Bargaining Theory, Trade Unions, and Industrial Strike Activity

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The purpose of this paper is to examine certain received theories of the firm, trade union behavior, and bargaining in order to derive testable implications concerning the conditions under which labor disputes are more likely to occur. There are at least three reasons why an investigation of industrial strike activity seems fruitful. First, it might be argued that, because of their relatively frequent disruption of key sectors of the economy, work stoppages are the most important public policy issue raised by the existence of trade unions. It would therefore be useful to know whether, as Hicks thought, " . . . the majority of actual strikes are doubtless the result of faulty negotiation" [18, p. 146] or whether they are an inevitable part of the functioning of an institutionalized market economy. Although it has long been known that the level of strike activity follows the business cycle [23] [20] [29], this leaves open the questions of the behavioral relations involved and their stability over time. Second, data on industrial disputes provide a potentially rich source of material for testing the implications of bargaining theories which purport to explain the outcome of labor-management negotiations.[1] Yet little work seems to have been done to date on the application of bargaining theoretic models to nonexperimental data. A third reason for undertaking a study of this problem stems from the continuing interest in the effect of unions upon both the relative wage structure and the rate of change of aggregate money wages. Most union "power" is derived from the threat of the strike, and, accordingly, we agree with Charles Holt's recent suggestion that ". . . the theory and analysis of industrial disputes may help to clarify the role that unions play in the determination of wages" [19, p. 50].

I. *A Theoretical Formulation*

Most bargaining models are addressed to a general two-party situation, e.g., bilateral monopoly, in which conventional economic theory fails to lead to a predictable outcome of the terms on which agreements will be reached. If one views labor-management negotiations from this point of departure it is usually difficult to derive any testable implications concerning the conditions under which the parties will fail to agree on a new contract prior to the point at which the previous contract expires. It is generally assumed that the union attempts to maximize some utility or objective quantity, for example the discounted value of its members' wage income over the length of the contract.[2] Likewise the firm would attempt to maximize some objective, say the discounted value of the

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[1] The two best-known theories of this sort are those of J. R. Hicks [18] and F. Zeuthen [32]. A very readable summary and critique of several more modern bargaining models is contained in Bishop [5].

[2] For some other possibilities see Dunlop [9].

future profit stream. The desire of a particular party to concede or hold out would then depend upon: (1) a set of objective factors such as the state of product demand, the elasticities of labor demand and capital-labor substitution, etc., as well as (2) a set of subjective factors such as the assessment of the bargaining strategy of the other party and attitudes toward risk-taking.[3] Since the failure to agree on a settlement prior to the point of contract expiration is costly to both parties (loss of the wage bill for the union and current profits for the firm), there should be a tendency for the parties to adjust their positions in such a way that they come to an agreement in time to avert a strike. It is the determination or solution of the terms of this agreement prior to a strike to which most bargaining theories appear to be addressed.

There are two explanations expressed in the bargaining literature regarding the reason why strikes take place at all. First, there is some possibility that one party will misjudge the other's intentions and that a strike will result. This view of strike activity, attributable to Hicks, may be summed up by the statement that ". . . adequate knowledge will always make a settlement possible" [18, p. 147],[4] although some strike activity is inevitable if trade unions are to keep management convinced of the effectiveness of their bargaining weapon. Second, there appears to be the presumption in some of the literature that a breakdown of negotiations cannot occur if the two parties are "rational," so that one might argue that any breakdown of negotiations is due to the fact that the two parties are "irrational."[5]

It is not apparent how the propensity of either or both of the parties to (a) miscalculate the intentions of the other or (b) act irrationally would be systematically related to any of the conceptually observable variables in the system. Hence, the conventional bargaining theory approach is not very helpful in deriving implications about the frequency or duration of strikes.[6]

A. *An Alternative Bargaining Model*

A more fruitful—and more "realistic"—approach to the problem is to recognize at the outset that there are not two but three parties involved in labor-management negotiations: the management, the union leadership, and the union rank and file. This approach incorporates a set of institutional assumptions derived from the widely-accepted model of trade union behavior which is based on a separate analysis of the motivation of the union leadership and rank and file. By this view[7] the objectives of the leadership are: (1) the survival and growth of the union as an institution, and (2) the personal political survival of the leaders. These objectives are accomplished, in most part, by satisfying the expectations of the rank and file as well as possible. Even if the union is not democratic in a political sense, the leadership will in most cases respond to the desires of the membership for reasons of conviction. On the other hand, the leadership is aware of the possibilities of each bargaining situation, and it does more than merely represent the wishes of the rank and file. If the membership's expected wage increase is much greater than the management will agree to, the union leaders

[3] Explicit discussion of both of these issues is contained in Harsanyi [16] and Hicks [18].

[4] This is also the view expressed by Walton and McKersie [28, p. 56]. For a model which explicitly treats imperfect knowledge and a two-party learning process, see Cross [8].

[5] This position can be inferred from Harsanyi [17]. See also Bishop's comment on Harsanyi's paper in [5].

[6] Bishop states this explicitly: "It should be appreciated that neither Zeuthen's theory nor this one [Bishop's] involves a prediction of the frequency or duration of conflicts; each is really concerned only with the terms on which conflicts may be 'rationally' avoided" [4, p. 415].

