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AN EMPIRICAL TEST OF AN ASYMMETRIC INFORMATION MODEL OF STRIKES

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ABSTRACT

Recent developments in the thoery of strategic bargaining demonstrate how informational asymmetries can lead to prolonged and costly bargaining. These models can be applied to contract negotiations between unions and firms yielding an economic theory of strikes. To date, however, few empirical tests of these models have been carried out. This paper presents some evidence supporting this view of strikes. A set of predictions concerning the incidence and unconditional duration of strikes is derived from a simple bargaining model where the union is uncertain about the firm's future profitability. These predictions are then tested on a micro data set of major U.S. contract negotiations which took place from 1973 to 1977.

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AN EMPIRICAL TEST OF AN ASYMMETRIC INFORMATION MODEL OF STRIKES

I. INTRODUCTION

Many theories have been advanced over the years to explain the occurrence of strikes during contract negotiations (for a survey see Kennan, 1985). Recently, game-theoretic bargaining models have been developed which offer potential new insights into why strikes take place (see for example Cramton, 1982, Hayes, 1984, Sobel and Takahashi, 1982, Tirole and Fudenberg, 1984, and Tracy, 1984). Despite the considerable theoretical work devoted to these asymmetric information models, no empirical tests of these models have been published to date. The purpose of this paper is to derive and test some comparative static results for a simple bargaining model.

The intuition behind these bargaining models is quite simple. The function of the negotiation process is to reestablish a division of the rents accruing to the bargaining pair consisting of the firm(s) and the union(s). Despite the bilateral monopoly situation which exists, if both are fully informed then the bargaining should not lead to a strike. From an economic viewpoint, a critical determinant of strike activity is uncertainty. This uncertainty can be concerning the size of the rents to be divided and/or the bargaining costs to either party. In the presence of uncertainty, bargaining serves as a learning process whereby one party may be able to infer the other's private information by observing his/her actions during the negotiations. A strike takes place whenever this process continues beyond the expiration of the current contract. By raising the costs of extending the bargaining, strikes bring about an eventual settlement.

The following implications will be derived from a simple model in which the union continues to make wage demands until a settlement is reached. Increasing the union's uncertainty about the firm's profitability over the next contract period increases both the probability and the expected duration of a strike. The larger the average rents to be divided between the firm and the union, the less likely it is that a strike will occur and the shorter is its expected duration. Finally, lowering the union's bargaining costs leads to an increase in overall strike activity.

The paper presents tests of these implications based of a micro data set of manufacturing contract negotiations. The uncertainty hypothesis is tested using measures of investor uncertainty over the firm's future profitability as a proxy for the union's uncertainty. This investor uncertainty is broken down into a component resulting from economy-wide events and a component resulting from firm-specific events. The data indicates that while both measures of uncertainty are positively related to strike activity, the firm-specific source has the largest and most significant impact.

The effect of business cycle shocks on strike activity is also tested. The impact of cyclic shocks to the industry as well as to the local labor market are separately controlled for. The model predicts different effects for each type of shock. Above average conditions in the industry tend to raise the rents to the match and therefore should reduce the level of strike activity. On the other hand, above average conditions in the local labor market lowers both the level of the rents and the relative bargaining costs to the union by providing part-time job opportunities. Both effects should tend to increase strike activity. The data confirms that strikes are counter-cyclic with respect to industry shocks and pro-cyclic with respect to local shocks.

The hypothesis that larger rents to the bargaining pair discourages strike activity is further tested by controlling for two additional sources of rents. These rents can consist of quasi-rents due to specificity in the match and monopoly rents due to market restrictions. Quasi-rents are proxied by both the industry average job tenure and labor market experience for union workers. The concentration ratio is used to control for monopoly rents. Increases in either average tenure or experience reduce strike activety with the latter effect being highly significant. The concentration effect is opposite to the prediction and weakly significant.

The outline of the paper is as follows. The second section of the paper presents background material relevant to the modelling of strikes. The third section contains a simple N-round bargaining model that illustrates the implications indicated above. The development of the variables used to test the model is outlined in the fourth section. The final section discusses the empirical specification and results.

II. THE CONTRACTING PROBLEM

Unions are assumed in this study to be wealth maximizing. Firms and unions are engaged in a long-term association which will involve numerous contract negotiations. The implication is that the union will not necessarily attempt to maximize their return from any given contract; instead, they try to maximize the discounted stream of expected returns from the sequence of future contracts. In this paper, I assume that is is not in the interest of the union to bankrupt the firm. This constrains the union's wage demands to a competitive wage plus a share of the rents accruing to the bargaining pair.[1] For simplicity, the bargaining model presented in the next section will not incorporate the repeated nature of contract negotiations.

Bargaining takes place precisely because of the presence of rents. If no rents exist, then either both parties accept a competitive return or the firm goes bankrupt. Consequently, for the contracting problem to be pervasive, rents must be pervasive. There are two basic sources of these rents. The first is quasi-rent generated by specificity in the match while the second is monopoly rent generated by restrictions on output. Quasi-rents exist when the productivity of the union workers at the firm exceeds their productivity outside the firm. Similar quasi-rents exist if specialized capital is used by the firm in its production process.[2] A union can attempt to capture a share of monopoly rents by either organizing into an existing monopoly situation or trying to form a cartel within a competitive industry.[3]

Agreeing to a division of these rents may involve an extended period of bargaining when informational asymmetries exist. However, when both sides are fully informed as to the size of the rents and the bargaining costs, neither can gain by delaying the agreement. Consequently, in order to avoid additional bargaining costs, both sides would agree on a new contract at the outset of the negotiations. When private information exists, bargaining can serve as a means of inferring this information. Bargaining continues as long as the value of the information that is expected to be learned from an additional round of negotiations outweighs the additional bargaining costs. Strikes tend to limit the length of negotiations by increasing the costs of continuing this learning process.

