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TESTING STRATEGIC BARGAINING MODELS USING STOCK MARKET DATA

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ABSTRACT

This paper presents three empirical tests of a class of asymmetric information bargaining models using stock market data. The basic idea behind these models is that protracted bargaining can be used to infer information that is privately known by another party to the negotiations. A fundamental implication of these models is that there should be evidence that negotiations result in learning taking place. In the context of union contract negotiations, if bargaining is primarily motivated by the union's uncertainty over the firm's future profitability, then there should be evidence that contract negotiations reduce this uncertainty. This prediction is tested by comparing the variance of the firm's stock price prior to and following a contract negotiation. The data indicate that bargaining results in a significant reduction in this variance. Other predictions of these bargaining models are that the firm's stock price should decline during a strike and increase on the settlement date. The data generally support these predictions with the exception of a decline in the firm's equity value following the settlement of a contract which did not involve a strike.

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I. INTRODUCTION

Recent studies of micro data on union contract negotiations have documented that anywhere from 15%-20% of these negotiations involved a strike.[1] Rationalizing these strikes within an economic framework has proven to be a difficult and ongoing task. The development of strategic bargaining models offers a potential solution to this problem.[2] The basic view taken in these game theoretic models is that bargaining can be used as a way for one party to infer information that is privately known by another party involved in the negotiations. Bargaining is viewed as a learning mechanism. In the context of labor contract negotiations, management may be better informed than the union leaders about the firm's future profitability. The more uncertain the union is about the firm's profitability, the more likely the union will engage in prolonged bargaining i.e. call a strike.

A new empirical literature is developing which attempts to test predictions based on this view of strike activity. Several studies have tested for positive relationships between strike activity and proxies for uncertainty. Tracy (1986, 1987) assumed that there is a positive correlation between the union and investor uncertainty over the firm's profitability. Measures of the latter were constructed from stock market data and used as a proxy for the former. Variances of the firm's excess returns were shown to have a positive and significant effect on both the likelihood and the duration of a strike. Using industry aggregate strike

[1]See Card (1987) and Tracy (1986).

[2]See Cramton (1984), Fudenberg & Tirole (1983), Hayes (1984), and Sobol & Takahashi (1983) for early developments of these models. Kennan (1986) provides a survey of the theoretical and empirical literature on strikes. Recent criticisms and reformulations of these models are given by Gul & Sonnenschein (1985) and Hart (1986).

data, McConnell (1987) finds that strikes are positively related to the variance in actual producer prices, but not significantly related to the variance in forecasted producer prices. Herrington (1988) uses micro strike data and finds that strikes are positively related to the variance in the firm's sales.

A second prediction of many of the one-sided asymmetric information models of strikes is that a negatively sloped wage "concession function" exists. That is the union's wage demands should decline as a strike progresses.[3] This prediction has been tested by Gramm (1984) and McConnell (1987) using U.S. data, and Card (1988) using Canadian data. Gramm finds a positive sloped concession function while McConnell finds a negative but relatively flat concession function.[4] Using the first difference in wages between contracts, Card finds no systematic relation between wages and strikes.

The mixed findings of the studies to date suggest that it would be worthwhile to develop and test further implications of this class of bargaining models. In the next section of the paper three additional tests will be derived. The intuition behind these tests is a follows. If investors understand the mechanics of the bargaining process, then by observing the course of the negotiations they may be able to infer along with the union information related to the firm's profitability. Assuming

[3]It should be noted that this prediction is sensitive to which party involved in the negotiations is uninformed. If the union has complete information and the firm is uninformed about the opportunity cost of labor, then an upward sloping wage concession function exists. When both parties are uninformed, then speculation suggests that there may not be a predicted sign for the slope of the concession function.

[4]Based on the entire sample, McConnell's estimates indicate that real wages fall by 3% over the first 100 days of a strike. The steepest concession function was for nonmanufacturing industries where the estimated decline is 7%.

that capital markets are efficient, this new information should be quickly capitalized into the firm's stock price.[5]

A fundamental implication of this class of bargaining models is that there should be evidence that negotiations result in learning taking place. In particular, if negotiations are primarily motivated by the union's uncertainty over the firm's future profitability, then there should be evidence that contract negotiations are followed by a reduction in this uncertainty. Following Tracy (1986, 1987) this hypothesis can be tested by comparing the variance in the firm's stock returns prior to and following a contract negotiation. The test is whether there is systematic evidence that the post-negotiation variance is smaller than the pre-negotiation variance.

Strategic bargaining models also give predictions concerning the pattern of the firm's stock returns both during a strike and following its settlement. Previous empirical studies of the stock market response to strikes have attempted to measure the resource cost of a strike to the firm using the reduction in the firm's equity value during the strike.[6] The reasoning is that if strikes involve resource costs to firms, then the news of a strike should result in a reduction of the equity value of the firm. This argument is inconsistent with the view that management trades off these strike costs during negotiations for future reductions in their wage bill. Rational bargaining by management suggests that conditional on the firm's state of demand, the expected value of the firm should increase throughout the strike until the settlement date.

Assume now that both the union and investors are uncertain about the firm's state of demand. The stock price reflects the firm's unconditional

[5]See Fama et al. (1969) for a discussion of the efficient market hypothesis.
[6]See Neumann (1980) and Becker & Olson (1986).

profitability rather than its conditional profitability. Incentive compatibility constraints incorporated into these bargaining models require that the higher a firm's state of demand, the sooner the firm settles with the union. Bargaining involves a sorting process. While the conditional value of the firm increases during a strike, the unconditional value decreases due to the adverse information about the firm's state of demand which is learned as the strike continues. If strikes act as a learning mechanism, then the firm's stock price should decline throughout a strike. These models also predict that when a settlement is reached the firm's stock price should be revised upwards. Prior to settlement the market price reflects the average state of demand for that stage of the bargaining. The settlement indicates that the firm's demand state is in the upper tail of that distribution.

To summarize, strategic bargaining models generate three implications concerning the stock market response to contract negotiations. First, the post-negotiation variance in the firm's stock price should be less than the pre-negotiation variance; second, the firm's stock price should decline during the course of a strike; and third, the firm's stock price should increase on the settlement of a new contract. Each of these three predictions will be tested in this paper.