[7] The following view of the nature of unionism is heavily dependent upon the position of Arthur M. Ross [24, esp. Chs. 1-3].

will attempt to convince the membership to be satisfied with a smaller increase. If they are unable to get the expected wage increase down to a sufficiently low level by the point of contract expiration, they face two alternatives: (1) signing an agreement which is less than the rank and file expects or (2) incurring a strike. If the leadership takes the first alternative, it faces the possibility that the contract will not be ratified by the membership and/or charges that they have "sold out" to management. The result will be internal union dissension and a decline in the political appeal and power of the leadership, both of which are antithetical to the basic objectives of the union leadership. The second alternative, although actually contrary to the membership's best interests, is preferred to the first by the leadership. Under strike conditions the leadership may at least appear as adversaries against management in a crusade which may even raise their political "stock" and will unify the workers. The outbreak of a strike, however, has the effect of lowering the rank and file's expectations due to the shock effect of the firm's resistance and the resultant loss of normal income. After some passage of time the leadership feels that the minimum acceptable wage increase has fallen to a level at which it can safely sign with management, and the strike ends.[8]

It is now possible to employ this essentially political model of the function of a strike to examine the firm's choice between giving in to the last union demand, which is the wage increase the rank and file finds acceptable as of the date of contract expiration, and "taking a strike" in order to obtain a lower settlement. The negotiated wage increase[9] which is acceptable to the union rank and file is

$$y_A \equiv \Delta W/\hat{W}, \tag{1}$$

where $\hat{W}$ is the previous contract wage rate and ΔW is the absolute wage increase. By the reasoning of the preceding discussion y_A depends on the length of the strike, S, say

$$y_A = v(S). \tag{2}$$

The precise shape of v is a matter of conjecture and surely differs between collective bargaining situations, but one would suppose that in the typical case it appears as in Figure 1.[10] Here $y_0 = v(0)$ is the acceptable wage increase at the point of contract expiration and $y_* = v(\infty)$ is the wage increase which the union would not accept with even an indefinitely long strike. This decay function may be represented as

$$y_A = y_* + (y_0 - y_*)e^{-\tau S}.[11] \tag{3}$$

For expository purposes let us suppose that

[8] Notable practitioners in the area of collective bargaining have long recognized this aspect of the function of a strike. William Simkin, Director of the Federal Mediation and Conciliation Service, has stated that: "If it is a fact, as it appears to be in many situations, that the union membership is unwilling to accept the reasonably attainable results of negotiations and is more militant than responsible leadership, a strike may be necessary to drive home the 'facts of life' " [26].

[9] Two comments are called for at this point. First, the analysis in the the text has been constructed on the assumption that bargaining takes place over the amount of a wage increase, not over the level of wages. This accords with the institutional literature with respect to collective bargaining, although this assumption could easily be changed. Second, nothing has been said in the text about bargaining over nonwage items, e.g., fringe benefits, and items relating to union functions such as company payment of shop stewards and dues check-off schemes. It is assumed implicitly throughout the text that these items have monetary equivalents and are imputed to the contracted wage.

[10] This is similar, but by no means identical, to Hicks's "union resistance curve" [28, p. 143].

[11] A more formal justification of the precise form of this equation may be obtained by assuming that under strike conditions the typical union member reduces his acceptable wage increase by some fraction of the difference between the currently acceptable wage increase and the lowest increase acceptable under any conditions, that is $\dot{y}_A = -\tau(y_A - y_*)$. This may be interpreted as a learning function, where the purpose of a strike is to set it in motion. Integration of this learning function gives equation (3) in the text. It is interesting to note that y_* may have any sign so that strikes to prevent wage decreases are by no means ruled out. The case $y_* \geq 0$ may be taken, however, as the more typical situation of downward wage rigidity.

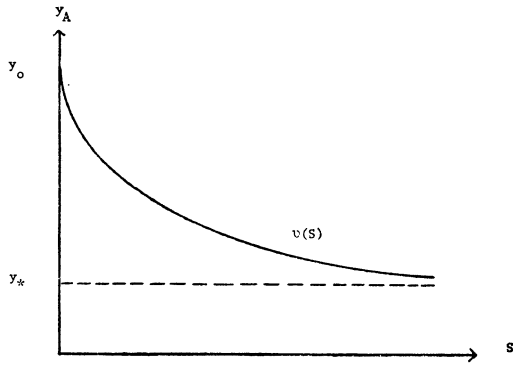

FIGURE 1

the typical firm is aware of the parameters of this relation and that it expects to produce a fixed output with the same technology to sell at the same price into the indefinite future. The profit level in each time period is

$$\pi = \alpha P - \beta W - H, \tag{4}$$

where P is product price, H is the level of fixed production costs, and W is the negotiated wage rate. The latter may be rewritten from (1) as

$$W = \hat{W}(1 + y_A). \tag{5}$$

The present value of the future profit stream is

$$V = \int_0^\infty \pi e^{-rt} dt, \tag{6}$$

which may be written, after substitution of (3) into (5) and the result into (4), as

$$V = \int_S^\infty [\alpha P - \beta \hat{W}(1 + y_* + (y_0 - y_*)e^{-rS})]e^{-rt} dt - \int_0^\infty He^{-rt} dt. \tag{7}$$