The idea that uncertainty is the central factor behind the dynamics of bargaining is an implication of the work by Rubenstein (1982). In his paper, Rubenstein analyzes a bargaining problem in which two individuals must divide a "pie" of known size. Each individual is fully informed as to the other's preferences and both prefer consuming the pie now as opposed to later. However, they must first agree on how the pie is to be divided before they can eat it. Each individual alternates making suggested splits. Using a strict form of rationality, Rubenstein demonstrates that the two individuals will always agree on the first suggested split. No dynamics develop in the bargaining even though an infinite number of rounds of negotiations are allowed.

By making each individual fully informed as to the size of the pie and the other's preferences, Rubenstein eliminated the need for bargaining to serve as a learning device. Relaxing this assumption of complete information will create some dynamics and thus allow for strikes to take place.

III. A BARGAINING MODEL WITH STRIKES

The purpose of this section is to analyze a simple bargaining model which illustrates the implications outlined in the introduction. The firm enters into the negotiations with full information. The union, though, must negotiate with incomplete information as to the size of the rents to be divided. Bargaining can last up to an arbitrary N rounds. At each round, the union proposes a contract consisting of a wage rate. Production takes place only after the firm agrees to a contract.[4]

Let the present value of the firm's profitability over the next contract peried net of non-labor costs be denoted by P. The value of P is calculated assuming that no strike takes place, ie that the firm accepts the union's first contract offer. At the outset of negotiations the firm knows P while the union believes that P is uniformly distributed over the interval $[\underline{P},\bar{P}]$. The costs to each side from delaying the agreement are parameterized by discount factors δ_u,δ_f. The payoff to the firm and the union from agreeing to a wage w after t rounds of negotiation are

$$\pi_U(w;t) = w\delta_U^{t-1}$$

$$\pi_F(w;P,t) = (P-w)\delta_F^{t-1}$$

If the union's first contract is accepted by the firm, then no strike takes place. In this case, t = 1 and no discounting occurs in the payoffs. If the bargaining continues beyond the first round, then a strike starts and the payoff to each side from a settlement is discounted to reflect its respective strike costs. If no agreement can be reached after N rounds, then the bargaining pair splits up. The union receives the present value of the flow of competitive wages, R, in the local labor market. The firm receives zero economic profits in its next best alternative use of its resources. The union's prior beliefs about P, the discount factors, and the value of R are assumed to be public information.[5]

At each round of bargaining, the union chooses a wage demand which maximizes its expected return conditional on the information it has available. In order to understand how the union infers the firm's private information during a strike, consider for example what the union learns by observing whether or not the firm accepts its wage demand in the $N-1^{th}$ round.

Let I_{N-1} denote the firm's information set at the start of the N^{th} round of negotiations. Denote the firm's conditional expectation of the union's N^{th} round wage demand by $Ew_N \mid I_{N-1}$. In addition, let $\hat{P}(w_{N-1})$ be the level of profitability for the firm if it is indifferent between accepting w_{N-1} or continuing the strike one round and accepting the next union wage demand. The value of $\hat{P}(w_{N-1})$ solves

$$\hat{P}(w_{N-1}) - w_{N-1} = [\hat{P}(w_{N-1}) - Ew_N \mid I_{N-1}]\delta_F$$

(1)

$$\hat{P}(w_{N-1}) = \frac{w_{N-1} - Ew_N \mid I_{N-1}\delta_F}{(1-\delta_F)}$$

The union learns if the firm's profitability is greater or less than $\hat{P}(w_{N-1})$ by observing if the firm accepts its wage demand w_{N-1}. If the firm rejects the union's wage demand, then the firm's profitability is less than or equal to $\hat{P}(w_{N-1})$. In this case, the union updates its beliefs by placing a zero probability on P lying in the interval $[\hat{P}(w_{N-1}), \hat{P}(w_{N-2})]$. As a consequence, the union enters into the Nth round of negotiations with posterior beliefs that P is uniformly distributed over the interval $[\underline{P}, \hat{P}(w_{N-1})]$.

The advantage of working with a bargaining model with a fixed number of rounds is that its solution can be found by solving recursively from the last round. Assume that the firm has rejected the union's penultimate wage demand. The union must now select its best final wage demand given its updated beliefs. In the N^{th} round, the firm will accept any wage demand that yields it nonnegative rents. Consequently, the expected value to the union from making a wage demand of w_N is

$$(2) \qquad V_U(w_N) = \left[\frac{\hat{P}(w_{N-1}) - w_N}{\hat{P}(w_{N-1}) - \underline{P}}\right] w_N + \left[\frac{w_N - \underline{P}}{\hat{P}(w_{N-1}) - \underline{P}}\right] R$$

The optimal N^{th} wage demand maximizes the union's expected payoff.

$$(3) \qquad w_N^* = \text{Max}\{R + 1/2[\hat{P}(w_{N-1}) - R], \underline{P}\}$$

Define $\hat{\underline{P}} = \underline{P} + (\underline{P}-R)$. Then $w_N^* > \underline{P}$ when $\hat{P}(w_{N-1}) > \hat{\underline{P}}$. Substituting the expression for w_N^* back into equation (2) and solving for the union's indirect payoff gives

$$(4) \qquad V_U(w_N^*) = \text{Max}\{R + (1/2)\ {}_2\frac{[\hat{P}(w_{N-1}) - R]^2}{[\hat{P}(w_{N-1}) - \underline{P}]}, \underline{P}\}$$

Following the methodology in Cramton (1982), the form of the final wage demand and the union's indirect payoff function suggest the following general structure. If $\hat{P}(w_{N-1}) > \hat{\underline{P}}$, then for any $j \leqslant N-2$

$$(5) \qquad \begin{aligned} w_{j+1}^* &= R + c_{j+1}[\hat{P}(w_j) - R] \\ V_U(w_{j+1}^*) &= R + 1/2c_{j+1}\frac{[\hat{P}(w_j) - R]^2}{[P(w_j) - \underline{P}]} \end{aligned}$$

We will check this conjecture by induction. Assume that this structure holds for the $j+1^{st}$ through the N^{th} rounds. We must demonstrate that it also holds for the j^{th} round.