II. A SIMPLE SEQUENTIAL BARGAINING MODEL

The three predictions discussed in the introduction can be formally derived from a variety of bargaining models. In this section a simple sequential bargaining model is presented which illustrates these implications. A number of abstractions are made to keep the model tractable. I ignore the repeated nature of bargaining and focus on a single contract negotiation. I assume that the union is risk neutral and that there is no wage/employment trade-off. The bargaining process itself is divided into discrete rounds. At the beginning of a round the union makes a new contract demand consisting of a wage rate which the firm can either accept or reject. No bargaining takes place between rounds, and production does not start until a contract has been agreed to by the firm.[7]

The firm enters into the bargaining process with complete information. The union is uncertain as to the firm's profitability over the next contract period. The discounted value of the firm's revenues net of nonlabor costs is denoted by P and is a random variable to the union. The firm knows the realization of P, while the union believes that P is uniformly distributed over the interval $(\underline{P}, \bar{P})$. The discounted value of the alternative wage available to the union members is denoted by R. During negotiations the union members receive the flow value from these alternative job opportunities while the firm receives zero economic rents. The total rents to be divided between the union and the firm is given by P - R which I assume is always positive. The size of the rents is known by the firm but not the union. The costs of strikes to the union and the firm are parameterized by discount factors δ_U, δ_F.

The length of the bargaining process is limited to a maximum of N rounds. The solution concept used in this presentation closely follows those found in Sobel & Takahashi (1983) and Cramton (1984). The advantage

[7]Recent work by Gul and Sonnenschein (1985) demonstrates the important role that commitment not to bargain "between rounds" plays in these models. They show that as the length of time between rounds becomes arbitrarily small, the probability of delay goes to zero. In this paper I assume that the time between rounds of negotiation are fixed for technological reasons. For example, there may exist scheduling deadlines for production to be able to resume in the following period. See Hart (1986) and Tracy (1987) for more detailed discussion.

of a fixed number of bargaining rounds is that the solution to the model can be derived recursively. Assume that the bargaining has reached the N^{th} round. The union now believes that P is uniformly distributed over the interval $(\underline{P}, \hat{P}_{N-1})$. Since this is the last round of bargaining the union knows that it is optimal for the firm to accept any wage demand that leaves the firm with a nonnegative level of rents. It follows that the expected payoff to the union from making a final wage demand of W_N is

$$V_{UN}(W_N) = \frac{(\hat{P}_{N-1} - W_N)}{(\hat{P}_{N-1} - \underline{P})} W_N + \frac{(W_N - \underline{P})}{(\hat{P}_{N-1} - \underline{P})} R \tag{1}$$

The optimal wage demand maximizes the union's expected payoff.

$$W_N^* = \text{Max} \{ R + \frac{1}{2} (\hat{P}_{N-1} - R), \underline{P} \} \tag{2}$$

Define $\hat{P}_{Min} = \underline{P} + (\underline{P} - R)$. Then $W_N^* > \underline{P}$ whenever $\hat{P}_{N-1} > \hat{P}_{Min}$. Substituting the expression for W_N^* back into (2) and solving for the indirect union payoff function gives

$$V_{UN}^* = \text{Max} \left\{ R + (\frac{1}{2})^2 \frac{(\hat{P}_{N-1} - R)^2}{(\hat{P}_{N-1} - \underline{P})}, \underline{P} \right\} \tag{3}$$

The form of the final wage demand and the union's indirect utility function suggests the following general structure. If $\hat{P}_{N-1} > \hat{P}_{Min}$, then for all j such that $j+1 < N-1$,

$$W^*_{j+1} = R + C_{j+1}(\hat{P}_j - R)$$
$$V^*_{Uj+1} = R + \frac{1}{2} C_{j+1} \frac{(\hat{P}_j - R)^2}{(\hat{P}_j - \underline{P})} \tag{4}$$

This structure can be verified by induction. Assume that the structure in (4) holds for the $j+1^{st}$ through n^{th} rounds and demonstrate that it also holds for the j^{th} round.

At the outset of the j^{th} round the union believes that the firm's profitability is uniformly distributed over the interval $(\underline{P}, \hat{P}_{j-1})$. What is the union's expected payoff from making a wage demand of W_j? If the firm's profitability exceeds the cutoff $\hat{P}_j$, then the firm will accept the contract 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 the bargaining.

$$V_{Uj} = \frac{(\hat{P}_{j-1} - \hat{P}_j)}{(\hat{P}_{j-1} - \underline{P})} W_j + \frac{(\hat{P}_j - \underline{P})}{(\hat{P}_{j-1} - \underline{P})} \left[(1 - \delta_U) R + \delta_U V^*_{Uj+1}\right] \tag{5}$$

The optimal wage demand, W^*_j, maximizes V_{Uj} subject to the constraint on how the firm chooses its new cutoff point, $\hat{P}_j$. By definition, a firm with profitability equal to the new cutoff point should be indifferent between accepting the current contract or accepting the expected contract in the next round of bargaining.

$$(\hat{P}_j - W_j) = (\hat{P}_j - W^*_{j+1}) \delta_F \tag{6}$$

To solve for W^*_j, substitute for V^*_{Uj+1} and W^*_{j+1} from (4) into (5). Use the constraint given by (6) to express W_j in terms of $\hat{P}_j$, and substitute for

W_j in (5). Now maximize the unconstrained union payoff function with respect to $\hat{P}_j$. The resulting expression for the new cutoff point is

$$\hat{P}_j = R + \frac{(1-\delta_F+\delta_F C_{j+1})}{2(1-\delta_F+\delta_F C_{j+1}) - \delta_U C_{j+1}} (\hat{P}_{j-1} - R) \quad (7)$$

The expression for W_j^* can be found by substituting for $\hat{P}_j$ in (7).

$$W_j^* = R + \frac{(1-\delta_F+\delta_F C_{j+1})^2}{2(1-\delta_F+\delta_F C_{j+1}) - \delta_U C_{j+1}} (\hat{P}_{j-1} - R) \quad (8)$$

The union's indirect payoff function is given by

$$V_{Uj}^* = R + \frac{1}{2} \left[\frac{(1-\delta_F+\delta_F C_{j+1})^2}{2(1-\delta_F+\delta_F C_{j+1}) - \delta_U C_{j+1}} \right] \frac{(\hat{P}_{j-1} - R)^2}{(\hat{P}_{j-1} - \underline{P})} \quad (9)$$

By checking (8) and (9) with the general structure given in (4) we see that the induction hypothesis holds. The expression for C_j is given by

$$C_j = \frac{(1-\delta_F+\delta_F C_{j+1})^2}{2(1-\delta_F+\delta_F C_{j+1}) - \delta_U C_{j+1}} \quad (10)$$

To close the model note that $C_N = 1/2$ and $\hat{P}_0 = \bar{P}$. So long as $\hat{P}_{N-1} > \hat{P}_{Min}$ the general structure in (4) and the initial and terminal conditions listed above completely describe the equilibrium union wage concession function.