Upon integration (7) becomes

$$V = [\alpha P - \beta \hat{W}(1 + y_* + (y_0 - y_*)e^{-rS})]\frac{e^{-rS}}{r} - \frac{H}{r}, \tag{8}$$

which depends only on S, the length of the strike.[12] The firm that maximizes V has the choice of agreeing to y_0 and avoiding a strike or of rejecting y_0 and incurring a strike which will result in a lower wage increase. In effect, the firm must weigh the effect on profits of strike costs against the possibly lower wage costs which can be expected to accompany a strike. The firm maximizes V by not agreeing to y_0 and incurring a strike only if (i) $dV/dS = 0$ and (ii) $d^2V/dS^2 < 0$ for some positive S; otherwise $S = 0$ and $y_A = y_0$. Differentiating (8) and solving for S one obtains

$$S = -\frac{1}{r} \times ln\left[\frac{\alpha P - \beta \hat{W}(1 + y_*)}{\beta \hat{W}\left(1 + \frac{r}{r}\right)(y_0 - y_*)}\right], \tag{9}$$

and the second order condition is satisfied when $y_0 > y_*$, which is true by assumption.[13] It follows from (9) that for a strike

[12] Thus far we have assumed that, even though the union-management relationship will continue indefinitely, contract negotiations take place only once. Without this assumption contract duration becomes a bargaining issue and expectations must be introduced explicitly into the analysis. Unfortunately, this involves complications all out of proportion to the authors' purpose in this paper. For an explicit justification of the assumption in the test, however, see Bishop [4, pp. 416–17].

[13] Needless to say, it is not necessary that firms actually make calculations such as those outlined in the text, only that they act as if such calculations had been made. On the other hand, there is some casual evidence to suggest that some firms explicitly engage in a maximization process similar to that noted above. The following quotations refer to the United Auto Workers-Ford Motor Company strike and may serve as an example of this casual evidence. They are taken from the *Ford Motor Company Report to Stockholders*, November 1967. "We are convinced that, in this situation, the UAW leadership concluded that no realistic settlement could be reached and ratified without a strike. . . . Given these difficult conditions, we believe the settlement we reached is a realistic one, even though it is higher than desirable. . . . A longer strike would have raised strike costs out of proportion to any resulting improvement in the outcome. In short, we believe the settlement represents the lowest possible combination of strike costs and settlement costs to the Company and the country."

to occur, $S>0$, it must be true that

$$(10) \quad y_0 > \frac{\alpha P - \beta \hat{W}\left(1 - \frac{\tau}{r} y_*\right)}{\beta \hat{W}\left(1 + \frac{\tau}{r}\right)}.$$

This inequality is more likely to be satisfied, *ceteris paribus*, the greater are y_0 and τ and less likely the greater are P, α/β (average product per worker, which is inversely related to the ratio of the wage bill to total cost), r, and y_*. By using (4) it is possible to rewrite (10) as

$$(11) \quad y_0 > \frac{\hat{\pi} + H + \frac{\tau}{r}\beta \hat{W} y_*}{\beta \hat{W}\left(1 + \frac{\tau}{r}\right)},$$

which implies that a strike is less likely to occur over time in a given firm or industry the greater is the previous profit level relative to the previous wage bill.

Although the above model is a very oversimplified view of the collective bargaining relationship, it does provide predictions concerning the probability of a strike's occurrence and the expected duration of such a strike. Without going into great detail, the following remarks seem appropriate.

1. It is possible to increase the realism of this model substantially without drastically altering its implications. Introduction of the possibility of employment effects from wage increases, the fact that contracts are not negotiated once but at discrete intervals into the future, and the inventory position of the firm would all tend to increase the realism of the process. These extensions are unnecessary at this point, however, because the simple form of the present model is quite adequate for the purposes of estimation considered in the next section.

2. The present approach has the advantage of providing a determinate solution to the bargaining problem in the single (but important) case of union-management negotiations. Such a solution is possible only because widely held views about the institutional behavior of the parties involved is explicitly considered. In this case it is assumed that only one party, management, can realistically vary its wage offer. The union leadership, which maximizes its utility by acting in accord with the expectations of the rank and file, must act to represent the union membership's wage demands. On the assumption that firms maximize the appropriately discounted present value of the future profit stream, it is seen that the basic function of the strike is as an equilibrating mechanism to square up the union membership's wage expectations with what the firm may be prepared to pay. For completeness the analysis should probably include a fourth party, stockholders, in so far as management has a separate, self-serving motivation similar to that exposited by Williamson [30]. We feel, however, that for the present partial analysis we may safely assume that in the typical case management actions coincide with stockholder interests.

3. The above model has implications for variables other than the frequency and duration of strikes and the rate of change of money wages. Suppose, for example, that over a period of time wage changes remain below what the rank and file union membership desires, perhaps because of moral suasion via the Presidential wage guideposts. The analysis of this paper predicts that in such a case there will be an increase in the number of contracts which fail membership ratification and that there will be an increase in internal union dissension. George Perry has recently argued [22] that wage changes have been smaller since 1962 than would have been expected on the basis of the experience of the 1950s.

Interestingly enough, there has been a substantial increase in contract ratification defeats since the point at which Perry dates the initial overprediction.[14] Further, this period corresponds to a widely known rash of rank and file rebellion against union leadership.[15]

B. *An Operational Formulation of the Bargaining Model*

From the analysis of a typical firm's choice between incurring and not incurring a strike it was concluded that the parties were less likely to agree prior to conflict the greater the acceptable wage increase (y_0) and the speed at which the membership's expectations are reduced during a strike (τ); the parties are the more likely to agree the greater is the ratio of the preagreement profit level to the wage bill (π^*), the firm's discount rate (r), and the minimum acceptable wage increase (y_*). Only one of these variables, π^*, has an obvious empirical counterpart, so further hypotheses must be provided to relate the other variables to observable phenomena.