At the outset of the j^{th} round of bargaining, the union believes that the firm's profitability is uniformly distributed over the interval $[\underline{P},\hat{P}(w_{j-1})]$. What is the union's expected payoff from making a wage demand of w_j? If the firm's profitability level exceeds the corresponding cutoff level, $\hat{P}(w_j)$, then the firm will accept the wage demand; otherwise, the union receives the one period flow value from its outside opportunities plus the discounted value from making its optimal wage demand in the next round of negotiations.

$$(6) \qquad V_U(w_j) = \left[\frac{\hat{P}(w_{j-1}) - \hat{P}(w_j)}{\hat{P}(w_{j-1}) - \underline{P}}\right] w_j + \left[\frac{\hat{P}(w_j) - \underline{P}}{\hat{P}(w_{j-1}) - \underline{P}}\right] [(1-\delta_U)R + \delta_U V_U(\overset{*}{w}_{j+1})]$$

The optimal wage demand maximizes $V_U(w_j)$ subject to the constraint on how the firm selects its new cutoff point, $\hat{P}(w_j)$.

$$(7) \qquad [\hat{P}(w_j) - w_j] = [\hat{P}(w_j) - w^*_{j+1}]\delta_F$$

To solve for w^*_j, substitute for w^*_{j+1} and $V_U(w^*_{j+1})$ from (5) into $V_U(w_j)$. Using the constraint, we can write w_j in terms of $\hat{P}(w_j)$ and substitute this into $V_U(w_j)$. We can now maximize the unconstrained payoff function with respect to $\hat{P}(w_j)$. This cutoff point is given by

$$(8) \qquad \hat{P}(w^*_j) = R + \frac{(1-\delta_F+\delta_F c_{j+1})}{2(1-\delta_F+\delta_F c_{j+1}) - \delta_U c_{j+1}} [\hat{P}(w_{j-1}) - R]$$

Substituting $\hat{P}(w^*_j)$ back into the constraint and solving for w^*_j gives

$$(9) \qquad w_j^* = R + \frac{(1-\delta_F+\delta_f c_{j+1})}{2(1-\delta_F+\delta_F c_{j+1}) - \delta_U c_{j+1}} [\hat{P}(w_{j-1}) - R]$$

Finally, substituting for $\hat{P}(w_j^*)$ and w_j^* into equation (6) allows us to solve for the union's indirect payoff function.

$$(10) \qquad V_U(w_j^*) = R + 1/2 \left[\frac{(1-\delta_F+\delta_F c_{j+1})^2}{2(1-\delta_F+\delta_F c_{j+1}) - \delta_U c_{j+1}}\right] \frac{[\hat{P}(w_{j-1}) - R]^2}{[\hat{P}(w_{j-1}) - \underline{P}]}$$

Checking equations (9) and (10) with the general structure given in equation (5), we see that the induction hypothesis holds. The equation for c_j is given by

$$(11) \qquad c_j = \frac{(1-\delta_F+\delta_F c_{j+1})^2}{2(1-\delta_F+\delta_F c_{j+1}) - \delta_U c_{j+1}}$$

To close the model we note that $c_N = 1/2$ and $\hat{P}_0 = \bar{P}$. So long as $\hat{P}(w_{N-1}) > \hat{\underline{P}}$, we can use equation (5) to describe the union's optimal "concession" function.[6]

Our interest is in the strike probability and expected strike duration which is implied by the concession function. Recall that a strike begins if the firm rejects the union's initial wage demand. The probability of a strike, then, is given by

$$(12) \qquad Pr = \left[\frac{\hat{P}(w_1^*) - \underline{P}}{\bar{P} - \underline{P}}\right]$$

From equation (8) and the fact that $\hat{P}_0 = \underline{P}$, we have that

$$(13) \qquad P(w_1^*) = R + k_1[\bar{P} - R]$$

where

$$k_1 = \frac{(1-\delta_F+\delta_F c_2)}{2(1-\delta_F+\delta_F c_2) - \delta_U c_2} < 1$$

The first three predictions to check are that the probability of a strike increases with the union's uncertainty over the firm's profitability, decreases with larger total expected rents to the bargaining pair, and increases with the value of the union workers' outside opportunities. Consider, first, the effect of a mean preserving spread (MPS) in the union's initial distribution of beliefs concerning the firm's future profitability. Stretching out the endpoints $\underline{P}$ and $\bar{P}$ by an amount Δ_1 has the following effect.

$$(14) \qquad \left.\frac{\partial Pr}{\partial \Delta_1}\right|_{\Delta_1 = 0} = (1-k_1)\frac{[\bar{P} + \underline{P} - 2R]}{[\bar{P} - \underline{P}]^2} > 0$$

Increasing the union's uncertainty raises the probability of a strike.

Shifting up the entire interval $[\underline{P},\bar{P}]$ by an amount Δ_2 while holding R constant increases the total expected rents to be divided yet leaves the uncertainty unchanged. The effect on the strike probability is

$$(15) \qquad \left.\frac{\partial Pr}{\partial \Delta_2}\right|_{\Delta_2 = 0} = -(1-k_1)\frac{1}{[\bar{P}-\underline{P}]} < 0$$

The larger the total expected rents to be shared, the smaller the strike probability.

Finally, the effect of raising the value of the union workers' outside opportunities is given by

$$(16) \qquad \frac{\partial Pr}{\partial R} = (1-k_1)\frac{1}{[\bar{P}-\underline{P}]} > 0$$

Improving these opportunities increases the probability of a strike occurring.