In solving the N-round bargaining model I have focused on the union's indirect payoff function. In order to analyze the implications of the model for investor behavior, I need to shift the focus to the firm's indirect payoff function. Prior to the t^{th} round of bargaining this function is given by

$$V^*_{Ft} = \sum_{j=0}^{N-t} \left[\frac{\hat{P}_{t-1+j} - \hat{P}_{t+j}}{\hat{P}_{t-1} - \underline{P}} \right] \left[\frac{1}{2} (\hat{P}_{t-1+j} + \hat{P}_{t+j}) - W^*_{t+j} \right] \delta_F^j \tag{11}$$

The basic implications concerning investor behavior during a strike follow from the next proposition.

Proposition:

At each round in the bargaining the following inequality holds

$$\frac{1}{2} (\hat{P}_{t-1} + \hat{P}_t) - W^*_t > V^*_{Ft} > V^*_{Ft+1}\, \delta_F$$

Demonstration:

Recall from (6) that

$$(\hat{P}_t - W^*_t) = (\hat{P}_t - W^*_{t+1})\, \delta_F$$

Since the cutoff points decline toward $\underline{P}$ during the negotiation,

$$\frac{1}{2} (\hat{P}_{t-1} + \hat{P}_t) > \hat{P}_t$$

$$\frac{1}{2} (\hat{P}_t + \hat{P}_{t+1}) < \hat{P}_t$$

These two inequalities imply that

$$\left[\frac{1}{2} (\hat{P}_{t-1} + \hat{P}_t) - W^*_t \right] > \left[\frac{1}{2} (\hat{P}_t + \hat{P}_{t+1}) - W^*_t \right] \delta_F \tag{12}$$

Sequentially applying this argument establishes the following general inequality.

$$\left[\frac{1}{2} (\hat{P}_{t-1} + \hat{P}_t) - W_t^* \right] > \left[\frac{1}{2} (\hat{P}_{t-1+j} - \hat{P}_{t+j}) - W_{t+j}^* \right] \delta_F^j \qquad (13)$$
$$j = 1, 2, \ldots, N-t$$

Since the firm's indirect payoff function is a weighted average of terms in (12), we have that

$$\frac{1}{2} (\hat{P}_{t-1} + \hat{P}_t) - W_t^* > V_{Ft}^*$$

This demonstrates the first part of the inequality. To show the second part of the inequality, rewrite (11) as follows.

$$V_{Ft}^* = \left[\frac{\hat{P}_{t-1} - \hat{P}_t}{\hat{P}_{t-1} - \underline{P}} \right] \left[\frac{1}{2} (\hat{P}_{t-1} + \hat{P}_t) - W_t^* \right] + \left[\frac{\hat{P}_t - \underline{P}}{\hat{P}_{t-1} - \underline{P}} \right] V_{Ft+1}^* \, \delta_F$$

From (13) and our first result, it follows that $V_{Ft}^* > V_{Ft+1}^* \delta_F$.

Assume that investors have the same information as the union. This implies that investors can calculate each term in the inequality given in the proposition. At the start of the t^{th} round of bargaining investors would evaluate the expected discounted value of the firm's share of the rents at V_{Ft}^*. If a settlement occurs during the t^{th} round, then the union's beliefs about the firm's state of demand is narrowed down from $(\underline{P}, \hat{P}_{t-1})$ to $(\hat{P}_t, \hat{P}_{t-1})$, and the settlement wage is known to be W_t^*. This new information causes investors to revise upward their previous evaluation of the firm's value to $1/2 \, (\hat{P}_{t-1} + \hat{P}_t) - W_t^* > V_{Ft}^*$. If no settlement occurs, then the firm's state of demand is revealed to be below $\hat{P}_t$. This new information causes the <u>current</u> value of the expected discounted value of the firm's share of the rents to be revised downward to $V_{Ft+1}^* \delta_F < V_{Ft}^*$. This pattern of upward revisions of the firm's equity value upon settlement and downward revisions with continued negotiations applies to each round of the negotiations.

To further illustrate this model consider the following example. Assume that at the outset of negotiations the union believes that the firm's profitability is uniformly distributed over the interval (50, 100). Let the asset value of a job outside the bargaining unit equal 48 and the firm and union discount parameters equal 0.9. Restrict bargaining to last no more than a total of ten rounds. The expected unconditional value of the firm at the outset of negotiations equals 14.56. The union's optimal first round wage demand is 64.00 which the firm accepts if its value of P exceeds 89.32. If a settlement occurs in the first round, then the expected unconditional value of the firm increases by 16.10. If the union's wage demand is rejected, then the firm value declines by 4.36. If bargaining continues until the ninth round, the union wage demand will have decreased from 64.00 to 52.70, the expected unconditional firm value will have decreased from 14.56 to 1.90, and the variance of the union's beliefs about the firm's profitability will have decreased from 9.50 to 0.32. These patterns illustrate each of the three predictions outlined in the introduction.

III. DATA DESCRIPTION

The primary source of data used in this study is a micro data set of major contract negotiations (i.e. contracts covering at least 1,000 workers) which was constructed as a joint project with John Abowd, David Card, and Sheena McConnell. Information on contract negotiations was gathered from three sources. The Bureau of Labor Statistics (BLS) publishes an annual bulletin titled <u>Wage Calendar</u> which lists "planned" expiration dates for major contracts in both manufacturing and nonmanufacturing industries.[8] For each contract expiration the BLS lists a contract identification number which is unique to that bargaining pair, the name of the firm (or employer association), the name of the union, the number of workers covered by the contract, the geographic location of the bargaining unit, the two-digit SIC industry classification for the product line involved, and the year and month of the planned expiration date. Unpublished BLS information was used to add the expiration day and four-digit SIC code for as many contracts as possible. Information on contract settlement and effective dates was obtained from a tape provided by the Current Wage Development (CWD) Section of the BLS. The settlement date is meant to refer to the date when the new contract was ratified.[9]

The sample contains contract negotiations from January 1970 through December 1981. The total sample size is 7,712 negotiations. Of this total, 271 observations correspond to scheduled reopenings rather than renegotiations of contracts. The reopenings were dropped from the sample. The next selection criteria was that a complete set of bargaining dates existed for the negotiation. This reduced the sample to 2,246 negotiations consisting of 1,954 nonstrikes and 292 strikes.

