Strikes, Wages, and Private Information

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Private information models of strikes suggest that the strike is used as an information-revealing device by the union in the presence of asymmetrical information. A testable prediction of these models is that there is a negative relationship between strikes and the unpredicted component of the wage. This paper shows that in a large sample of U.S. labor contracts the real wage falls by about 3 percent after a strike lasting 100 days.

This paper examines the relationship between wages and strikes in order to shed light on the empirical relevance of some strike models. There are basically only two major theories to explain why strikes occur. One argues that strikes are accidents or mistakes that occur during negotiations. The only prediction of this theory is that strikes should be less frequent and shorter when the cost of the strike is higher. The other suggests that the strike is used as an information-revealing device in the presence of asymmetrical information. The major assumption in these models is that the union uses the strike to gain information from the firm's management on the size of the economic rent that accrues from the firm's activity. These models predict that strikes should be more frequent and longer when the component of the rent that is unobservable to the union is lower than anticipated.

A major problem with testing this second class of models is that the important determining variable is by definition unobservable to the union and hence is presumably also unobservable to the econometrician. These models also predict, however, that there should be a negative correlation between the final negotiated wage and strike activity. This relationship should map out a negatively sloped "concession schedule." This is a directly testable hypothesis which does not rely on any assumption about the form of the private information held by the firm. Moreover, it is unlikely that wages and strikes would be correlated if strikes were just mistakes.

The wage-strike relationship is examined here using a unique data set of U.S. labor contracts which includes information on both the negotiated wage and any work stoppages. It has two major advantages over previously existing U.S. contract data sets.[1] First, it contains a very broad cross section of contracts, including contracts from both manufacturing and nonmanufacturing industries. Second, it uses the most comprehensive listing of strikes available to identify whether a strike occurred at a contract negotiation.

In order to estimate the concession schedule, it is necessary to control for all observable variables which affect the level of wages or strike activity. In particular, as the outcome of previous wage negotiations is an important source of information to the union, previous wage settlements in similar firms are included in the wage equation. The estimated wage equation differs from those estimated in previous studies of wage determination in that the average expected *real* wage over the term of the contract is used as the dependent variable rather than the change in the nominal wage.

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[1]For example, the data used by Wayne Vroman (1984).

The rest of the paper is organized as follows. Section I presents a brief discussion of the theoretical models of strikes. A description of the data used in the paper is given in Section II and Section III reports the results of estimating the real wage model. Section IV presents evidence on the negative correlation between negotiated real wages and strikes. Section V discusses the role of previous wage settlements in the determination of the real wage, and Section VI contains some concluding remarks.

I. Background

The first strand of the theoretical strike literature, which originated in John Hicks (1963), suggests that strikes are mistakes or accidents and does not explain why these strikes occur. Hicks also suggested that the union will be more prepared to accept a lower wage after a long strike than after only a short strike. John Kennan (1980) and Melvin Reder and George Neumann (1980) argue that even if strikes are mistakes they should occur less often and for a shorter duration the higher the total cost of the strike to the union and the firm. While this theory can be tested empirically,[2] the cost of the strike would presumably matter in almost any economic theory of strikes.

The second strand of the strike literature suggests that strikes are a result of imperfect information on the workers' part as to the firm's ability to pay higher wages. The absence of complete information is an essential feature of the strike model constructed by Orley Ashenfelter and George Johnson (1969). They maintained that there are three, not two, parties involved in labor negotiations: the firm's management, the union leaders, and the union rank and file. The union leaders and the firm's management share all information relevant to the bargaining, and so the union leaders know the maximum wage the firm's management will agree to. The union rank and file do not share this information and may have unrealistically high expectations about the wage the firm is willing to grant. It is assumed that during a strike these expectations are revised downward and the minimum acceptable wage increase for the rank and file falls along a negatively sloped concession schedule. The union leaders agree to take strike action to avoid the politically damaging consequences of accepting a wage increase much lower than that expected by the rank and file. The firm maximizes its expected profit taking the union's concession schedule as given. The equilibrium wage increase and strike length occurs at the point along the concession schedule at which there is a tangency with an iso-profit curve or at a corner solution with no strike.[3] An oft-cited criticism of the Ashenfelter-Johnson model is that it does not explain why the wage expectations of the union rank and file should fall as the strike progresses.

The recently developed private information models of strikes[4] provide the first fully consistent models of why strikes occur during labor negotiations. The important contribution of these models is that they recognize that a strike can be used as a screening device when there is an asymmetry in the information held by the negotiating parties. As such, the strike may be an *ex ante*-efficient bargaining tool. These models provide a rationalization for the downward-sloping concession schedule of Hicks and Ashenfelter and Johnson.

Suppose that the firm has information on the size of the rent which is not shared by the union, and the cost of the strike increases with the size of the rent. A strike can then be used as a screening device by the union to infer information about the size of the rent in the following way. The union strikes more often and for longer when the firm offers a low wage claiming that the value of the rent is low. There is obviously

[2] See Sheena McConnell (1988) for evidence that strikes do vary inversely with the cost of the strike to the negotiating parties.

[3] The concession schedule must be convex over some strike lengths for there to be an interior solution.

[4] See, for example, Peter Crampton (1984), Drew Fudenberg, David Levine, and Paul Ruud (1985), Sanford Morton (1983), Beth Hayes (1984), Joseph Tracy (1987a), and John Kennan (1986).

no incentive for the firm to offer a high wage and pretend that the value of the rent is high when it is not, therefore there is no need for the union to penalize the firm for offering a high wage. On the other hand, if the union does not penalize the firm for offering a low wage, the firm is always better off offering a low wage irrespective of the true value of the rent. Hence, while these models predict that strikes should vary inversely with the *unobservable* size of the rent, the models also predict that strikes should be inversely correlated with the *observable* negotiated wage. If there is a continuum of possible states of nature, the possible wage and strike outcomes map out a negatively sloped concession schedule.[5] This is a directly testable prediction of the private information models. Furthermore, there is no reason to expect a negative correlation between wages and strikes in a simple model in which strikes are mistakes.