The next set of predictions to check concerns the impact of the above list of factors on the length of the bargaining that occurs. The expected unconditional strike duration is given by

$$(17)\quad E(D) = \left[\frac{P-\hat{P}(w_1^*)}{\bar{P}-\underline{P}}\right](0) + \left[\frac{\hat{P}(w_1^*)-\hat{P}(w_2^*)}{\bar{P}-\underline{P}}\right](1) + \ldots + \left[\frac{\hat{P}(w_{N-1})-\underline{P}}{\bar{P}-\underline{P}}\right](N-1)$$

To evaluate this expectation, we need to express the cutoff points, $\hat{P}(w_j)$, in terms of the underlying parameters of the bargaining model. In general we can write

$$(18)\qquad \hat{P}(w_j) = R + k_j[\hat{P}(w_{j-1}) - R]$$

where

$$k_j = \frac{(1-\delta_F+\delta_F c_{j+1})}{2(1-\delta_F+\delta_F c_{j+1}) - \delta_U c_{j+1}}$$

Using backward substitution we get that

$$(19)\qquad \hat{P}(w_j) = R + K_j[\bar{P} - R]$$

where

$$K_j = \prod_{i=1}^{j} k_i$$

Substituting for the cutoff terms in (17) and simplifying gives

$$(20)\qquad E(D) = \left[\frac{\bar{P}-R}{\bar{P}-\underline{P}}\right]\sum_{j=1}^{N-2} K_j(1-k_{j+1})(j) + \frac{1}{[\bar{P}-\underline{P}]}[R + K_j(\bar{P}-R) - \underline{P}](N-1)$$

We can use equation (20) to check the predictions concerning the unconditional strike duration. The impact of a MPS is given by

$$\frac{\partial E(D)}{\partial \Delta_1}\Bigg|_{\Delta_1=0} = -\frac{[\bar{P}+\underline{P}-2R]}{[\bar{P}-\underline{P}]^2}\left\{\sum_{j=1}^{N-2} K_j(1-k_{j+1})(j) + [K_{N-1}-1](N-1)\right\} \tag{21}$$

The effect of an increase in the total expected rents is

$$\frac{\partial E(D)}{\partial \Delta_2}\Bigg|_{\Delta_2=0} = \frac{1}{[\bar{P}-\underline{P}]}\left\{\sum_{j=1}^{N-2} K_j(1-k_{j+1})(j) + [K_{N-1}-1](N-1)\right\} \tag{22}$$

Finally, the effect of a change in the union's outside opportunities is

$$\frac{\partial E(D)}{\partial R} = \frac{1}{[\bar{P}-\underline{P}]}\left\{\sum_{j=1}^{N-2} K_j(1-k_{j+1})(j) + [K_{N-1}-1](N-1)\right\} \tag{23}$$

The three prediction concerning the incidence of strikes extend to the unconditional durations if the following inequality holds.

$$\sum_{j=1}^{N-2} K_j(1-k_{j+1})(j) + [K_{N-1}-1](N-1) < 0$$

This can be demonstrated using an induction argument.[7]

In summary, then, this simple N round bargaining model predicts that the probability of a strike and its expected unconditional duration are positively related to the degree of uncertainty facing the union and the value of the union's outside opportunities. On the other hand, both measures of strike activity are negatively related to the total expected size of the rents to be shared by the firm and the union. These results incorporate optimal behavior by the union and the firm at each round of the bargaining.

IV. DESCRIPTION OF THE VARIABLES USED TO TEST THE MODEL

The micro data set used in this study consists of all major contract negotiations in manufacturing industries between 1973 and 1977 that were reported by the Bureau of Labor Statistics.[8] Both contract renegotiations and scheduled reopenings are included in the data. For each negotiation we know the firm and the union involved in the negotiations, the industry and region affected by the contract, whether a strike took place, and if so how long the strike lasted. Details of the construction of this data are presented in Tracy (1986).

Viewing contract negotiations as a process of splitting rents presents difficulties when it comes to empirically testing the model. The predictions are that strike activity is positively related to the degree of uncertainty facing the union as well as the union's outside opportunities and inversely related to the total amount of the rents to be shared. The difficulty is that we can not directly measure these variables. Instead, we must test the model by finding proxies for these unobserved parameters of the model.

Consider the problem of measuring the union's uncertainty over the firm's future profitability. Assume that on average, the greater the uncertainty that exists in the financial market as to the firm's profitability, the greater is the union's uncertainty as well. If this positive correlation exists, then we can use measures of investor uncertainty as our proxy. The finance literature suggests several methods for measuring this investor uncertainty. The efficient market hypothesis stresses that security prices adjust as new information is capitalized in the market. As a result, the current price of a security is taken as an unbiased in dicator of the firm's profitability conditional on current information. Any news which changes investor's expectations will show up as price movements.

A measure of overall investor uncertainty is given by the volatility of the firm's security returns. Tracy (1986) found that this broad measure of uncertainty was positively related to both the incidence and the conditional duration of strikes. While this is viewed as consistent with the asymmetric information model of strikes, it would be desirable to derive a sharper test of the model.

In the bargaining model we assumed that the firm knew the exact demand conditions for the upcoming contract period. In reality, firms as well as unions must forecast future demand conditions. There is no a priori reason to believe that firms are more capable than unions at predicting the influence of economy wide factors on the firm's profitability. Consequently, it is unlikely that the union would engage in costly bargaining in an attempt to learn this type of information from the firm. On the other hand, the firm may possess superior information concerning firm specific factors affecting its future performance. The relevant uncertainty facing the union in this model should be over firm specific information rather than general economy information.