Strike information was collected from the BLS and the Bureau of National Affairs (BNA). Both the BLS and the BNA gather strike data from public sources. The BLS public source strike data is contained in a weekly

[8]By planned we mean the expiration date which is anticipated as of the signing of the contract. As I will show later, the actual expiration date often differs from this planned date.

[9]The CWD data also is restricted to major contracts. However, for many negotiations in our sample no settlement or effective dates are available. This is due to an unfortunate policy by the CWD of deleting all historical information about a bargaining pair if its current coverage falls below 1,000 workers.

bulletin titled Industrial Relation Facts (IRF). In an attempt to obtain more accurate and detailed information about a strike, the BLS also carried out a separate survey of firms and unions reported to be involved in a strike. Summary statistics on strike activity compiled from this survey were published annually by the BLS in a bulletin titled Work Stoppages. This survey was discontinued at the end of 1981 in response to budget cutbacks at the BLS. The original survey data was released for research with the names of the firm and union removed from the records. By matching the reported variables with the same variables in the public sources we were able to recover most of the firm and union names. Details of this matching process are given in Tracy (1986).

If a strike took place during a negotiation, then a third selection criteria was that a match could be found in the BLS survey data. This reduced the number of strikes from 292 to 212 leaving a total of 2,166 negotiations. Requiring a complete bargaining chronology resulted in a loss of nearly 70% of the total number of observations. While this is a considerable loss of data, I will demonstrate below the importance of having this dating information available. The final selection criteria was that security price information for the firm was available during the time period surrounding the negotiation. Security price data was taken from the CRSP daily return file and was available for 1,253 out of the 2,166 remaining negotiations.

Having a complete set of bargaining dates allows us to examine in detail the sequence of events surrounding each negotiation. Consider first those negotiations that do not involve a strike. While it is the case that most nonstrikes have settlement and effective dates close to the planned expiration date, there are many exceptions. Define an "early settlement" to be a negotiation where the settlement date is at least five days prior to the planned expiration date and the effective date is the day following the expiration date. A total of 54 early settlements (2.8% of nonstrikes) occurred in the sample. Define an "early expiration" to be a negotiation where both the settlement and effective date are at least five days prior to the planned expiration date. That is early expirations correspond to cases where the contract ends prior to its planned expiration date. A total of 276 early expirations (14.1% of nonstrikes) occurred in the sample.

Figure one shows the distribution of early settlements and expirations by their respective durations. For an early settlement the duration is defined to be the number of calendar days between the settlement date of the new contract and the planned expiration date of the previous contract. The duration for an early expiration is the number of calendar days between the effective date of the new contract and the planned expiration date of the previous contract. While the early settlements typically have durations of one month or less, cases do exist of durations of six months to one year. Early expirations occur most frequently with durations of two to three months and a year or more.

The reader may have noted that the sum of the contracts which settle at the planned expiration date, the early settlements, and the early expirations do not add up to the total number of nonstrikes in the sample. The 626 remaining negotiations (32.0% of nonstrikes) consist of what I call settlement "delays." Define a delay as a negotiation where the settlement date is at least five calendar days <u>after</u> the planned expiration date, the effective date is the day following the planned expiration date, and no strike is observed for the negotiation.[10] Delays consist of cases where

[10]Delays might be followed by a strike. If the length of the delay prior to

negotiations continue beyond the expiration of the current contract without a work stoppage and the new contract is back dated. While there has been little discussion in the strike literature about delayed settlements, the incidence of delays in this sample is roughly five times greater than the incidence of strikes. Figure two shows the distribution of delays and strikes by their respective durations. One important point to note is that delays are not necessarily brief in length as evidenced by the prevalence of delays exceeding three months in duration.

How should we treat delays in the analysis? Recent bargaining models do not seem to offer an explanation for delays. These models rationalize prolonged bargaining as a mechanism for eliciting privately held information. However, in the models discussed earlier, this mechanism is effective only if there are costs associated with prolonging the negotiations. Unlike strikes where workers withhold their labor services, it is unclear what exactly the costs are associated with a delay. In the empirical analysis I distinguish between nonstrikes, delays, and strikes rather than categorizing delays with either nonstrikes or strikes.

Figures one and two illustrate for nonstrikes the distribution of settlement dates around the current contract's planned expiration date. Without the settlement and effective dates it would be impossible to know where a particular negotiation fits into this overall distribution. This can be particularly problematic for investigating certain questions. For example suppose that we are interested in examining the pattern of a firm's

the strike was quite long, then we were unlikely to have matched the strike information with that negotiation. We are in the process of rematching the strikes using the settlement and effective dates. This will allow us to determine whether a delay involved a strike, what the length of delay was prior to a strike beginning, and how long the strike lasted following the delay. Analyzing this data will require a richer class of bargaining models than the one described earlier in the paper.

security returns just prior to the expiration of a contract for which no strike takes place. If the only information available was the planned expiration date, then we would end up including in the analysis security returns for negotiations which have already been concluded, and the new contract is either in effect or soon to become effective. As a consequence, the analysis would not accurately reflect the pattern of security returns for negotiations which are ongoing and nearing the contract's expiration.

Issues of timing are also important for negotiations involving a strike. The BLS survey data offers two important advantages over the BLS and BNA public source strike data. First, reporting errors may exist in the public source data which have been corrected in the survey data. Second, if a strike involved several unions, firms, or plants within a firm, the BLS surveyed each separate entity involved in the strike. Distinct beginning and ending dates as well as number of workers involved were recorded for each entity. Of the 126 strikes during the sample period for which BLS survey information was available, approximately one-third had multiple beginning and/or ending dates listed. For these strikes there is no single definition of the strike duration.