It seems plausible to argue that although τ, r, and y_* may vary between industries and regions because of different institutional arrangements, they will change only slowly through time. For example, τ should depend upon the size of benefits generally paid out of strike funds, how much unemployment compensation may be paid strikers, etc.; all of which are institutionally determined.[16]

Aggregating across firms and assuming a linear relationship in the relevant ranges of the variables, the preceding discussion suggests the following preliminary specification:

$$(12)\quad S_t' = \beta_0 + \beta_1 T + \beta_2 y_{0t} + \beta_3 \pi^*_{t-1},$$

where S_t' is the probability of a strike in period t, and T indexes the passage of time. We expect $\beta_2 > 0$, $\beta_3 < 0$, $\beta_0 > 0$, since some strikes take place for institutional reasons, and $\beta_1 < 0$, since the number of institutional strikes has been steadily declining.[17]

Intuitively, one would expect y_{0t} to depend negatively on the unemployment rate, u_t. First, when unemployment is low the typical worker has the opportunity to move to a higher-paying job. Since the costs of movement may be substantial, however, he will first try to increase his wages in his present job and this will tend to increase y_0. Second, the leadership will be less likely to try to reduce y_0 when unemployment is low because the employment effects of a large wage increase will have little effect on their political stature, and sizeable strike funds may replace part of the worker's lost income. Finally, during periods of low unemployment there will be decreased opposition among the rank and file to a militant course of action since there will be part-time job opportunities for potential strikers.

[14] Perry uses the extent of overprediction of actual wage rate changes by a Phillips-type curve for the aggregate manufacturing sector to establish the dating of guidepost effectiveness. It is easy to see from his Table I [22, p. 899] that there is an increasing tendency for overprediction in the period from late 1962 through early 1966 (the last period presented). The following fiscal-year (July through June) data on the percentage of total joint-meeting Federal Mediation and Conciliation Service cases involving contract rejections match up very nicely: 1964–8.7 percent, 1965–10.0 percent, 1966–11.7 percent, 1967–14.2 percent. See Simkin [26].

[15] See, for example, Murray Gart [13]. Although most of this discontent has been manifest at the local level, it has also shown up in political turnover at the highest levels.

[16] A particular source of difficulty is encountered if y_* is a function of y_0, say $y_* = y_*(y_0)$. Even in this situation, however, the qualitative content of the model is retained so long as $dy_*/dy_0 < 1 + r/\tau$.

[17] The major reasons for this secular decline in strike activity have been enumerated succinctly by David Cole: "It has been possible over the years to all but eliminate two of the three major causes of strikes by resort to other means: disputes over recognition are now largely resolved by means of the election, and grievances by means of voluntary arbitration" [7, p. vii]. Data on strike activity by cause show that the number of strikes over union organization declined secularly from 839 in 1952 to 751 in 1957 to 582 in 1962. See [33, D-722].

A second determinant of y_0 should be a moving average of previous changes in real wages,

$$(13) \qquad y_{0t} = \alpha_1 + \alpha_2 \sum_{i=0}^{M} \mu_i \Delta R_{t-i}.$$

Intuitively we would expect $\alpha_1 > 0$, $\alpha_2 < 0$, and the μ_i to have an inverted U-shape. That is, we would expect that when real wages have been increasing rapidly y_0 would be low. A more formal justification for these expectations is as follows: Suppose that y_0 depends positively on the difference between the expected long-run increase in real wages, ΔR^L, and the currently anticipated increase in real wages, ΔR^A, i. e.,

$$(14) \qquad y_{0t} = \gamma_1[\Delta R_t^L - \Delta R_t^A].$$

Suppose further that ΔR^L is composed of a very long-run constant increase ("workers always want more") and a moving average of previous real wage changes:

$$(15) \quad \Delta R_t^L = (1 - \sigma)V + \sigma \sum_{i=0}^{N} \delta_i \Delta R_{t-i},$$

where $0 < \sigma < 1$, $\Sigma\delta_i = 1$, and V is the very long-run component. $\Delta R^A{}_t$ is presumably determined solely by a moving average of previous real wage changes:

$$(16) \qquad \Delta R_t^A = \sum_{i=0}^{K} \lambda_i \Delta R_{t-i},$$

where $\Sigma\lambda_i = 1$. Substitution of (15) and (16) into (14) gives:

$$(17) \quad y_{0t} = \gamma_1(1 - \sigma)V + \gamma_1 \sum_{i=0}^{M} [\sigma\delta_i - \lambda_i]\Delta R_{t-i}.$$

Setting $\gamma_1(1-\sigma)V = \alpha_1$, $-\gamma_1 = \alpha_2$, and $(\lambda_i - \sigma\delta_i) = \mu_i$ gives precisely the form of (13). Note also that if the λ_i and δ_i have the usually assumed exponentially decaying form, then their difference will have an inverted U-shape.

A final determinant of y_{0t} should be profits. If the firm's profit level has been high in recent periods, the typical union member may feel that he deserves a larger wage increase. Also, the motivation of the leadership to attempt the task of persuading the membership to be content with a lower settlement will be diminished. Hence, high profit levels will have the effect of raising y_0 to some extent.