The volatility of the firm's security return reflects both firm specific and economy wide sources of uncertainty. The finance theory market model allows us to separate out each source. The market model expresses a security's return as a linear function of the market return plus a residual.

$$\tilde{R}_{it} = \alpha_i + \beta_i \tilde{R}_{Mt} + \tilde{U}_{it}$$

where

$\tilde{R}_{it}$ = return on the i^{th} security at time t

$\tilde{R}_{Mt}$ = return on a value weighted portfolio of securities at time t

The slope coefficient, β_i, is the firm's "systematic risk factor" and captures the security's sensitivity to market influences.

The residual is called the "excess" return and has a zero expectation conditional on current inforamtion. The excess return nets out much of the effect of general economy news on the firm's profitability by controlling for changes in the market return. Schwert (1981, p.125) argues that "...using the market model to control for market wide variations in returns to all assets yields more precise estimates of the firm specific effects on asset returns".

In order to estimate these excess returns, a market model was fitted to a 250 trading day sample for each negotiation in the data for which the firm was actively traded.[9] The firm specific source of uncertainty will be proxied by the standard deviation of the excess returns. The standard deviation of the market returns multiplied by the firm's systematic risk factor will proxy general economy uncertainty. Adjusting for the firm's beta is important since firms with low betas are more insulated from general economy influences. The asymmetric information model suggests that the firm specific source of uncertainty should have the dominant influence on strike activity. This provides a sharper test of the model than simply looking at an overall uncertainty measure.

The next element of the bargaining environment to control for is the average size of the rents to the match between the firm and the union. The model predicts that higher average rents will reduce the overall level of strike activity. In section one, I emphasized that these rents can be made up of quasi-rents and/or monopoly rents. We need, then, proxies for each type of rent.

An important source of quasi-rents is firm specific human capital (Becker, 1972). Workers often receive on-the-job training which has its full value only when used in that firm (or industry). In Williamson's (1975) terminology, firm specific training imparts an "idiosyncratic" nature to a task. The end result is that a worker's productivity is raised above its level in other firms thus creating quasi-rents.

In the absence of direct measures of the extent of on-the-job training, the most natural proxy variable is the average job tenure of union workers in that industry. The 1979 May Current Population Survey (CPS) contains both a union coverage and job a tenure question. All union workers answering the tenure question were sorted by two-digit industry and the industry average tenure was calculated. A problem with this measure was that several industry averages were based on very small samples of workers. This may introduce serious measurement error into this variable.[10]

An alternative proxy overcomes this problem of small sample size but is a less direct measure of specific training. Union workers were pooled from four years of May CPS's (1973-1976) and their potential work experience was calculated. This provided a large sample of workers in each industry to use to obtain industry average experience estimates. As a comparison, the same measure of experience was calculated from the May 1979 CPS. All three measures will be tested in the next section. The prediction is that they will be inversely related to strike incidence and unconditional strike durations.

The extent of monopoly rents depends in part on the industry structure that the firm operates in. A simple characterization of this industry structure is given by the concentration ratio. Specifically, the measure used is the percent of the total sales in a four-digit industry classification that were accounted for by the four largest firms. To the extent that higher levels of measured concentration lead to a greater ability to generate monopoly rents, then the model predicts that strike activity will be inversely related to the concentration ratio.

An additional factor which potentially could affect the rents to be shared by a bargaining pair is the cyclic conditions facing the industry at the time of the negotiations. When industry demand conditions are above average, rents may tend to be larger than usual. This implies that, others things constant, it is costly for the bargaining pair to be involved in a strike at this time.

These cyclic demand shocks will be measured using residuals from an industry employment trend regression. These trend regressions were estimated using quarterly three-digit employment data for the period 1970-1981. A linear time trend with quarterly dummy variables and an autoregressive error term was fit for each three-digit industry in the negotiation sample. To avoid any potential feedback between the actual amount of strike activity in a quarter and the residual, forecasted residuals are used in the analysis.

The final element of the model to proxy for are the union's outside opportunities. During the course of a strike, union members may be obtain part-time jobs which help to offset their strike costs. The likelihood of finding temporary employment will be affected by the general labor market conditions in the locality. Following the apporach used to measure the cyclic shocks to the industry, cyclic conditions in the local labor market will be proxied by forecasted residuals from local employment trend regressions.

This concludes the discussion of the proxy variables used to test the predictions from the asymmetric information model of strikes. Several additional variables will also be included in the analysis to control for other factors which may affect the bargaining environment. A discussion of the motivation for and construction of these variables is given in Tracy (1986).

V. EMPIRICAL SPECIFICATION AND RESULTS

One of the implications of the model outlined in section three is that any variable which increases the likelihood of a strike should also increase the unconditional strike duration. The choice of an econometric specification should be flexible enough to allow the data to reject this association. An example of a specification which violates this condition is the Tobit model. Consequently, I will separately model the probability of a strike and the conditional duration. This will allow me to calculate the marginal effect of a variable on the likelihood of a strike, the conditional duration, and the unconditional duration. Prior to estimation the data was standardized by subtracting from each variable its sample mean and dividing by its sample standard deviation.

The probability of a strike is assumed to be given by a logistic function.

$$(26) \qquad Pr = \frac{1}{1+EXP(-X\beta^{S})}$$

The marginal effect of a change in a variable X_k on the probability of a strike is

$$\frac{\partial Pr}{\partial X_k} = \beta_k^S \frac{EXP(-X\beta^S)}{[1+EXP(-X\beta^S)]^2} \tag{27}$$

The conditional strike durations are analyzed using a proportional hazard function.

$$\lambda(t;X) = \lambda\gamma(\lambda t)^{\gamma-1}EXP(X\beta^D) \tag{28}$$

The conditional settlement probability decreases, remains constant, or increases during the course of a strike as $\gamma < 1$, $\gamma = 1$, $\gamma > 1$. In addition, the industry and local employment residuals are allowed to vary if the strike enters a new quarter. The marginal effect of a variable X_k on the conditional strike duration is

$$\frac{\partial E(D \mid S)}{\partial X_k} = - \frac{\beta_k^D \Gamma(1+1/\gamma)}{\lambda\gamma[EXP(X\beta^D)]^{1/\gamma}} \tag{29}$$