There have been some attempts directly to test the private information models by assuming a particular form of private information. The fundamental problem in testing this type of model is that the important determining variable is by assumption unobservable. Any measure of the unobservable component of the rent must be based on the assumption that the econometrician can measure a variable which the union cannot. Unions are presumably sufficiently sophisticated to infer the value of the unobservable variable in the same manner as the researcher. Tracy (1987a) and Beverly Hirtle (1985) attempt to proxy the unobservable component of the rent using the residual from a CAPM securities-pricing equation. Although Tracy found some evidence in a sample of contracts covering the years 1973 to 1977 that the probability of a strike is positively correlated with the variance of this residual, Hirtle, using a sample covering a longer period of time, 1957 to 1980, found little evidence to support this relationship.

These previous attempts to test the private information strike models relied on essentially arbitrary assumptions about the form of the private information held by the firm. The advantage of the approach adopted in this paper is that it relies only on the relationship between two readily observable phenomena: wages and strikes. If the negative relationship between wages and strikes does not hold, then a *prima facie* case can be made against these models without resorting to any assumptions about the form of the private information.

It is important to note that it must be the firm that possesses the private information for this relationship between wages and strikes to hold. If the *union* possesses information not shared by the firm, and the work stoppage is used by the firm as a screening device then there would be a *positive* correlation between wages and strikes.

II. The Data

While there are many studies of the wage determination process under collective bargaining in Canada, there is a dearth of similar studies for the United States.[6] This is because in the United States there is no single source of contract data which includes data on work stoppages and negotiated wages. To construct a micro data set for the United States it is necessary to collect contract data, strike data, and wage data separately, and match the three sets of information together. The data used in this study consist of 3,001 contracts negotiated between 1970 and 1981. These contracts cover 883 employer-union bargaining pairs in 20 manufacturing and 25 nonmanufacturing industries.[7]

The starting point of the data set is a listing of contracts to which all data on

[5]See Morton for the derivation of a wage-strike schedule in a private information model with a continuum of states of nature. Unlike the concession schedule in the Ashenfelter and Johnson model, this curve need not be convex at any point.

[6]Wayne Vroman, Wallace Hendricks, and Lawrence Kahn (1985) and John Abowd (1987) used large micro contract and wage settlement data sets for the United States.

[7]A detailed description of the construction of the data set used in this study is given in a data appendix which is available on request from the author.

strikes and wages are matched.[8] This contract listing included most contracts which covered 1000 or more workers and included information on the name of the company or association, the union(s) involved in the negotiations, the date the contract was ratified, the effective date of the contract, and its expiration date. Unfortunately, it did not provide any information on strikes at contract negotiations or details of the negotiated wage.

McConnell (1988) and Tracy (1987b) used available sources of strike data to construct a "master" listing of all strikes that occurred in the United States during the period between 1970 and 1981 and involved 1000 or more workers. The three principal sources of strike data were the *Industrial Relations Facts*, a weekly publication of the Bureau of Labor Statistics (BLS); a tape provided by the Bureau of National Affairs (BNA); and a tape from the BLS which for reasons of confidentiality did not include the name of the firm or the name of the union. Using this "master" strike listing, it was possible to identify whether a strike occurred at the beginning of a contract and, if so, the length of the strike. Matching the strikes to the contracts was aided considerably by the detailed information on the expiration date of the last contract and the negotiated date of the new contract provided by the contract data. As few of the theoretical models of strikes discuss why strikes occur while a contract is in effect (as, for example, in the case of grievance strikes), I took care to include only those strikes which occur at contract negotiations over the terms of the new agreement.[9] There were 518 strikes that matched to a contract in the sample, yielding a strike rate of 17 percent.

Wage changes for most of the contracts listed on the situation tape are published by the BLS in the *Current Wage Developments* (CWD). A typical contract specifies an initial wage increase effective within a few months from the date the contract is negotiated and non-contingent deferred wage increases effective later in the contract. Many contracts (38 percent in this sample) also specify wage increases contingent on price increases using a cost-of-living adjustment (COLA) formula. The CWD lists not only initial wage changes but also non-contingent deferred increases and the realized value of COLA increases.

While wage *changes* for most of the contracts on the contract listing are published in the CWD, the BLS does not publish data on wage *levels* for individual firms. Fortunately, at least one "base" wage level could be found for most bargaining pairs from wage data collected by the BNA[10] or from the hourly wage in their respective four-digit SIC industry. The complete history of wage levels for each bargaining pair was then calculated by adding (or subtracting) the wage changes to the base wage level if the change occurred after (or before) the effective date of the base wage level.

In most of the existing wage determination studies the change in the nominal wage rate between the end of the last contract and the end of the current contract is compared with the expected change in the price level over the contract.[11] However, the wage rate that should matter to the parties in a contract negotiation is the expected real wage level. In this study, the negotiated wage is calculated as the average,[12] over the length of the contract,[13] of the real wage levels expected at the time of the negotiations.

If there is no COLA clause, the expected real wage rate is just the nominal wage level deflated by the expected price level. However, if there is a COLA clause then the expected nominal wage will depend on the

[8] The *Current Wage Developments Situation Tape* is provided by the Bureau of Labor Statistics.

[9] Strikes over local issues during general multiplant negotiations are also excluded.

[10] I would like to thank John Abowd for making these data available to me.

[11] See, for example, Louis Christofides, Robert Swidinsky, and David Wilton (1980a), Craig Riddell (1979), and Wayne Vroman (1984).

[12] This implicitly assumes that the union has a discount rate of zero.

[13] The length of a contract is defined as the number of months between the effective date and the expiration date of the contract.