For contract negotiations with multiple strike dates, the duration of the strike can vary significantly depending on the method used to calculate the duration. Define DUR1 as the strike duration measured from the first reported beginning date to the last reported ending date. By construction, DUR1 will give the maximum strike duration estimate. Define DUR2 as the strike duration measured from the first reported beginning date to the first reported ending date. A rationale for using DUR2 is that it <u>may</u> more closely relate to the length of time required to settle the master contract where we want to ignore all strike continuations which are due to "local issue" bargaining. The median values for DUR1 and DUR2 are 23 days and 21 days respectively, while the maximum values are 631 days and 358 days respectively. In this study I limit the analysis to strikes with common beginning and ending dates.

IV. EMPIRICAL RESULTS

The first implication of the model which I test is that bargaining results in a reduction in the variance of the firm's security price. The following time line will be useful for discussing how these variances were computed.

```
     E-1Y,6M  E-6M      E-3M       E    S S+1W  S+3M,1W S+1Y,3M,1W
   <---|---------|---------|---------|----|---|---------|---------|--------->TIME
       (REG A) (VAR A)                          (VAR B) (REG B)
```

Where E = expiration date
S = settlement date
Y = year
M = month
W = week.

The pre- and post-settlement variances were each estimated using forecasted residuals from separate market models. A simple one factor model was estimated by OLS using a year of daily stock returns data.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it}$$

Where R_{it} = return for firm i at time t
R_{mt} = return for value weighted portfolio of stocks at time t
ϵ_{it} = excess return for firm i at time t.

The coefficients of these market models tended to be unstable through time. As a result, using a single market model based on the interval marked REG A to estimate both variances would on average result in estimates of VAR B which were biased upward due to model misspecification. For this reason, VAR B was estimated from residuals forecasted from a separate market model estimated over the interval marked REG B. Both variances were computed using three months of daily forecasted residuals.

As discussed in the previous section there is a distribution of settlement dates around the planned expiration date for a nonstrike. This requires careful definition on a case by case basis of the E and S points in the time line above. For a delay, E was set to the planned expiration date and S was set to the CWD reported settlement date. For early expirations, E was set to the CWD reported effective date, and S was set to the reported settlement date.[11] For early settlements both E and S are set equal to the reported settlement date. Finally, for strikes S was set to the maximum of the strike ending date and the CWD reported settlement date.

One problem that arises in this data is that several negotiations may be ongoing for the same firm at a given point in time. When this occurs the estimated variances can be biased by the fact that other negotiations involving the firm are also in progress. To deal with this problem I checked each negotiation for a given firm against all other negotiations involving the same firm. If the interval used to calculate VAR A or VAR B overlapped the interval (E-3M, S+1W) for any other negotiation for the firm, then these variances were excluded from the analysis. These overlap checks were carried out using all contracts in the original data for which CRSP data were available. For the purpose of overlap checks, nonstrikes with missing expirations days were assumed to have expired in the middle of the month. Similarly, strikes with no BLS survey match had S set equal to the planned expiration date. Of the 1,253 observations in the sample, 647 were

[11]For most early expirations the effective date is either the same as or precedes the settlement date.

deleted as a result of overlap problems, 27 were deleted because security price data was not available for the entire period needed, and 48 nonstrikes and 1 strike were deleted due to date inconsistencies. A total of 530 negotiations consisting of 362 nonstrikes, 62 strikes, and 106 delays were analyzed.

There are two remaining points to discuss before turning to the results of the statistical analysis. The first is the specific choice of the interval used to measure the pre-negotiation variance. The interval (E-3M, E) was not selected since its variance may be affected by the fact that the contract was due to expire. I selected the interval (E-6M, E-3M) since it was close to the contract expiration which helps it proxy for the union's uncertainty going into bargaining, but is not so close to the expiration so as to be directly affected by the negotiations. Table 1 summarizes the empirical distributions of the three month variances starting from one year prior to the expiration. The median values of the ratios of these variances indicate that the variances are fairly constant from one year to three months prior to a contract's expiration and decline slightly in the last three months of the contract. While I have not replicated my statistical tests using other choices of intervals for calculating the pre-negotiation variance, there is no evidence of a systematic movement in these variances in the overall interval (E-12M, E-3M).

The second point is that it is likely that the firm stock market variances have time series variation which is independent of any bargaining effects. Controlling for this heteroscedasticity in the underlying variance should improve the ability to detect bargaining induced changes in the variance. This is of particular importance for the sample of strikes since they have the longest period of time separating the two variance estimates.

A simple model of conditional heteroscedasticity is used in the analysis. I assume that, absent any bargaining effects, the variance of firm i's security returns is proportional to the variance of the market returns.

$$\sigma^2_{it} = k_i \, \sigma^2_{mt}$$

Following French, Schwert, & Stambaugh (1987) I first estimate a time-series model for the market variance. Daily market returns were used to calculate monthly estimates of the market variance from 1962 to 1985. The natural log instead of the level of the monthly variances were used in order to reduce the skewness in the distribution. First differences were then taken to remove the nonstationarity in the data. Examining the sample autocorrelations led to selecting a third-order moving average representation of the first differences of $\ln \sigma^2_{mt}$.

$$(1 - L)\ln \sigma^2_{mt} = \theta_0 + (1 - \theta_1 L - \theta_2 L^2 - \theta_3 L^3)\, u_t$$

The original data as well as the smoothed series of market variances are given in figure three.

Tests of the variance reduction hypothesis were carried out using both the unadjusted and the adjusted firm pre and post variances. The adjusted firm variances are normalized by the time weighted average of the predicted monthly market variances for the months included in the interval used to calculate the firm variance. If bargaining leads to lower variances, then we would expect on average a positive difference between the pre- and post-negotiation variances.

Wilcoxon signed-rank tests of the differences in the unadjusted and the adjusted variances are given in table 2. The test statistic is calculated by taking the differences between the pre and post variances, ranking the absolute values of these differences, and summing the ranks assigned to the positive differences. Large values for this statistic indicate a reduction in the firm's variance. Table 2 reports standardized values of the test statistic which have an asymptotic standard normal distribution. This test assumes symmetry of the distribution of these differences but is robust to the degree of "fatness" in the tails of the distribution. The unadjusted data suggests that variances decline significantly for nonstrikes but not for strikes or delays. Adjusting for conditional heteroscedasticity indicates a significant variance reduction for nonstrikes and strikes but not for delays.