The implied marginal effect of Xk on the unconditional strike duration is

$$\begin{aligned}\frac{\partial E(D)}{\partial X_k} = &\left[\frac{1}{1+EXP(-X\beta^S)}\right]\left[-\frac{\beta_k^D\Gamma(1+1/\gamma)}{\lambda\gamma[EXP(X\beta^D)]^{1/\gamma}}\right] \\ &+ \left[\frac{\Gamma(1+1/\gamma)}{\lambda[EXP(X\beta^D)]^{1/\gamma}}\right]\left[\beta_k^S\frac{EXP(-X\beta^S)}{[1+EXP(-X\beta^S)]^2}\right]\end{aligned} \tag{30}$$

The sample means and standard deviations of the variables used in the analysis are presented in table 1. The impact of variables on the probability and duration of a strike are presented in table 2 and table 3.[11] Consider first the role of uncertainty in bargaining. As in Tracy (1986), overall variability in the security returns has a significant and positive effect on strike incidence. A one standard deviation increase in this broad measure of uncertainty leads to nearly a three percent increase in the likelihood of a strike. From table 3 we see that this same increase in uncertainty increases the conditional strike duration by over eight days and the unconditional duration by two and a half days.

The second specification in each table presents the results from disaggregating this broad uncertainty measure into its two basic components. The data clearly indicates that uncertainty over firm specific information is more important than uncertainty over general economy information in determining strike activity. While both types of uncertainty raise the likelihood of a strike, the marginal effect arising from variability in the firm's excess returns is more than twice the magnitude and much more precisely measured than the marginal effect from variability in the adjusted market returns. Similarly, only increases in the firm specific uncertainty measure leads to longer conditional and unconditional strike durations. A one standard deviation increased in the volatility of the excess returns results in an eight day increase in the conditional durations and over a two day increase in the unconditional duration.

The key assumption of the asymmetric information model of strikes outlined earlier is that the firm has private information concerning its future profitability. The data clearly establishes the connection between volatility in the firm's security price and strike activity. These price movements reflect the markets reaction to news pertaining to the firm's performance.

The connection between these uncertainty measures and the model relies on some of this news being known by the firm in advance of its disclosure. This assumption is more reasonable for the types of firm specific information which are captured by the excess returns. Consequently, the finding that variability in the excess returns is the key uncertainty measure lends additional support to this learning model of bargaining and strikes.

Turn now to the variables used to test for the effect of changes in the magnitude of the rents on the bargaining process. Consider first the various measures for the amount of firm-specific human capital in the industry. Table 2 and table 3 report only the results from using the experience measure obtained from the pooled sample of union workers. This reflects a concern with the possibility of serious measurement error in the job tenure and experience measures calculated from the May 1979 CPS data. A one standard deviation increase in the pooled experience measure is associated with an eight percent drop in the strike probability. However, experience had no significant effect on the conditional strike duration.

As a comparison, the exact same measure of experience calculated from the 1979 data resulted in a logistic coefficient of -0.05971 with a t-statistic of -0.71. Similarly, the logistic coefficient for the job tenure measure was -0.11316 with a t-statistic of -1.34. The potential measurement error problem is evidenced by the dramatic difference in results between the pooled and nonpooled experience measures. These results also indicate that given the measurement error problems that may exist, job tenure is the superior measure. The marginal effect and significance level for tenure is nearly double the corresponding nonpooled experience figures. This is consistent with the notion that what creates quasi-rents is firm-specific not general human capital. Finally, a likelihood ratio test was carried out using the pooled data to check the restriction that the correct specification was experience rather than age and education entered separately. The test statistic was $-2\ln\lambda = 0.696$ implying that the data does not reject that experience is the correct variable to use.

The data does not support the hypothesis that higher degrees of industry concentration are associated with lower strike incidences. On the contrary, a one standard deviation increase in the concentration ratio is associated with a 1.7 percent increase in the probability of a strike. This marginal effect is weakly significant. There is no corresponding connection between the level of industry concentration and conditional strike durations. Consequently, while the unconditional marginal effect is positive, it is not significant.

Cyclic movements in the rents to the bargaining pair also seem to affect strike activity in a manner consistent with the model. A five percent increase in forecasted industry employment is associated with nearly a two percent drop in the likelihood of a strike. Similar to the experience measure, the industry employment residual does not significantly decrease the conditional strike duration. Consequently, while the unconditional marginal effect is negative as predicted it is not measured very precisely.

The last variable to check which relates to the bargaining model is the local employment residual. The model suggests that improvements in local labor market conditions would have the opposite effect on strike activity as compared to improvements in industry labor market conditions. The data supports this prediction. A 4 percent increase in local forecasted employment is associated with slightly over a 5 percent increase in the probability of a strike. The t-statistic associated with this marginal effect is 4.80 for the second specification. Unlike the industry employment residual, the local employment residual does significantly affect the conditional duration of a strike. The same 4 percent increase in forecasted employment is associated with a dramatic two week reduction in the conditional duration. This implies that the effect of local labor market conditions on the incidence of strikes is opposite to its effect on the conditional durations.

Recall that the model has the property that the marginal effects of a variable on the incidence and the unconditional durations should be the same. In the case of the local employment residual, we see that despite the large drop in conditional durations, the point estimate for the unconditional marginal effect is positive although not significantly different from zero. It would be of interest to see if other data sets on strikes yield similar findings for measures of local employment conditions.