TABLE 1—FREQUENCIES OF CONTRACTS, STRIKES, AND AVERAGE WAGES BY INDUSTRY

Industry	Number of Contracts	Number of Strikes	Strike Probability	Average Strike Duration[a] (days)	Average Expected Real Wage (1967$)
Food and Allied products	284	46	0.16	44.8	3.10
Tobacco	24	3	0.13	26.7	3.34
Textile Products	62	6	0.10	20.3	2.38
Men's and Women's Apparel	150	3	0.02	16.8	2.14
Lumber and Wood Products	60	7	0.12	40.7	3.00
Furniture and Fixtures	20	4	0.20	16.8	2.86
Paper and Allied Products	187	21	0.11	59.9	3.39
Printing and Publishing	62	7	0.11	9.7	3.63
Chemicals	96	17	0.18	52.4	3.57
Petroleum Products	50	11	0.22	51.9	4.39
Rubber and Plastics	36	16	0.44	54.3	3.23
Leather	37	5	0.14	39.0	2.11
Stone, Clay, and Glass	86	10	0.12	51.2	3.39
Primary Metals	201	26	0.13	28.2	4.13
Fabricated Metal Products	112	36	0.32	41.2	3.54
Nonelectrical Machinery	124	55	0.44	43.8	3.61
Electrical Machinery	182	43	0.24	34.9	3.09
Transportation Equipment	242	82	0.34	46.5	3.75
Scientific Instruments, Photo. Goods, and Watches	32	6	0.19	49.3	2.72
Miscellaneous Manufacturing	26	8	0.31	24.1	2.72
Railways	66	2	0.03	1.0	4.00
Public Transportation	4	0	0	–	3.51
Motor Freight	26	6	0.23	12.3	4.30
Water Transportation	23	5	0.22	6.8	3.21
Airlines	73	9	0.12	24.1	9.81
Communications	136	17	0.13	26.9	3.76
Utilities	233	24	0.10	75.8	4.03
Wholesale Trade-Durable Goods	12	2	0.17	58.5	3.23
Wholesale Trade-Nondurable Goods	24	6	0.25	18.8	3.62
Department Stores	54	2	0.04	4.5	2.18
Auto Dealers and Service Stations	23	6	0.26	45.3	3.57
Apparel Stores	7	0	0.00	–	2.04
Restaurants	32	0	0.00	–	1.91
Retail Trade-Miscellaneous[b]	13	1	0.08	19.0	2.19
Security and Commodity Brokers	3	0	0.00	–	3.87
Insurance Carriers	17	4	0.24	76.5	2.81
Real Estate	21	4	0.19	31.5	2.63
Lodging	42	3	0.07	20.0	1.79
Personal Services[c]	12	0	0.00	–	1.97
Business Services	27	4	0.15	9.8	2.41
Auto Repair	4	1	0.25	11.0	2.62
Miscellaneous Repair Services	4	1	0.25	11.0	3.66
Entertainment	6	0	0.00	–	2.33
Health Services	56	7	0.13	24.3	2.80
Motion Pictures	10	2	0.20	47.5	4.33
Total	3001	518	0.17	41.4	3.48

Source: As described in text.

[a]Strike duration is measured conditional on a strike's occurrence.

[b]Primarily Drugstores and Liquor Stores.

[c]Primarily Dry-cleaning and laundry establishments.

TABLE 2—FREQUENCIES OF CONTRACTS, STRIKES, AND AVERAGE WAGES BY YEAR

Year	(1) Number of Contracts	(2) Number of Strikes	(3) Strike Probability	(4) Average Strike Duration[a] (days)	(5) Average Expected Real Wage (1967$)
1970	64	22	0.35	24.3	3.15
1971	226	53	0.24	46.8	3.45
1972	181	27	0.15	38.5	3.29
1973	300	42	0.14	33.3	3.63
1974	381	78	0.21	36.3	3.52
1975	248	43	0.17	54.1	3.57
1976	251	55	0.22	40.1	3.51
1977	359	60	0.17	33.0	3.99
1978	209	42	0.20	63.9	3.50
1979	239	40	0.17	42.3	3.24
1980	307	25	0.08	35.3	3.33
1981	236	31	0.13	36.1	3.05

Source: As described in text.
[a]Strike duration measured conditional on a strike's occurring.

COLA rule and expected prices. As the CWD rarely publishes exact COLA formulas, a COLA rule was estimated using the change in the price level and the subsequent actual COLA payment. To find the expected COLA payments, the expected change in the price index was substituted for the actual change in the price index in the estimated COLA rule.[14]

Table 1 shows the frequency and duration of strikes together with the average expected real wage rate by industry. Strikes are most frequent in durable-goods manufacturing industries, where a strike occurs during 25 percent of contract negotiations, and are least frequent in nonmanufacturing industries, where strikes occur during only 11 percent of negotiations. The average strike length is 41 days, the median strike length is 22 days, and the modal strike length is only one day. The longest strikes are in the nondurable goods manufacturing industries, and strikes are the shortest, in addition to being the least frequent, in nonmanufacturing industries.

[14]Expected future prices were estimated on the assumptions that the price level can be explained by twelve lags plus monthly dummies, this relationship is used to forecast future prices, and expectations are formed at the time the contract is negotiated.

Table 2 gives strike frequencies, average strike duration, and average wages by year. There is a general decline in the frequency of strikes over the period considered, with strike frequency peaking in 1970 at 35 percent and reaching a low of 8 percent in 1980. Strike duration, however, peaks in 1978 and is lowest in 1970, when strikes were most frequent. The correlation between average strike duration and average strike probability by industry or by year is not significantly different from zero. Furthermore, there is no significant correlation between either strike frequency or strike duration and the negotiated wage by two-digit SIC industry or by year.

III. Estimates of the Real Wage Equation

According to the private information theory of strikes, a work stoppage is used to screen low rent firms from high rent firms, and, hence, there should be a negative correlation between wages and strikes. The absence in this sample of a correlation across industries or time periods between strikes and wages should not be interpreted as refuting the private information models. While the private information models stress that a variable unobservable to the union is important in determining the frequency and duration of strikes, they do not suggest that

variables observable to both parties are unimportant. Indeed, in common with the "total cost" model of strikes, the private information models predict that strike activity should be inversely related to factors which affect the cost of a strike.