These findings support the variance reduction hypothesis. As a further check I recalculated this test using two variance estimates taken three months apart during the middle of the current contract. This constitutes the control sample listed in table 2. Since no systematic bargaining events occur at this point in time in the contract, I would expect to find no significant difference in the variances. Neither the adjusted nor unadjusted data indicate a significant reduction in variance for the controls. This provides some evidence concerning the reliability of the statistical method.

The bargaining model suggested two other empirical regularities which should show up in the data: the excess returns on average should be negative during a strike and should on average be positive following a settlement. Table 3 gives mean and median daily excess returns for the eleven trading days surrounding the beginning of a strike. The mean excess returns indicate that the equity value of the firm declines by nearly 0.5% on the announcement of a strike. While this effect is large relative to the standard error, the median excess return on this date is much smaller in absolute magnitude.[12]

The cumulative effect of a strike or a delay on the firm's equity value is given in table 4. The excess returns are cumulated from the first to the penultimate day of the strike or the delay. The mean and median cumulative excess returns (CER) for the strike sample are -1.4% and -1.8% respectively.[13] Disaggregating the data by the duration of the strike reveals that the mean CERs are negative for all but one of the duration categories while the median CER's are negative for all duration categories. The largest mean CER is for strikes of 2-3 months in duration and indicates an equity loss of slightly over 3%. In contrast to the announcement effect of a strike, the median CERs are all larger in absolute value than the mean CERs. The largest median CER is for strikes of 3-4 months in duration and indicates an equity loss of nearly 6%. No similar equity losses are associated with delays. This result combined with the earlier result on variance changes, indicate that there are an important distinctions between strikes and delays which should be accounted for in future bargaining models.

The market reaction to the settlement of a strike is given in table 5. There is a mixed pattern of positive and negative excess returns in the days preceding the settlement. Both the mean and median excess returns are positive on the settlement date and indicate an equity gain of around 0.2%.

[12]The standard errors for the mean excess returns are calculated under the assumption that the excess returns are independent across negotiations as well as across observations within a negotiation. The variance of the excess return is assumed to equal the residual variance estimated from the market model. As such, these standard errors are only approximate and are included for comparison purpose.

[13]A larger sample of strikes is used in this analysis than in the variance analysis. A key difference is that strikes which have missing expiration days are kept in this sample.

The one anomaly in this table is the large negative median excess return associated with the third trading day following the settlement. The corresponding mean excess return for that day is negative but small in magnitude.

The bargaining models outlined earlier also predict a positive excess return on the settlement date of nonstrikes. The market reaction to contract settlements for which no strike or delay occurred is given in table 6. For the entire sample of nonstrikes the data indicate that the firm's equity value declines for the three trading days beginning with the settlement date. The mean and median excess returns indicate a decline in equity value of the firm in the range of 0.2%-0.3%. Focusing only on settlements close to the planned expiration of the previous contract reveals the same pattern of negative excess returns. This finding is at odds both with the predictions of the models and with previous empirical results in the literature.[14]

V. CONCLUSION

Strategic bargaining models suggest that strikes may be used as a mechanism for inferring information which is privately held by the other party to the negotiations. Several papers have tested for the empirical relationship between ex ante levels of uncertainty and the incidence and duration of strikes. The evidence to date has been mixed. In this paper I presented an alternative test of these models of strikes. If uncertainty is a primary motivation for prolonged bargaining, then bargaining should resolve some of this uncertainty. This suggests that a fundamental test of

[14]See for example Becker & Olson (1986) who report positive settlement effects for their sample of nonstrikes.

this class of bargaining models is that there should be evidence that contract negotiations reduce uncertainty. This test is implemented by examining variances of a firm's excess returns before and after bargaining. The data indicate that bargaining does result in a significant reduction in this variance. Strategic bargaining models also suggest that the firm's excess returns should be negative during a strike and positive on the settlement date. In general the data support these predictions with the exception being the finding of negative excess returns following the settlement of nonstrikes. Finally, a significant portion of prolonged negotiations occur without a strike taking place. Unlike strikes, there is no significant reduction in variance of the firm's excess returns or decline in the firm's equity value associated with a delay. An important future research topic involves expanding current bargaining models to incoporate the decision to delay vs. strike.

REFERENCES

Becker, Brian E. and Olson, Craig A. "The Consequences of Strikes for Shareholder Equity." **Industrial and Labor Relations Review** 39, no. 3 (April 1986): 425-38.

Brown, Steven and Warner, Jerold. "Using Daily Stock Returns Data." Journal **of Financial Economics** 14 (1985)

Card, David. "A Longitudinal Analysis of Strikes and Wages." **Journal of Labor Economics** (1988):

__________ "Strikes and Wages: A Test of a Signalling Model." National Bureau of Economic Research, Working Paper No. 2550, April 1988.

Conover, W. J. **Practical NonParametric Statistics** (New York: John Wiley & Sons, Inc., 1971).

Cramton, Peter. "Bargaining With Incomplete Information: An Infinite-Horizon Model With Continuous Uncertainty." **Review of Economic Studies** 49, no. 167 (1984): 579-93.

Fama, Eugene; Fisher, Lawrence; Jensen, Michael; and Roll, Richard. "The Adjustment of Stock Prices to New Information." International Economic **Review** 10, no. 1 (February 1969): 1-21.

Fudenberg, Drew and Triole, Jean. "Sequential Bargaining With Incomplete Information." **Review of Economic Studies** 50, no. 161 (November 1983): 221-48.

French, Kenneth R.; Schwert, G. William; and Stambaugh, Robert T. "Expected Stock Returns and Volatility." **Journal of Financial Economics** 19 (1987): 3-29.

Gramm, Cynthia. "The Impact of Strike Incidence and Length on Negotiated Wage Settlements." Working Paper, University of Iowa, 1984.

Greer, Charles; Martin, Stanley; and Reusser, Ted. "The Effect of Strikes on Shareholder Returns." **Journal of Labor Research** 1, no. 2 (Fall 1980)

Gul, Faruk and Sonnenschein, Hugo. "One-Sided Uncertainty Does Not Cause Delay." **Mimeo**, Stanford University, Graduate School of Business, 1985.

Hart, Olvier. "Bargaining and Delay." **Mimeo**, **Massachusetts** Institute of Technology, 1986.

Hayes, Beth. "Unions and Strikes with Asymmetric Information." **Journal of Labor Economics** 2, no. 1 (January 1984): 57-83.