Combining the above hypotheses about the determinants of y_0, and assuming that the effect of profits on y_0 can be represented as $\alpha_4\pi^*_{t-1}$, gives:

$$(18) \qquad y_{0t} = \alpha_1 + \alpha_2 \sum_{i=0}^{M} \mu_i \Delta R_{t-i} + \alpha_3 u_t + \alpha_4 \pi^*_{t-1}.$$

After substitution of (18) into (12) we have the following estimating equation:

$$(19) \quad S_t' = A + B_1 \sum_{i=0}^{M} \mu_i \Delta R_{t-i} + B_2 u_t + B_3 \pi^*_{t-1} + B_4 T + \epsilon_t,$$

where A and the B_i are implicitly defined above and where ϵ_t is a disturbance term. On the basis of previous arguments we expect $A > 0$, $B_1\mu_i < 0$, $B_2 < 0$, and $B_4 < 0$. Since $B_3 = \beta_2\alpha_4 + \beta_3$, and $\beta_2\alpha_4 > 0$, $\beta_3 < 0$, the sign of the coefficient on profits in equation (19) is indeterminant. Although management is more likely to give in when previous profits are high, the union is also likely to increase its demands. Hence, it is not clear whether the net effect of an increase in profits will be to increase, decrease, or have no appreciable effect on the probability of occurrence of a strike. The specification of (19) concerning the effect of previous changes in real wages is based on the implicit assumption that workers view money wage changes and price changes as the reverse of each other. It is, of course, possibile that this is not so—complete money illusion being an extreme exception

—so this assumption is tested in the next section.

II. *Empirical Results*

A. *Specification and Estimation Problems*

If time-series observations were available on the number of strikes which begin in any quarter, S_t, and the number of contract expirations in any quarter, N_t, then S'_t could be set equal to S_t/N_t and (19) could be estimated directly. Although there are quarterly data for S_t, there are only limited surveys for N_t.[18] In essence, the difficulty faced is that even though equation (19) is derived from a model where the dependent variable is the probability of occurrence of a strike, it will be necessary to estimate it with data on only the frequency of occurrence of strikes.

Lacking the necessary observations on N_t, we are forced to make some plausible assumption about how it varies.[19] One possible hypothesis is that $N_t=n$, where n is a constant. Given the near-plateau in union membership reached in 1952 [27], and the increased tendency toward multiple-employer bargaining, this assumption does not seem implausible with respect to the *annual* number of contract expirations.[20] In order to deal with quarterly data, however, we must at least recognize that there is a strong seasonal influence in contract expirations. There are, of course, important economic reasons why this should be so. First, trade unions in the areas of the economy where inclement weather affects production and employment will always try to gear contract expirations to periods when the effects of a strike are least likely to be nullified by the fact that production would not have taken place anyway. Second, most trade unions will try to avoid contract expirations in periods when the demand for current income is high (the winter holidays, for example) and to obtain contract expirations in periods with the fewest paid holidays. Both of the above considerations suggest that the fall and winter quarters will contain fewer contract expirations and, *ceteris paribus*, fewer strikes. As a working assumption, therefore, we set

$$N_t = \sum_{j=1}^{4} \Phi_j N_{jt},$$

where Φ_j is the (constant) number of contract expirations in the jth quarter of all years and N_{jt} is a dummy variable set equal to one in the jth quarter of the year and zero otherwise. Substituting S_t/N_t for S'_t in (19) and multiplying both sides by

$$\sum_{j=1}^{4} \Phi_j N_{jt}$$

gives

$$(20)\quad S_t = A \sum \Phi_j N_{jt} + \sum \Phi_j N_{jt} X_t B + \sum \Phi_j N_{jt} \epsilon_t,$$

where for notational convenience the four independent variables in (19) have been replaced by the row vector X_t and B is the

[18] The data on S_t, for example, cover strikes involving more than six workers, while the limited data on N_t cover negotiations involving 1,000 or more workers. There is, of course, the further problem that some institutional strikes do not take place at a time of contract expiration.

[19] Needless to say, if we were willing to proceed by simply regressing the frequency of strike activity on any number of intuitively relevant independent variables, none of the above assumptions would be explicitly introduced. The use of such an *ad hoc* approach, however, would imperil any attempt to understand the mechanism which underlies the determination of strike activity.

[20] Some casual evidence for this assumption in the period 1963–67 is contained in Simkin [26]. The implication of the argument in the text is that the union always has its way on the seasonal aspect of disputes over contract expiration, which is not fully consistent with the caveat in footnote 16. In fact, the seasonal pattern implicitly suggested for strike activity has been observed over a long period of time. See, for example, Dale Yoder [31]. Our argument is simply that the precise period of the year in which a strike takes place is most generally under the control of the union, even if the point of contract expiration is not.

column vector of coefficients on these variables.

Since the Φ_j are unknown, the simplest procedure for obtaining an unbiased estimator for (20) would be to use a separate relationship for each quarter of the year. Unfortunately, the number of variables which will be needed on the right-hand side of (20) is too large to make this solution feasible with the length of the time series available. Therefore, as an admittedly rough approximation to (19) and (20), we have specified the following equation:

$$(21)\quad S_t = A\Phi_1 N_{1t} + A\Phi_2 N_{2t} + A\Phi_3 N_{3t} + A\Phi_4 N_{4t} + B_1' \sum_{i=0}^{M} \mu_i \Delta R_{t-i} + B_2' u_t + B_3' \pi^*_{t-1} + B_4' T + \epsilon_t$$

where the N_{jt} are a set of seasonal dummies and ϵ_t' is an error term.[21] It is not difficult to show, under the usual assumptions about the way in which the independent variables in (21) are generated [14, pp. 268–69], that the least squares estimators of $B_1'\mu_i$, B_2', B_3' and B_4' are consistent and asymptotically unbiased estimators of $\frac{1}{4}\Sigma\Phi_j(B_1\mu_i)$, $\frac{1}{4}\Sigma\Phi_j B_2$, $\frac{1}{4}\Sigma\Phi_j B_3$, and $\frac{1}{4}\Sigma\Phi_j B_4$. That is, our estimates of the coefficients in equation (21) may be interpreted as the *mean response*, averaged across quarters, of a stimulus from the independent variable. Since each of the Φ_j must be positive, all of the previous predictions about the signs of the coefficients in equation (19) hold for equation (21).