The observable variables which influence strike activity determine the position of the wage-strike concession schedule but not the equilibrium point on the concession schedule. It is very important when attempting to test the private information models to control for all other variables which are observable by both parties. If these are not adequately controlled for, there is a danger that we may be estimating a curve mapped out by shifts in the concession schedule rather than movements along it. For example, higher unemployment may shift the concession schedule downward because workers are less likely to strike when there are fewer opportunities for alternative work, and the firm may be able to hire workers at a lower wage. The resulting spurious positive correlation between wages and strikes has nothing to do with the existence of private information.

For expository purposes we can think of dividing the wage rate into two components. The first component is a function of all the variables which determine wages or strikes and which are observable to both parties. The second component of the wage is a function of only that part of the rent that is unobservable to the union. If strikes are to be used as a screening mechanism they need only be correlated with this second component of the wage. In an empirical context, we can think of the first component of the wage as the predicted wage in a wage determination equation and the second component of the wage as the residual of the equation. The private information models predict a negative correlation between strikes and the residual from the wage equation and not between strikes and the predicted wage.

The following wage determination equation is estimated:

$$(1) \qquad \log(w_{it}) = \alpha_i + \phi_1 t + \phi_2 t^2 + \beta X_{it} + e_{it},$$

where w_{it} is the average expected real wage negotiated by bargaining pair i for a contract negotiated at time t, α_i is a bargaining pair-specific effect, t is a time trend, X_{it} is a column vector of independent variables, β is the row vector of coefficients on the independent variables, and e_{it} is an independently and identically distributed error term. Table 3 presents estimates of this equation.[15]

Columns 3, 4, and 5 of Table 3 show the results of estimating the model including a fixed effect for each bargaining pair to control for any specific company or union effects which we do not observe. For comparison with previous studies I report the results of regressions with no fixed effects and with only industry dummies in columns 1 and 2 of Table 3, respectively.[16] Nearly all the variation in the negotiated real wage can be explained by the bargaining pair effects and the time trend. Inclusion of the bargaining pair effects increases the total sum of squares of the real wage explained by the model from 20 percent to 95 percent. Column 6 presents the estimates of a model including both fixed effects for each bargaining pair and a dummy for each year.[17]

The model also includes as independent variables the national unemployment rate and the unemployment rate by state as measures of the state of the labor market, the annual rate of employment growth by industry as a measure of the state of the product market, and the average real wage rate over all industries as a measure of the alternative wage available to workers. There is some evidence to suggest that strike activity decreased during the Nixon Wage and Price Controls and so dummy variables are included for both the Nixon Controls and for the existence of Carter's Council of Wage and Price Stability (COWPS).

[15] The means of the explanatory variables are presented in Appendix Table 1 for reference.

[16] Christofides, Swidinsky, and Wilton (1980a), Vroman (1984), and Riddell (1979) use the differenced nominal wage rate but do not difference the independent variables.

[17] While there are 3,001 contracts in the complete data set, 1,015 contracts are lost due to the absence of a preceding contract in the sample. This leaves 1986 observations for the estimation.

TABLE 3—OLS ESTIMATES OF THE REAL WAGE EQUATION, DEPENDENT VARIABLE: LOGARITHM OF THE EXPECTED REAL WAGE RATE

	(1)	(2)	(3)	(4)	(5)	(6)
	No Fixed Effects Included	Industry Fixed Effects Included	Bargaining Pair Effects Included			Bargaining Pair Effects and Year Effects Included
Time Trend (×100)	0.02	0.56	0.79	0.44	0.69	–
	(0.26)[a]	(0.17)	(0.08)	(0.12)	(0.10)	
Time Trend sqd (×100)	−0.002	−0.004	−0.005	−0.003	−0.004	–
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
(Log) of Average Price Level	−0.52	−0.02	−0.13	−0.02	−0.07	−0.03
Over Previous Contract	(0.42.)	(0.23)	(0.16)	(0.17)	(0.18)	(0.18)
(Log) of Average Expected	1.17	0.23	0.35	0.19	0.15	0.03
Price Level Over Previous Contract	(0.37)	(0.25)	(0.13)	(0.15)	(0.15)	(0.16)
Average Wage—	0.45	0.70	–	1.06	0.34	−0.05
All Industries (Log)[b]	(0.55)	(0.38)		(0.27)	(0.22)	(0.35)
National Unemployment	–	–	–	0.01	–	0.01
Rate (Percent)[c]				(0.01)		(0.01)
State Unemployment	−1.19	−0.66	–	–	−0.14	–
Rate (Percent) (×100)[d]	(0.47)	(0.32)			(0.24)	
Employment Growth	−0.13	0.01	–	–	0.09	0.07
by Industry (Percent) (×100)[e]	(0.13)	(0.10)			(0.06)	(0.06)
Dummy = 1 If Contract	−0.16	−0.02	−0.01	−0.01	−0.01	−0.01
Negotiated at Scheduled Reopening	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Dummy = 1 If Negotiated	−0.09	0.04	0.09	0.06	0.07	0.06
During 1st Stage of Nixon Wage and Price Controls[f]	(0.09)	(0.06)	(0.03)	(0.03)	(0.03)	(0.05)
Dummy = 1 If Negotiated	−0.06	0.02	0.07	0.06	0.06	0.06
During 2nd Stage of Nixon Wage and Price Controls[g]	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Dummy = 1 If Negotiated	−0.06	−0.06	0.07	0.06	0.06	0.06
During 1st Stage of Carter's COWPS[h]	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Dummy = 1 If Negotiated	0.01	0.01	−0.01	−0.00	−0.00	0.01
During 2nd Stage of Carter's COWPS[i]	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
Duration of Contract	−0.25	−0.10	−0.13	−0.13	−0.13	−0.13
(Months) (×100)	(0.09)	(0.06)	(0.04)	(0.04)	(0.04)	(0.04)
Dummy = 1 If COLA	0.12	−0.01	0.03	0.03	0.03	0.03
Clause Present	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Dummy for Type of Bargaining Structure[j]						
1. Single Firm-	0.05	0.02	–	–	–	–
Multiple Plant	(0.01)	(0.01)				
2. Industry Association	−0.15	−0.01	–	–	–	–
	(0.17)	(0.03)				
3. Multiple Union	0.08	0.02	–	–	–	–
	(0.05)	(0.01)				
R-Squared	0.20	0.65	0.95	0.95	0.95	0.95

[a] Standard errors are in parentheses.