Kennan, John. "The Economics of Strikes." In **Handbook of Labor Economics**, edited by Orley Ashenfelter and Richard Layard (Amsterdam: North Holland Press, 1986).

McConnell, Sheena. "Cyclical Fluctuations in Strike Activity." Working Paper No. 215, Princeton University, Industrial Relations Section, January 1987.

Neumann, George. "The Predictability of Strikes: Evidence From the Stock Market." Industrial and Labor Relations Review 33, no. 4 (July 1980)

Rubenstein, Ariel. "Perfect Equilibrium in a Bargaining Model." Econometrica 50, no. 1 (January 1982): 97-109.

Sobel, Joel and Takahashi, Ichiro. "A Multistage Model of Bargaining." Review of Economic Studies 50, no. 3 (July 1983): 411-26.

Tracy, Joseph. "An Investigation into the Determinants of U.S. Strike Activity." **American Economic Review** 76 (June 1986): 423-36.

__________. "An Empirical Test of an Asymmetric Information Model of Strikes." Journal of Labor Economics 5, no. 2 (April 1987): 149-73.

Table 1

Deciles of Empirical Distributions of Unadjusted Variance Ratios

Decile	V(E-6M,E-3M) / V(E-12M,E-9M)	V(E-6M,E-3M) / V(E-9M,E-6M)	V(E-6M,E-3M) / V(E-3M,E)	V(E-6M,E-3M) / V(S,S+3M): Nonstrikes	V(E-6M,E-3M) / V(S,S+3M): Strikes	V(E-6M,E-3M) / V(S,S+3M): Delays	Controls
0.90	2.34	2.09	2.00	2.31	2.31	2.74	2.24
0.80	1.71	1.61	1.58	1.82	1.78	1.82	1.59
0.70	1.38	1.30	1.38	1.59	1.45	1.55	1.36
0.60	1.18	1.13	1.20	1.32	1.38	1.23	1.18
0.50	1.00	0.98	1.06	1.12	1.14	1.03	1.05
0.40	0.85	0.87	0.93	0.93	0.89	0.89	0.88
0.30	0.75	0.74	0.80	0.79	0.81	0.74	0.76
0.20	0.63	0.63	0.66	0.63	0.61	0.63	0.61
0.10	0.49	0.49	0.53	0.50	0.47	0.46	0.45

Table 2

Wilcoxon Signed Rank Test Results

Category	N	Unadjusted	Adjusted
Non Strikes	345	2.86 (0.002)	1.90 (0.029)
Strikes	62	0.97 (0.165)	2.35 (0.009)
Delays	106	0.67 (0.250)	0.31 (0.355)
Controls	952	0.28 (0.391)	1.21 (0.112)

Note: Table gives standardized Wilcoxon test statistics. The associated one-taled probability values are given in parentheses.

Table 3

Stock Market Response to Beginning of a Strike

	Time Line										
Statistic	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Mean Excess Return (X100)	0.141	-0.061	0.030	0.052	-0.119	-0.460	-0.076	-0.203	0.063	-0.064	-0.013
Median Excess Return (X100)	0.000	-0.120	-0.003	-0.112	-0.148	-0.161	-0.052	-0.092	0.026	-0.064	-0.010
Standard Error (X100)	0.112	0.112	0.112	0.112	0.112	0.115	0.116	0.120	0.121	0.120	0.124
Number of Observations	296	296	296	296	296	285	281	268	265	257	238

Note: Strike beginning date is indicated by time = 0. The time line is measured in trading days. The time line is measured in trading days. The number of observations equal the total number of residuals used to calculate the mean and median excess returns.

Table 4

Cumulative Excess Returns For Delays and Strikes

Statistic	All Delays	All Strikes	< 1 Month	1-2 Months	2-3 Months	3-4 Months	4+ Months
Mean Cumulative Excess Return (X100)	-0.0250	-1.4334	-1.0058	-3.3340	0.4424	-2.0333	-1.0164
Median Cumulative Excess Return (X100)		-1.8834	-1.0421	-4.8634	-1.5230	-5.9058	-1.3595
Standard Error (X100)	0.0200	0.74	0.56	1.57	2.52	4.78	4.29
Number of Observations	240	233	104	53	29	14	23

Note: The number of observations equals the number of delays or strikes used to calculate the mean and median cumulative excess return.

Table 5

Stock Market Response to the Ending of a Strike

	Time Line										
Variable	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Mean Excess Return (X100)	-0.043	-0.154	-0.113	0.053	0.096	0.224	0.031	0.052	-0.096	-0.135	-0.335
Median Excess Return (X100)	0.022	-0.216	-0.147	0.093	-0.143	0.207	-0.092	-0.032	-2.219	-0.099	-0.237
Standard Error (X100)	0.120	0.120	0.120	0.116	0.115	0.112	0.112	0.112	0.112	0.112	0.112
Number of Observations	257	266	281	285	296	296	296	296	296	296	296

Table 6

Stock Market Response to a Settlement Without a Delay or Strike

	Time Line										
Statistic	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
All Nonstrikes:											
Mean Excess Return (X100)	0.007	-0.014	-0.073	0.061	-0.029	0.015	-0.126	-0.109	-0.059	0.084	-0.024
Median Excess Return (X100)	0.064	-0.034	-0.083	-0.020	-0.096	-0.071	-0.078	-0.144	-0.079	-0.001	-0.023
Standard Error (X100)	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066
Number of Observations	720	720	720	720	720	720	720	720	720	720	720
Settlements at Expiration Date:											
Mean Excess Return (X100)	-0.037	0.065	-0.036	0.060	0.007	0.033	-0.135	-0.122	-0.085	0.099	-0.021
Median Excess Return (X100)	-0.092	-0.135	-0.095	-0.040	-0.106	-0.063	-0.053	-0.003	-0.015	0.098	0.130
Standard Error (X100)	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.072
Number of Observations	538	538	538	538	538	538	538	538	538	538	538