Turn now to the other variables included in the analysis. The capital intensity of the production technology has some impact on the bargaining environment. A one standard deviation increase in the capital/labor ratio increases the strike probability by around two percent and increases the conditional duration by slightly over ten days. Neither effect, though, is measured with much precision. Changes in the firm's inventory position prior to the negotiations does not affect the level of strike activity. Firm size as measured by the net plant and equipment is an important aspect to the negotiations. Larger firms were found to have lower incidences of strikes and shorter conditional durations with the second effect being significant. These two effects combined to produce a negative and significant scale effect on the unconditional duration. Despite the role played by the industry unionization rate in union wage differential studies, this variable did not affect the level of strike activity. Finally, higher employment growth rates for the industry or the locality tend to raise the likelihood of a strike slightly and shorten the conditional durations.

The results presented in table 2 and table 3 are estimated using both interindustry as well as intraindustry variation in the data. A question of interest is whether the key findings of the study hold principally across industries but not necessarily within industries. The answer to this issue can be found by reestimating the model exploiting only within industry variation in the data. To do this, seventeen industry fixed effects were included in the logistic model. The food, textile, and apparel industries comprised the left out group. The latter two experienced no strikes which implied that no separate fixed effect could be estimated for them.

The "within" logistic coefficients and their implied marginal effects are given in table 4. Looking within industries the firm specific source of uncertainty is still the key uncertainty measure affecting strikes. While its marginal effect is reduced from 2.5 percent to 1.8 percent, this effect remains larger and more significant than the corresponding effect from the economy wide measure of uncertainty. No estimate for labor force experience is possible since it was measured only at the two-digit industry level. The two employment residuals retain their opposite and significant effects on strike activity. Finally, the industry concentration marginal effect is higher and more significant when based solely on within industry variation.

In summary, the aim of this study was to explore and test the comparative static results from a simple asymmetric information model of negotiations and strikes. The central idea of the model was that bargaining may serve as a means whereby the union can infer information about the firm's future profitability that is privately known by the firm. An implication was that increases in the union's uncertainty over the firm's profitabiltiy would increase the incidence and unconditional duration of strikes. Two distinct measures of profit uncertainty were generated. The data indicated that not only were both measures directly related to strike activity, but that the firm specific measure was the key source of uncertainty. This finding is important since the firm specific uncertainty measure seems to be more closely tied to the information asymmetry built into the model. As a whole, the data seemes consistent with the predicitions of the simple bargaining model outlined in this paper. Clearly, additional tests should be developed for this class of bargaining models and checked against the data.

FOOTNOTES

1. A separate issue is how the union prevents its older members from behaving as income vs wealth maximizers. Pension funds and seniority rules may serve help to overcome this problem by extending the horizon of older members.

2. See Klein, Crawford and Alchian (1979) for a discussion of the appropriability of these quasi-rents.

3. See McDonald and Robinson (1985) for a model of a union generating monopoly rents in a competitive industry.

4. Sobel and Takahashi (1982) give a general discussion of this type of model. See also the work by Cramton (1982).

5. I also assume the $R < \underline{P}$; that is, with complete information is would always be efficient for the firm and the union to sign a contract.

6. I am currently working on deriving the concession function and its comparative statistics for the case where $\hat{P}(W_{N-1}) < \hat{\underline{P}}$. In this case, the union sets $W_N = \underline{P}^*$ which guarantees that the firm will accept the contract.

7. Details of this induction argument are available upon request.

8. Major contracts are those which cover at least 1,000 workers.

9. Speculation as to the outcome of the bargaining will begin to occur as the contract expiration date approaches. This speculation will induce price movements of its own that do not reflect the union's uncertainty about the firm's future demand conditions. To avoid picking up these price movements in the uncertainty measure, the sample period used to estimate the market model ended six months prior to the contract expiration date.

10. A total of eight industries had less than thirty observations on which to

calculate the industry average tenure. For example, the tobacco industry had one observation, the lumber industry three observations, and the textile industry five observations.

11. Table 2 also reports "pseudo" R^2 statistics for each specification. This R^2 is calculated as follows

$$\text{"PSEUDO"}R^2 \equiv \frac{1-(L_\beta/L_\Omega)^{2/N}}{1-(L_\Omega)^{2/N}}$$

where L_β = maximized value of the unrestricted likelihood function

L_Ω = maximized value of the likelihood function restricted to an intercept term

N = sample size.

This measure was proposed by Cragg and Uhler (1970).

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Table 1

UNCONDITIONAL SAMPLE MEANS AND STANDARD DEVIATIONS

Variable	Mean	Standard Deviation
Standard Deviation of Raw Returns	0.02037	0.00767
Standard Deviation of Excess Returns	0.01811	0.00743
Adjusted Standard Deviation of Market Returns	0.00902	0.00399
Job Tenure	12.43359	2.01233
Labor Force Experience	21.73313	1.18687
Concentration Ratio	45.93783	21.08371
Industry Predicted Employment Residual	0.08162	5.00552
State Predicted Employment Residual	-0.66899	4.07979
Capital/Labor	23.03008	30.82444
Change in Inventory/Sales	-2.23681	16.18654
Net Plant and Equipment	3,250.39116	12,440.27673
Union Coverage Rate	42.61226	12.44273
Industry Employment Growth Rate	0.12839	0.44945
State Employment Growth Rate	2.17487	1.14497
Strike	0.15011	0.35732
Conditional Duration	50.00000	64.92886