[b] The hourly wage rate for production or non-supervisory workers in all industries. *Source*: *Employment and Earnings*.

[c] The monthly unemployment rate of the civilian labor force over 16-years-old. *Source*: *Monthly Labor Review*.

[d] The annual unemployment rate by state. *Source*: *Geographic Profile of Employment and Unemployment*.

[e] The growth rate of employment over the previous year by the two-digit SIC industry. *Source*: *Employment and Earnings*.

[f] Policy in effect August 1971 to December 1972.

[g] Policy in effect January 1973 to April 1974.

[h] Policy in effect November 1978 to December 1979.

[i] Policy in effect January 1980 to August 1980.

[j] The reference bargaining structure is a single plant company and a single union.

As contracts are rarely fully indexed, unexpected inflation over the previous contract may affect wage negotiations. To allow for this "price catch-up" effect, the average and expected price level over the previous contract are included in the model. Neither price term is precisely estimated suggesting that past uncompensated changes in the price level have an insignificant impact on the wage determination process.[18]

Some wage negotiations take place at a scheduled reopening of a contract at which only wages and salaries are discussed. The incidence of strikes at contract reopenings is only 5 percent, significantly lower than the average for the whole sample, but as shown in Table 3, the wage rate negotiated at a contract reopening is not significantly different from a wage negotiated at a contract expiration. Both shorter contracts and the inclusion of a COLA clause are associated with higher negotiated wages. Columns 1 and 2 of Table 3 show that real wages are highest for firms bargaining with more than one union and lowest for an industry association bargaining with a single union.

IV. Estimates of the Effect of Strike Activity on the Real Wage

There is no clear consensus in the wage determination literature on the relationship between strikes and wages in either the United States or Canada. Henry Farber (1978), in the first empirical study of wages and strikes using U.S. micro-contract data, estimated the Ashenfelter and Johnson model for ten firms and found that although the rate of concession varied from firm to firm, it was always positive. Fudenberg, Levine, and Ruud (1985), using a similar small data set of 159 contracts for 15 firms, estimated a system of wage and strike equations suggested by a private information model of strikes. The level of sales was used as a measure of the variable unobservable to the union. Their estimated rate of concession is positive and about 6.9 percent per year.

[18]For a fuller discussion of price catchup see Christofides, Swidinsky, and Wilton (1980a).

This negative correlation between wages and strikes does not hold up when tested using larger micro data sets. Riddell (1980), using a data set of 2,360 Canadian labour contracts from the period covering 1953 through 1973, found that the occurrence of a strike had a positive effect on the nominal wage change. On the other hand, David Card (1988) found no effect of strike activity on the real wage rate for a data set of 2,258 Canadian labour contracts from the years 1964 through 1985. Similarly, Vroman found neither the occurrence of a strike nor the length of a strike had any significant effect on the nominal wage in the United States.

Estimates of the effect of the probability and duration of a strike on the negotiated real wage rate are presented in Table 4. The models estimated in columns 1, 2, 3–4, and 5 of Table 4 differ from the models estimated in columns 1, 2, 5, and 6, respectively, of Table 3 only by the addition of strike variables. The measure of strike length included in the model is the unconditional duration of the strike. This measure counts the absence of a strike as a zero-length strike.

Column 1 of Table 4 shows the estimates of a real wage equation which does not include any bargaining pair or year-fixed effects for comparison with the Vroman and Riddell studies. As Vroman found with U.S. contract data, there is no significant relationship between strikes and wages. When industry-fixed effects are included in column 2 there is actually a significant *positive* relationship between strike duration and wages. However, as shown in columns 4 and 5, in this sample there is a significant negative relationship between unconditional strike duration and the negotiated real wage when bargaining-pair effects are included. The real wage falls by about 0.03 percent for each day of the strike. The occurrence of a strike is also negatively related to the real wage, although the coefficient on the strike dummy in column 3 is imprecisely estimated. The fact that the estimated coefficients of the strike variables change from positive to negative in sign when bargaining-pair effects are added suggests that there is some omitted variable bias when only industry-fixed effects are included. The addition of year effects to

TABLE 4—ESTIMATES OF THE EFFECT OF STRIKE ACTIVITY ON THE REAL WAGE RATE, DEPENDENT VARIABLE: LOGARITHM OF THE EXPECTED REAL WAGE RATE[a]

	(1)	(2)	(3)	(4)	(5)
	No Fixed Effects Included	Industry Fixed Effects Included	Bargaining Pair Effects Included		Bargaining Pair Effects and Year Effects Included
Dummy = 1 If Strike Occurred (×100)	0.38	−0.01	−0.82	0.21	0.28
	(2.07)[b]	(0.01)	(0.73)	(0.89)	(0.87)
Unconditional Strike Duration (Days)[c] ($\times 10^4$)	0.04	3.82	–	−2.35	−3.12
	(0.03)	(1.96)		(1.21)	(1.20)
R-Squared	0.20	0.65	0.95	0.95	0.95

[a] Regressions also include all independent variables included in the respective columns of Table 3.
[b] Standard errors are in parentheses.
[c] If no strike occurred, unconditional strike duration equals zero.