Figure 1

EMPIRICAL DISTRIBUTION OF EARLY SETTLEMENT & EXPIRATION DURATIONS

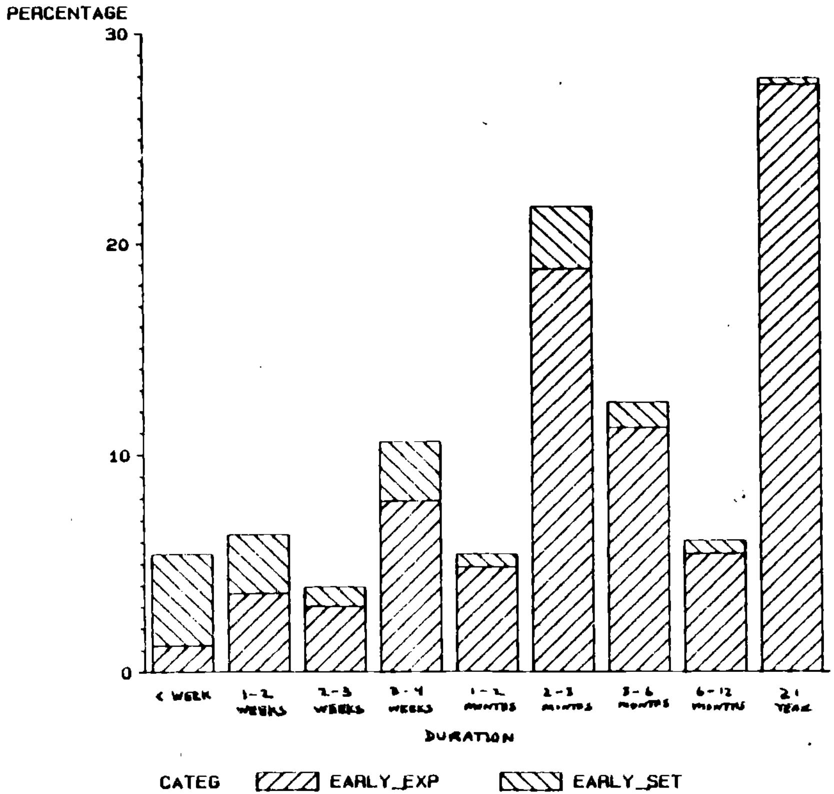


Figure 2

EMPIRICAL DISTRIBUTION OF STRIKE & DELAY DURATIONS

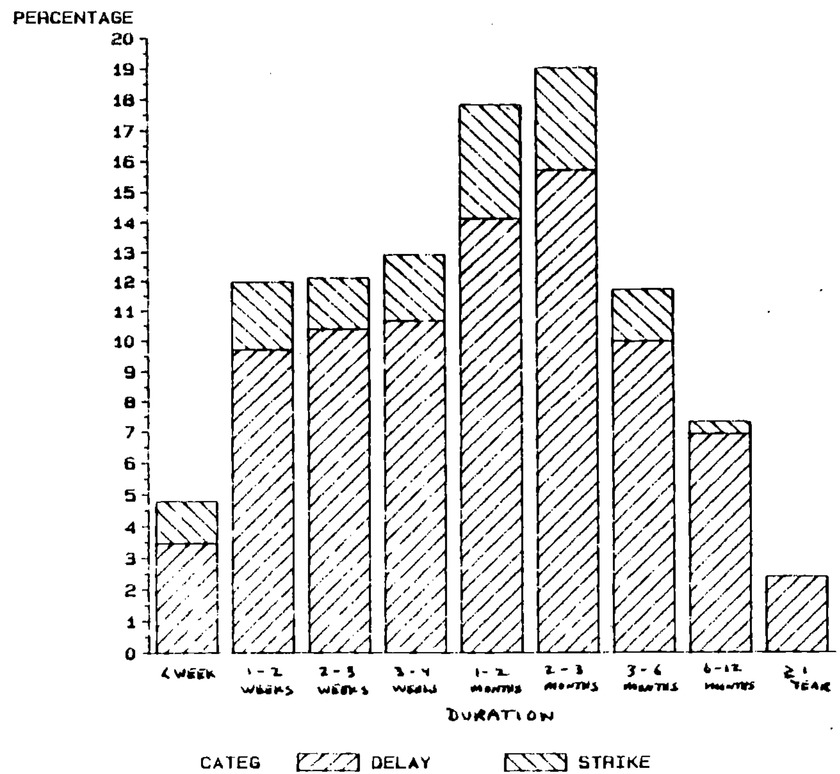
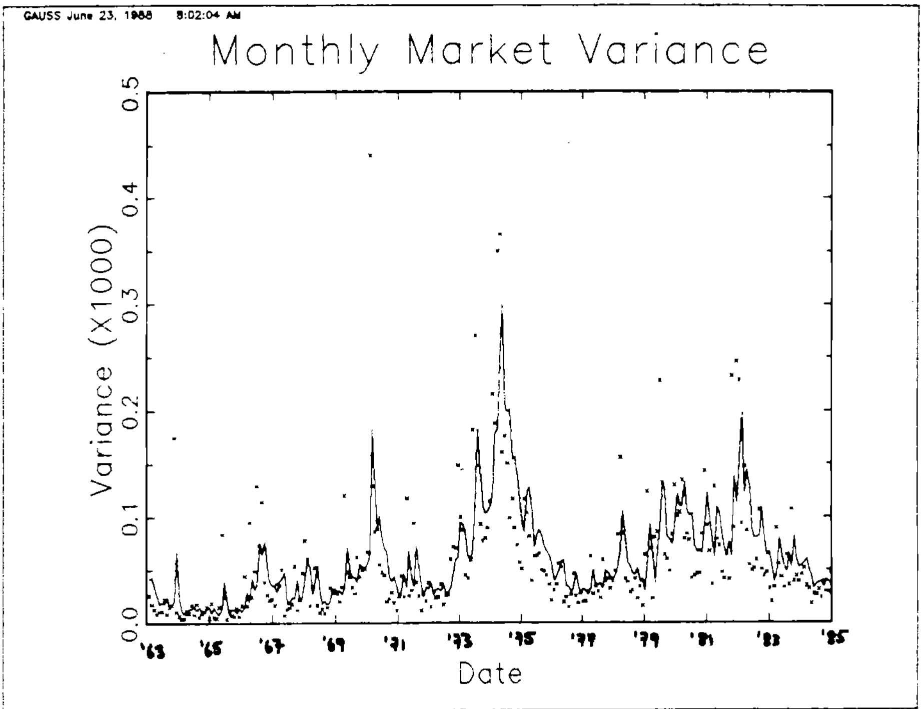


Figure 3



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Monthly Market Variance
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'65
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