Finally the actual rent earned by the firm is $\pi + \bar{w}$. Since we can't observe actual rents, but only revenue R^* we assume

$$(2.15) \quad R^* = \epsilon(\pi + \bar{w})$$

where ϵ has the log-normal density

$$(2.16) \quad g(\epsilon|\sigma^2) = \frac{\exp[-(\log \epsilon)^2/2\sigma^2]}{\sqrt{2\pi\sigma^2} \epsilon}$$

with geometric mean equal to one. Assuming as a continuous time approximation that the settlement w actually equals the firm's reservation wage we have $\pi = w/\eta$ and setting

$$(2.17) \quad \epsilon = R^* / [w^* + \frac{(1-\eta)}{\eta} w]$$

the full likelihood function is

$$(2.19) \quad g(\epsilon|\sigma^2) f(\bar{w}|\bar{\mu}, \bar{\sigma}^2) p.$$

From this we must estimate the unknown parameters $\lambda, \bar{\pi}, \Delta, \gamma$ (equivalently r), $s, \bar{\mu}, \bar{\sigma}^2$ and σ^2 .

[It remains to describe how these parameters depend on the exogenous variables.]

Commitment by Firms: One of our goals is to test the validity of the model itself. To do so we must consider alternative models. Probably the most important alternative to the bargaining model above is the hypothesis

that the firm is able to precommit itself to a "tough" bargaining stance. This is discussed, for example, in Crawford (198?).

It is not our intention to provide a model of bargaining with commitment. We do, however, wish to learn from the data whether or not firms successfully commit themselves. The important empirical implication of commitment by firms is that large increases in firm profitability will not result in correspondingly large wage settlements. The firm by taking a "tough" stance can retain most of its profits and keep union wages at or near the competitive level. To incorporate this possibility into the empirical model we should allow the possibility that the firm can shield some of its profits from the union. Thus if π is interpreted as that part of the firms rents which the union can actually obtain through negotiation then the actual profits of the firm are $\psi\pi$ where $\psi > 1$. Firm revenue is given not (2.15) but rather by

$$(2.20) \quad R^* = \epsilon(\psi \pi + \bar{w})$$

and (2.17) must be modified to

$$(2.21) \quad \epsilon = R^*/[w^* + (\frac{\psi - \eta}{\eta}) w].$$

Otherwise the likelihood function is unchanged.

The hypothesis that our model is the true one and that there is no precommitment by firms is the equivalent to the hypothesis $\psi = 1$.

[It remains to describe how ψ depends on exogenous variables.]

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