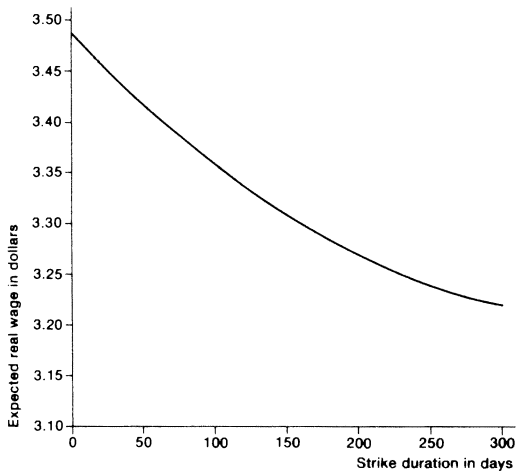

FIGURE 1. THE ESTIMATED CONCESSION SCHEDULE

the model in column 6 has little impact on the coefficients, but the model is estimated more precisely.[19]

Figure 1 illustrates the concession schedule estimated in column 4 of Table 4. After the average strike length of 41 days the negotiated wage is only about 1 percent, or about 3.5 1967 cents, lower than it would have been in the absence of a strike. The annual rate of concession is approximately 8.6 percent.

If strike duration is included in the model with a strike dummy, as in columns 4–5, the effect of the strike dummy becomes much smaller and insignificant. Thus, as predicted by the private information models, in these data the absence of a strike is equivalent to a strike of zero days in duration.

V. The Effect of Previous Wage Negotiations on the Real Wage

It has long been recognized that the outcomes of wage negotiations are highly correlated with previous wage settlements at other firms.[20] Failure to control for the effect of prior wage settlements, or "wage spillover," will at best lead to inefficient estimates of the predicted wage and, if strikes are correlated with previous wage settlements, could lead to biased estimates of the relationship between strikes and real wages.

There are two principal rationales for including previous wage settlements in a wage

[19] The model was also estimated using the complete sample of 3,001 contracts excluding the price catch-up terms from the model. The concession rate fell slightly to 0.02 percent per day, but was still significantly different from zero.

[20] See John Burton and John Addison (1977) for a review of the empirical studies of the correlation between wage settlements.

determination equation. First, there may be a variable omitted from the regression which is also correlated with wages at other firms. This may be a variable that is not observable to the union or the econometrician. If the value of this unobservable variable is correlated across firms, the results of other wage negotiations will provide valuable information to unions at firms in the same industry.

The second rationale is that wage settlements at other firms may enter directly into wage negotiations. The reservation wage is a determinant of the negotiated wage in nearly all theories of wage determination and is itself a function of wages offered at other firms. Moreover, if turnover costs are high, a profit-maximizing firm will set an optimal wage differential between its wage and the wage set by other firms competing for the same workers.[21] Also, for institutional or political reasons, workers may care about the level of their wage rates relative to those paid at other firms.

In this study five different categories are used to define the set of reference wages. In the first two categories it is assumed that the reference wages are those negotiated in the same two- and three-digit SIC industry, respectively. The third category assumes that the important reference wages are those in the same broad regional area irrespective of the industry.[22] The fourth category is defined as the set of previous wage settlements in the same two-digit SIC industry and region. Finally, I have also defined a set of reference wages consisting of previous wage settlements by the same union regardless of the industry in which they occurred.

All previous wage settlements at other firms which occurred after the ratification of the previous contract between the workers and the firm are included in the reference wage set. It is unlikely that any wages negotiated prior to this date will enter directly into the bargaining process, and, because all information is revealed at the end of negotiations,[23] no new information can be gained from settlements at other firms prior to the negotiated date of the last contract.

The simplest way to model the effect of previous wage negotiations would be to take a straight average of all the wages in the reference wage set. This would give the same weight to those wages negotiated one month ago as to those wages negotiated three years ago. To avoid this, following Louis Christofides, Robert Swidinsky, and David Wilton (1980b), a weighted average of the reference wages is used where the weight given the jth reference wage, v_j is the following quadratic function:

$$(2) \qquad V_j = \theta_0 + \theta_1 m_j + \theta_2 m_j^2,$$

where m_j is the number of months between the date the reference wage was negotiated and the date the current contract was negotiated.[24] Constraining the sum of the weights for each observation to equal one, $\Sigma v_j = 1$, it can easily be shown that

$$(3) \quad \sum_j v_j \log(w_j) = \sum_j \log(w_j)/J + \theta_1 \sum_j (m_j - \hat{m}_j)\log(w_j) + \theta_2 \sum_j (m_j^2 - \hat{m}_j^2)\log(w_j),$$

where w_j is the wage for the jth contract settlement in the reference set, J is the total number of settlements in the reference set, $\hat{m}_j = \Sigma m_j/J$ and $\hat{m}_j^2 = \Sigma m_j^2/J$. Thus the real

[21] See, for example, John Dunlop (1944).

[22] The ten regions are New England, Mid-Atlantic, East-North Central, West-North Central, South Atlantic, East-South Central, West-South Central, Mountain, Pacific, and a category which includes bargaining groups from more than one region.

[23] Although there may be a pooling equilibrium in which the wage is independent of the size of the rent. In these cases, the negotiated wage will contain no information on the size of the rent.

[24] This is just a Shirley Almon (1965) lag of the reference wages.

TABLE 5—ESTIMATES OF THE EFFECT OF STRIKE ACTIVITY AND PREVIOUS WAGE SETTLEMENTS ON THE REAL WAGE RATE, DEPENDENT VARIABLE: LOGARITHM OF THE AVERAGE EXPECTED REAL WAGE MODEL INCLUDES BARGAINING PAIR SPECIFIC-FIXED EFFECTS[a]

Model: $\log(\text{wit}) = a_i + \beta X_{it} + \partial\Sigma\log(w_{it})/J + \partial\varnothing_1\Sigma(m_j - \hat{m}_j)\log(w_j) + \partial\varnothing_2\Sigma(m_j^2 - \hat{m}_j^2)\log(w_j) + e_{it}$