Before turning to estimation and testing of equation (21), one final difficulty must be resolved. The lag coefficients on ΔR_{t-i} pose two estimation problems. First, we have a priori reason to suppose that these coefficients will not have the familiar exponential-decay form. Second, we expect a lag distribution on ΔR_{t-i}, but not on the other variables in the equation.[22] As an alternative to the standard technique, therefore, we have used the straightforward procedure suggested by Shirley Almon [1] for estimating equation (21). On the assumption that the lag distribution can be approximated by a polynomial, Lagrangian interpolation polynomials are used to create moving averages of the independent variable. These moving averages are then introduced into an ordinary regression equation and their coefficients (and hence the implied coefficients of the lag distribution) estimated. In the results that follow we have used a third degree polynomial approximation and constrained the lag distribution to assume zero values at the beginning and at a finite lag.[23]

B. *The Results*

Our discussion of empirical results is divided into three sections. First, we discuss the general implications of the estimated version of equation (21). Second, we modify the estimating equation to allow for the possibility of money illusion on the part of workers. Finally, we test the stability of the preferred equation and consider the effect of some important institutional changes on the volume of aggregate strike activity.

1. The initial results of fitting equation (21) are reported in Tables 1 and 2 under the rubric of equations (21a) and (21b),

[21] If the disturbance term in (19) is homoscedastic, then the disturbance term in (21) is heteroscedastic because its variance moves systematically with the quarter of the year being considered. Namely, if var $(\epsilon_t) = C$, a constant, then var $(\epsilon_t') = \text{var}\,(\Phi_j\epsilon_t) = \Phi_j^2 C$. If one views S_t' in (19) as a sample proportion, however, the procedure used to obtain (21) suggests that ϵ_t' will be (nearly) homoscedastic. Since this becomes an empirical issue, we have tested the estimated version of (21) for unequal residual variances to see if this difficulty is damaging to our results. See footnote 24 below.

[22] For a discussion of the estimation problems raised by these difficulties see Griliches [15].

[23] This means that two "Almon variables" were entered into the regression to estimate the lag distribution on real wage changes. It should be noted, however, that the results were generally insensitive to either the degree of the polynomial or the constraints placed on the lag coefficients.

TABLE 1—ESTIMATED REGRESSION COEFFICIENTS AND RELATED STATISTICS[a,b] FOR THE VARIABLES IN EQUATIONS 21a, 21b, 21c, AND 21d

Equation	U_t	$\Sigma\Delta R_{t-i}$	$\Sigma\Delta W_{t-i}$	$\Sigma\Delta P_{t-i}$	π^*_{t-i}	N_1	N_2	N_3	T	C	LG	R^2	$\hat{R}^2$	DW	SEE
(21a)	−123.0	−62.2	—	—	1.6	213.6	594.8	457.9	−2.2	1519.8	—	.938	.820	1.44	75.9
	(13.1)	(12.9)			(136.7)	(30.8)	(28.4)	(27.9)	(0.7)	(170.0)					
(21b)	−123.2	−62.2	—	—	—	213.7	594.8	457.9	−2.2	1521.7	—	.938	.820	1.44	75.2
	(9.4)	(12.3)				(28.7)	(27.4)	(27.5)	(0.7)	(70.4)					
(21c)	−132.6	—	−80.6	64.4	—	227.3	602.4	459.4	−2.8	1663.8	—	.941	.828	1.52	75.0
	(11.8)		(24.7)	(14.2)		(30.2)	(27.8)	(27.4)	(1.1)	(168.4)					
(21d)	−135.3	−62.9	—	—	—	225.7	598.7	460.5	−2.3	1570.4	87.8	.946	.843	1.61	70.7
	(9.8)	(11.5)				(27.3)	(25.8)	(25.8)	(0.6)	(68.4)	(30.9)				

[a] R^2 is the coefficient of determination about the overall mean, $\hat{R}^2$ is the coefficient of determination about the quarterly means, *DW* is the Durbin-Watson statistic, and *SEE* is the Standard Error of Estimate for the regression equation.

[b] Estimated standard errors of the estimated regression coefficients are in parentheses under the relevant coefficients.

Sources: The civilian unemployment rate, u_t, is a quarterly average of the monthly rates published in Table A-6 of the *Monthly Labor Review*, U. S. Bureau of Labor Statistics. The Consumer Price Index is obtained from D-1 of the *MLR*. Our wage rate is an average, weighted by relative 1957 production worker employment, of average hourly earnings in mining, construction, and manufacturing, and the data are obtained from *Employment and Earnings* volumes, U. S. Bureau of Labor Statistics. None of these variables is seasonally adjusted. Our profits variable is the ratio of Corporate Profits after tax, excluding Inventory Valuation Adjustment, to Total Compensation. The source of these data is various issues of the *Survey of Current Business*, Table 3, U. S. Dept. of Commerce. Finally, the number of strikes beginning in each quarter are obtained in Table E-1 of various issues of the *MLR*.