Table 2
LOGISTIC MODEL: NO FIXED EFFECTS

Variable	(1) Logistic Coefficient	(1) Marginal Effect	(2) Logistic Coefficient	(2) Marginal Effect
Standard Deviation of Raw Returns	0.27971 (3.37)	0.02982 (3.37)		
Standard Deviation of Excess Returns			0.23818 (2.75)	0.02531 (2.74)
Adjusted Standard Deviation of Market Returns			0.11622 (1.30)	0.01235 (1.30)
Labor Force Experience	-0.74876 (-5.98)	-0.07983 (-6.60)	-0.75729 (-6.03)	-0.08048 (-6.66)
Concentration Ratio	0.16087 (1.88)	0.01715 (1.88)	0.16047 (1.87)	0.01705 (1.88)
Industry Predicted Employment Residual	-0.18710 (-2.16)	-0.01995 (-2.16)	-0.18378 (-2.11)	-0.01953 (-2.12)
State Predicted Employment Residual	0.47905 (4.64)	0.05107 (4.74)	0.48766 (4.70)	0.05182 (4.80)
Capital/Labor	0.20364 (1.47)	0.02171 (1.48)	0.20981 (1.51)	0.02230 (1.51)
Change in Inventory/Sales	-0.04966 (-0.61)	-0.00529 (-0.61)	-0.05364 (-0.66)	-0.00570 (-0.66)
Net Plant and Equipment	-0.20450 (-1.79)	-0.02180 (-1.80)	-0.19604 (-1.71)	-0.02083 (-1.72)
Union Coverage Rate	-0.03025 (-0.34)	-0.00322 (-0.34)	-0.03075 (-0.34)	-0.00327 (-0.34)
Industry Employment Growth Rate	0.13872 (1.67)	0.01479 (1.67)	0.12979 (1.55)	0.01379 (1.55)
State Employment Growth Rate	0.11384 (1.33)	0.01214 (1.34)	0.11612 (1.36)	0.01234 (1.36)
Intercept	-1.97986 (-20.76)		-1.98409 (-20.73)	
Log Likelihood	-508.484		-507.704	
Pseudo R^2	0.126		0.128	

N = 1,319. Note: t-statistics in parentheses.

Table 3
PROPORTIONAL HAZARD MODEL: NO FIXED EFFECTS

Variable	(1) Hazard Coefficient	(1) Conditional Marginal Effect	(1) Unconditional Marginal Effect	(2) Hazard Coefficient	(2) Conditional Marginal Effect	(2) Unconditional Marginal Effect
Standard Deviation of Raw Returns	-0.15875 (-2.01)	8.11 (2.05)	2.51 (3.60)			
Standard Deviation of Excess Returns				-0.15711 (-1.81)	8.05 (1.84)	2.27 (3.20)
Adjusted Standard Deviation of Market Returns				0.00042 (0.00)	-0.02 (-0.00)	0.63 (0.85)
Labor Force Experience	0.03401 (0.27)	-1.74 (0.27)	-4.29 (-4.74)	0.03053 (0.24)	-1.56 (-0.24)	-4.31 (4.78)
Concentration Ratio	0.02801 (0.33)	-1.43 (-0.33)	0.70 (1.04)	0.02506 (0.29)	-1.28 (-0.29)	0.72 (1.01)
Industry Predicted Employment Residual	0.02704 (0.31)	-1.38 (-0.31)	-1.19 (-1.63)	0.03386 (0.38)	-1.73 (-0.38)	-1.21 (-1.62)
State Predicted Employment Residual	0.27565 (2.81)	-14.08 (-2.60)	0.90 (1.12)	0.27558 (2.80)	-14.11 (-2.60)	0.95 (1.20)
Capital/Labor	-0.20336 (-1.45)	10.39 (1.47)	2.37 (2.14)	-0.20209 (-1.42)	10.35 (1.45)	2.39 (2.15)
Change in Inventory/Sales	-0.01293 (-0.16)	0.66 (0.16)	-0.19 (-0.29)	-0.01183 (-0.15)	0.61 (0.15)	-0.22 (-0.33)
Net Plant and Equipment	0.22208 (1.95)	-11.34 (-2.02)	-2.49 (-2.56)	0.22181 (1.93)	-11.36 (-2.00)	-2.44 (-2.49)
Union Coverage Rate	0.05950 (0.68)	-3.04 (-0.68)	-0.53 (-0.75)	0.06261 (0.71)	-3.21 (0.71)	-0.56 (-0.77)
Industry Employment Growth Rate	0.18029 (2.17)	-9.21 (-2.06)	-0.36 (-0.54)	0.18026 (2.16)	-9.23 (-2.05)	-0.41 (-0.60)
State Employment Growth Rate	0.05880 (0.71)	-3.00 (-0.70)	0.26 (0.36)	0.05650 (0.68)	-2.89 (-0.67)	0.28 (0.40)
Lambda	0.01957 (10.93)			0.01952 (11.19)		
Gamma	1.04735 (18.28)			1.04812 (18.20)		
Log Likelihood	-956.629			-956.713		

N = 198. Note: t-statistics in parentheses.

Table 4

LOGISTIC MODEL: INDUSTRY FIXED EFFECTS INCLUDED

Variable	Logistic Coeffecient	Marginal Effect
Standard Deviation of Excess Returns	0.17769 (1.95)	0.01825 (1.95)
Adjusted Standard Deviation of Market Returns	0.14024 (1.47)	0.01440 (1.47)
Labor Force Experience	-	-
Concentration Ratio	0.21864 (1.95)	0.02246 (1.92)
Industry Predicted Employment Residual	-0.20372 (-2.21)	-0.02092 (-2.22)
State Predicted Employment Residual	0.49469 (4.50)	0.05081 (4.60)
Capital/Labor	0.11356 (0.64)	0.01166 (0.64)
Change in Inventory/Sales	-0.01890 (-0.22)	-0.00194 (-0.22)
Net Plant and Equipment	-0.18388 (-1.38)	-0.01889 (-1.38)
Union Coverage Rate	-	-
Industry Employment Growth Rate	0.09484 (0.88)	0.00974 (0.88)
State Employment Growth Rate	0.17499 (1.96)	0.01797 (1.96)
Intercept	-3.14056 (-6.65)	
Log Likelihood	-491.624	
Pseudo R^2	0.167	

N = 1,319. Note: t-statistics in parentheses.