Previous Wage Settlements by:	(1) Two-digit SIC Industry	(2) Two-digit SIC Industry	(3) Three-digit SIC Industry	(4) Three-digit SIC Industry	(5) Region	(6) Region	(7) 2-Digit SIC Industry and Region	(8) 2-Digit SIC Industry and Region	(9) Union	(10) Union
∂	0.17	0.18	0.17	0.17	0.08	0.10	0.10	0.12	0.08	0.08
	(0.05)[b]	(0.03)	(0.03)	(0.03)	(0.06)	(0.09)	(0.03)	(0.03)	(0.04)	(0.04)
$\varnothing_1(\times 100)$	−0.39	−0.42	−0.44	−0.55	0.43	0.41	0.90	−0.78	0.80	0.95
	(0.51)[c]	(0.48)	(0.79)	(0.77)	(0.41)	(0.38)	(1.41)	(1.27)	(0.95)	(0.94)
$\varnothing_2(\times 100)$	0.01	0.01	0.02	0.02	−0.02	−0.02	0.03	0.02	−0.02	−0.02
	(0.01)[c]	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
Dummy = 1 If Strike	−1.07	0.30	−1.16	0.26	−1.15	0.18	−1.08	0.46	−1.18	0.13
Occurs ($\times 100$)	(0.72)	(0.86)	(0.71)	(0.86)	(0.72)	(0.87)	(0.72)	(0.87)	(0.72)	(0.87)
Unconditional	–	−3.38	–	−3.47	–	−3.23	–	−3.50	–	−3.15
Strike Duration (Days)($\times 10^4$)		(1.20)		(1.19)		(1.20)		(1.21)		(1.20)
Average Value of J	68	68	6	6	26	26	28	28	10	10
R-Squared	0.96	0.96	0.95	0.95	0.95	0.95	0.95	0.96	0.96	0.96

[a] Regressions also include all independent variables included in column 4 of Table 4.
[b] Standard errors are in parentheses.
[c] Large sample standard errors estimated from the approximation: $V(\varnothing_1) = [1/\partial]^2 V(\tau) + [-\tau/\partial]^2 V(\partial) - 2[1/\partial][\tau/\partial]\text{cov}(\tau, \partial)$, where $\tau = \partial\varnothing$.
[d] J is the number of previous contracts included in the respective category.

wage model reduces to

$$(4)\quad \log(w_{it}) = \alpha_i + \beta X_{it} + \delta \sum_j \log(wj)/J + \tau_1 \sum_j (m_j - \hat{m}_j)\log(w_j) + \tau_2 \sum_j (m_j^2 - \hat{m}_j^2)\log(w_j) + e_{it},$$

where $\tau_1 = \theta_1\delta$ and $\tau_2 = \theta_2\delta$.

The results of estimating equation (4) are shown in Table 5.[25] The inclusion of wage settlements for previous contracts improves the fit of the model but has little effect on the estimates of the other coefficients. The estimates of the coefficient δ show that the average of the previous wage settlements has a positive and sometimes fairly large effect on the negotiated wage. The largest effects are from other wage settlements negotiated in the same industry. The elasticity of the real wage with respect to prior wage settlements in the same two-digit industry and three-digit industry is 0.17. The effect of previous wage settlements in the same geographical region is insignificantly different from zero. Interestingly, the reference wages defined by two-digit industry and region have a significant effect on the negotiated wage, but it is smaller than the effect of reference wages defined by two-digit industry alone.[26] There is a small positive correlation between the outcomes of successive wage negotiations by the same union.

The odd-numbered columns of Table 5 show that after controlling for the reference wages, the decline in the real wage associ-

[25] Estimates of the coefficients θ_1 and θ_2 were found by dividing the estimates of τ_1 and τ_2, respectively, by the estimate of δ. As the estimates of θ_1 and θ_2 are nonlinear functions of the OLS estimates, they are not unbiased in small samples but are still asymptotically unbiased. The large sample variances of these estimates were approximated by the delta method. See Jan Kmenta (1971, 442–44).

[26] The importance of reference wages by industry but not by geographic region was also found by Christofides, Swidinsky, and Wilton (1980b) in their study of wage spillovers in Canada.

TABLE 6—THE EFFECT OF STRIKE ACTIVITY ON THE REAL WAGE BY BROAD INDUSTRY GROUPING, DEPENDENT VARIABLE: LOGARITHM OF THE AVERAGE EXPECTED REAL WAGE

Model Includes Bargaining Pair Specific-Fixed Effects and Previous Wage Settlements by Two-Digit SIC industry[a]	(1)	(2)
Dummy = 1 If Strike Occurs (×100)	−0.66	0.26
Manufacturing—Durable-Good Industries	(1.06)[b]	(1.27)
Dummy = 1 If Strike Occurs (×100)	−0.57	2.05
Manufacturing—Nondurable Good Industries	(1.22)	(1.52)
Dummy = 1 If Strike Occurs (×100)	−3.33	−2.81
Nonmanufacturing Industries	(1.57)	(1.91)
Unconditional Strike Duration (Days) ($\times 10^4$)	–	−2.08
Manufacturing—Durable-Good Industries		(1.52)
Unconditional Strike Duration (Days)($\times 10^4$)	–	−6.66
Manufacturing—Nondurable Good Industries		(2.41)
Unconditional Strike Duration (Days)($\times 10^4$)	–	−1.54
Nonmanufacturing Industries		(3.17)
R-Squared	0.96	0.96

[a]Regressions also include all independent variables present in column 4 of Table 3.
[b]Standard errors are in parentheses.

ated with the occurrence of a strike increases for each category of reference wages, yet it is still not significantly different from zero.[27] Similarly, comparing the even-numbered columns of Table 5 to column 4 of Table 4 shows that there is a small increase in the rate of concession when previous wage settlements from each of the five categories are included. The rate of concession is largest—3.5 percent per 100 days of strike—when previous wage settlements by industry and region are included in the model. Although there is some evidence of omitted variable bias when previous wage settlements are not included, this bias is not large enough to change the qualitative nature of the results.[28] The negative coefficient on unconditional strike duration implies that strikes occur more frequently and last longer when the wage offered by a firm is lower than the "going" rate for that industry and region. The strike ensures that the management is not bluffing when it claims that there are firm-specific problems which prevent it from offering a higher wage.