TABLE 2—ESTIMATED LAG COEFFICIENTS AND THEIR STANDARD ERRORS FOR EQUATIONS 21b AND 21c

Lag	(21b) $\Sigma\Delta R_{t-i}$	(21c) $\Sigma\Delta W_{t-i}$	(21c) $\Sigma\Delta P_{t-i}$
0	−4.0 (1.6)	− 7.0 (2.6)	4.5 (2.0)
1	−6.9 (2.3)	−11.4 (4.0)	7.5 (2.9)
2	−8.6 (2.4)	−13.4 (4.3)	9.3 (3.0)
3	−9.5 (2.1)	−13.5 (4.1)	10.0 (2.6)
4	−9.4 (1.9)	−12.2 (3.7)	9.8 (2.2)
5	−8.6 (1.9)	−10.0 (3.6)	8.7 (2.0)
6	−7.1 (2.1)	− 7.2 (3.5)	7.1 (2.1)
7	−5.2 (2.1)	− 4.3 (3.2)	4.9 (2.1)
8	−2.7 (1.5)	− 1.8 (2.2)	2.5 (1.5)

and the lag distribution coefficients for equation (21b) are charted in Figure 2. The following symbols are used in these tables:

u_t = the civilian unemployment rate,
$\Delta R_t = \Delta W_t - \Delta P_t$,
ΔW_t = the annual percentage rate of change of money wages,
ΔP_t = the annual percentage rate of change of consumer prices,
π_t^* = the ratio of corporate profits after taxes to total compensation,
N_{jt} = seasonal dummies for first, second, and third quarters,
T = time in quarters,
C = constant term.

The period of fit is 1952I-1967II, which is consistent with our assumption that the annual number of contract expirations has been relatively constant since 1952.

As can be seen from Tables 1 and 2, the results provide strong support for the hypotheses advanced in Section I. In equation (21a) the coefficients of each of the independent variables, except that for profits, are highly significant.[24] Although several different measures of profits and moving averages of profits were tried, none produced results substantially different from those reported in Table 1. Our tentative conclusion is that the *net* effect of profits *on strike activity* is small. In equation (21b) π^*_{t-1} has been deleted. The independent variables in this preferred equation explain about 94 per cent of the variance of the dependent variable about its overall mean, and about 82 per cent of the variance of the dependent variable about its quarterly means. The standard error for

[24] Since there is some question about the appropriateness of the usual statistical tests in the case where the disturbance variances are unequal (see footnote 21), we have applied Bartlett's well-known test for unequal variances to these data. See Bennett and Franklin [3] concerning the computational procedures of this test. For the number of degrees of freedom in each of the quarterly groupings, B, the test statistic, is satisfactorily approximated by the χ^2 distribution with 3 degrees of freedom. In this case, $B = 2.01$, and we cannot reject the hypothesis of equal quarterly residual variances at even the .25 level.

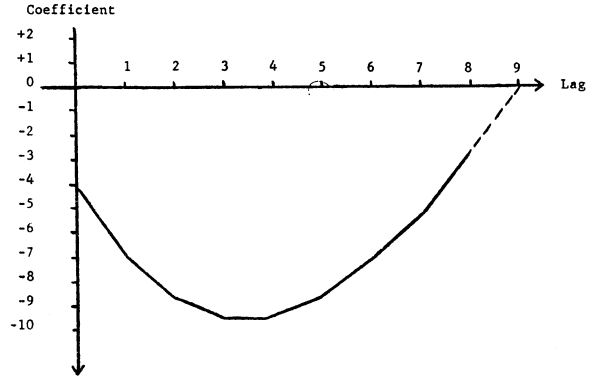

FIGURE 2—LAG DISTRIBUTION COEFFICIENTS ON REAL WAGE CHANGES

this equation is a remarkably low 75 strikes, as against a mean of about 980 strikes per quarter. A glance at Figure 2 suggests that the lag distribution on real wages is of the shape predicted. A steady-state decline of one percentage point in the rate of change of real wages is associated with an increase of about 62 strikes per quarter. The seasonal dummies confirm the hypothesis that strike activity is much heavier in the spring and summer quarters than in the fall and winter quarters.[25] Finally, a decline of one percentage point in the civilian unemployment rate is associated with an increase of about 123 strikes per quarter.

2. The results for equation (21c) reported in Tables 1 and 2 incorporate the hypothesis that the rates of change of money wages and prices are not mirror images in their effects on aggregate strike activity, i.e., we allow for the possibility that the rate of change of money wages has a more (or less) important effect on strike activity than the rate of change of prices. It is clear from these results that the effect of money wage changes on strike activity is somewhat greater than the effect of price changes. The differences in the effects of these variables, however, is not very substantial. More formally, we may test the null hypothesis that

$$\sum_{i=0}^{9} \mu_i^w + \sum_{i=0}^{9} \mu_i^p = 0$$

by forming the ratio

$$t = \frac{\sum \hat{\mu}_i^w + \sum \hat{\mu}_i^p}{\text{var } (\sum \hat{\mu}_i^w + \sum \hat{\mu}_i^p)^{\frac{1}{2}}},$$

where the $\hat{\mu}_i^w$ are the estimated lag distribution coefficients on money wage changes and the $\hat{\mu}_i^p$ are the estimated lag distribution coefficients on price changes. In this case $t = -1.07$ which clearly is not significant at conventional test levels. We may also test the null hypothesis $\mu_i^w = -\mu_i^p$ $(i = 0, \cdots, 9)$ with an F-ratio. In this case $F(2, 49) = 1.09$, which also is not significant at conventional test levels.[26] We tentatively conclude that wage and price changes act essentially as mirror-images with respect to aggregate strike activity.

3. Since the volume of strike activity has heretofore been associated with any number of unstable causal factors, there may be some question about the general stability of an equation like (21b) over time. In order to test for the possible instability of this equation we have arbitrarily divided the sample period in half and performed the standard test of the null hypothesis that the parameters of equation (21b) are identical for the two time periods. In this case $F(8, 46) = 1.40$, which clearly is not significant at conventional test levels. We conclude that there is little evidence to suggest that this relationship is unstable.

[25] The coefficients on the seasonal dummies and the constant term in equation (21b) allow us to estimate $A\Sigma\Phi_j$ and $A\Phi_j (i = 1, \cdots, 4)$. Hence, they provide estimates of

$$\frac{A\Phi_j}{A\Sigma\Phi_j} = \frac{\Phi_j}{\Sigma\Phi_j} \quad (j = 1, \cdots, 4),$$

i.e., the percentage of total annual contract expirations which take place in each quarter. These estimates are, from the first to fourth quarters: 23.6 per cent, 28.9 per cent, 26.9 per cent, 20.4 per cent. Simkin [26] provides the number of "active" Federal Mediation and Conciliation Service cases closed each month in 1966, which, assuming a short lag from beginning to closure of a case, should be a good proxy for the "typical" number of contract expirations per month. Assuming a mean lag of one month for closures, these independent data provide the following estimates of the percentage of total contract expirations which take place in each quarter: 22.8 per cent, 32.3 per cent, 25.6 per cent, 19.2 per cent. These latter estimates are strikingly close to those obtained from equation (21b), and lend additional credence to our argument that the seasonality in strike activity is due to a seasonality in contract expirations.

[26] The first test described in the above paragraph requires computation of the estimated variance of $\Sigma\hat{\mu}_i^w + \Sigma\hat{\mu}_i^p$, which can easily be worked out as a linear combination of the variances and covariances of the "Almon variables" in the regression equation. The second test is a straightforward application of some of the results in Chow [6].

Finally, we have estimated equation (21d) to allow for the possibility that passage of the Landrum-Griffin Act in 1959 has had a positive impact on the amount of aggregate strike activity. It has been argued that this law, which is designed to regulate the internal affairs of trade unions in order to ensure "union democracy,"[27] has had the effect of: (a) increasing the militancy of union leaders as a response to the implicit encouragement the law gives to the growth of dissident groups within the union, and (b) making the leadership more sensitive to the "less responsible" wage demands of the union members.[28] Adding a dummy variable, *LG*, to the estimating equation to test for the effect of the Landrum-Griffin Act gives the results reported as equation (21d) in Table 1. The standard error, Durbin-Watson Statistic, and R^2 are all improved by this modification. The coefficient of *LG* suggests a modest, but significant increase of about 88 strikes per quarter over the pre-Landrum-Griffin period.[29]

III. *Conclusions and Implications*

Although we are not firmly wedded to the precise estimates presented in this paper, it seems that the aggregate level of strike activity is behaviorally related to the degree of tightness of the labor market and previous rates of change of real wages. Among the implications of our analysis are the following:

1. The incorporation of a widely accepted set of assumptions about the behavior of trade unions into the traditional theory of the firm produces a straightforward solution to the outcome of union-management bargaining which lies within the corpus of conventional economic reasoning. Although conventional bargaining models are based on assumptions which do not seem to represent the institutional framework of union-management negotiations, this could be excused if they provided refutable predictions about observable behavior, but they do not. The simple formulation of this paper, which specifically acknowledges the *three-party nature* of collective bargaining, does yield refutable predictions, and they are found to be consistent with the data.

2. As was shown with the case of the Landrum-Griffin Act, even a simple version of the model described in this paper can be helpful in evaluation of the effects of changes in the institutional framework within which collective bargaining must function. Other institutional changes, e.g., the payment of unemployment compensation to strikers, could be investigated. Further, the model described in this paper provides a more explicit rationale for some of the work which has been done on explanations of the rate of change of aggregate money wages.[30]

3. Finally, the results have a number of implications for public policy with respect to wage determination in the unionized sector of the economy. First, policies which

[27] See [12] for details on the provisions of this law. It was signed in September of 1959 and most of its provisions were in effect within ninety days. Hence, in the following results we have assumed that the law began having an effect in 1959 IV and reached its full effectiveness linearly by 1960 IV.

[28] For arguments similar to these see Estey [11, pp. 57–59). In terms of the formulation in Section I, these arguments suggest that y_0 would generally be higher after passage of the Landrum-Griffin Act than before.

[29] To test for the possibility that we had confused the effect of the Landrum-Griffin Act with the effect of the Guideposts, we added another dummy variable to the equation. The coefficient of LG remained similar with respect to its standard error while the Guideposts coefficient was negative and less than half its standard error. In terms of the formulation in Section I, this negative effect is what would be predicted since the Guideposts supposedly lower y_0.

[30] For example, the studies by O. Eckstein and T. A. Wilson [10] and G. L. Perry [21] both include profits as determinants of money wage changes on the basis of casual bargaining model considerations, and J. D. Sargan [25] estimates a model which includes the level of real wages. In [2] a variable specifically measuring the volume of strike activity is found to have an effect on aggregate money wage changes.

are geared to induce labor leaders to convince their constituencies to be satisfied with "more reasonable" wage settlements are likely to result eventually in political turmoil within trade unions. It does not, therefore, seem likely that such a policy can continue for long without encouraging the growth and power of more militant leadership and a subsequent decline in the effectiveness of the original policy. Second, in addition to the well-known tradeoff between wage changes and unemployment there seem also to be tradeoffs between unemployment, wage changes, and industrial strike activity. To the extent that the maintenance of industrial peace is a goal of public policy, this adds an additional dimension to the problem of maintaining full employment and stable prices.

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