Table 6 provides a breakdown of the relationship between strikes and wages by broad industry category. The occurrence of a strike and the length of a strike have a negative effect on the real wage in each of the industry groups. In nonmanufacturing industries it is the occurrence of a strike rather than the length of the strike that matters. A wage negotiated after a strike of any length is about 3 percent lower than a wage negotiated without a strike. The relative unimportance of the effect of the duration of a strike may be because in nonmanufacturing industries there is less variation in the length of the strike. The effect of strike duration on the real wage is largest in nondurable-goods manufacturing industries. The rate of concession is twice as fast in these industries as it is for all industries together. Neither the occurrence of a strike nor strike length is significantly correlated with the real wage in durable-goods manufacturing industries.

[27]The inclusion of the strike variables has no effect on the coefficients of the reference wage variables.

[28]The bias may be the result of omitting a suitable measure of the workers' alternative wage from the wage determination equation. Strike models suggest that, since the cost of a strike to the workers falls with a rise in the alternative wage, there should be a positive correlation between strikes and the alternative wage. If reference wages are a good proxy for the alternative wage, omitting them from the wage determination equation could impart the positive bias to the coefficient on the strike variable that was found.

TABLE A1—MEANS OF VARIABLES USED IN THE REGRESSIONS

Average Expected Real Wage	$3.48
Average Price Level Over the Past Contract (1967=100)	167
Average Expected Price Level Over the Past Contract (1967=100)	166
Average Real Wage for All Industries	$2.84
National Unemployment Rate	6.5 Percent
Unemployment Rate by State	6.7 Percent

VI. Conclusion

The major finding of this paper is that both the occurrence of a strike and the length of a strike are negatively correlated with the unpredicted component of the real wage. A strike of 100 days is associated with a decrease in the real wage of about 3 percent. This result is robust to the inclusion in the model of wages previously negotiated at other firms. This finding provides support for the theory that strikes are used as information revealing tools rather than occurring as a result of mistakes during negotiations.

REFERENCES

Abowd, John M., "Collective Bargaining and the Division of the Enterprise," NBER Working Paper No. 2137, January 1987.

Almon, Shirley, "The Distributed Lag between Capital Appropriations and Net Expenditures," *Econometrica*, January 1965, *33*, 178–96.

Ashenfelter, Orley and Johnson, George E., "Bargaining Theory, Trade Unions, and Industrial Strike Activity," *American Economic Review*, March 1969, *59*, 35–49.

Burton, John and Addison, John T., "The Institutionalist Analysis of Wage Inflation: A Critical Appraisal," *Research in Labor Economics*, 1977, *1*, 333–76.

Card, David, "Strikes and Wages: A Test of a Signalling Model," unpublished research paper, Princeton University, February 1988.

Christofides, Louis N., Swidinsky, Robert and Wilton, David A., (1980a) "A Microeconometric Analysis of the Canadian Wage Determination Process," *Economica*, May 1980, *47*, 165–78.

_____, _____ **and** _____, (1980b) "A Microeconometric Analysis of Spillovers within the Canadian Wage Determination Process," *Review of Economics and Statistics*, May 1980, *62*, 213–21.

Crampton, Peter C., "Bargaining with Incomplete Information: An Infinite Horizon Model with Two-Sided Uncertainty," *Review of Economic Studies*, October 1984, *51*, 579–93.

Dunlop, John T., *Wage Determination under Trade Unions*, New York: Augustus M. Kelley, 1944.

Farber, Henry S., "Bargaining Theory, Wage Outcomes, and the Occurrence of Strikes: An Econometric Analysis," *American Economic Review*, June 1978, *68*, 262–71.

Fudenberg, Drew, Levine, David and Ruud, Paul A., "Strike Activity and Wage Settlements," unpublished research paper, University of California at Berkeley, May 1985.

Hayes, Beth, "Unions and Strikes with Asymmetric Information," *Journal of Labor Economics*, January 1984, *2*, 57–83.

Hendricks, Wallace E. and Kahn, Lawrence, M., "Wage Indexation in the United States, Cola or Uncola?," Cambridge, MA: Ballinger, 1985.

Hicks, John R., *The Theory of Wages*, New York: Macmillan, 2nd ed., 1963.

Hirtle, Beverly J., "Interfirm Information, Strikes, and Union Bargaining Behavior," unpublished research paper, MIT, October 1985.

Kennan, John, "Pareto Optimality and the Economics of Strike Duration," *Journal of Labor Research*, Spring 1980, *1*, 77–94.

_____, "The Economics of Strikes," in Orley Ashenfelter and Richard Layard, eds., *Handbook of Labor Economics*, Amsterdam: North-Holland, 1986, ch. 19.

Kmenta, Jan, *Elements of Econometrics*, New York: Macmillan, 1971, 442–44.

McConnell, Sheena, "An Empirical Study of Strike Activity in the United States," unpublished doctoral dissertation, Princeton University, January 1988.

Morton, Sanford, "The Optimality of Strikes

in Labor Negotiations," Discussion Paper No. 83/7, Tulane University, April 1983.

Reder, Melvin N. and Neumann, George R., "Conflict and Contract: The Case of Strikes," *Journal of Political Economy*, October 1980, *88*, 867–86.

Riddell, W. Craig, "The Empirical Foundations of the Phillips Curve: Evidence from Canadian Wage Contract Data," *Econometrica*, January 1979, *47*, 1–24.

_____, "The Effects of Strikes and Strike Length on Negotiated Wage Settlements," University of British Columbia Discussion Paper No. 80-2, January 1980.

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

_____, (1987a) "An Empirical Test of an Asymmetric Information Model of Strikes," *Journal of Labor Economics*, April 1987, *5*, 149–73.

_____, (1987b) "Testing a Strategic Model of Bargaining Using Stock Market Data," unpublished research paper, Yale University, May 1987.

Vroman, Wayne, "Wage Contract Settlements in U.S. Manufacturing," *Review of Economics and Statistics*, November 1984, *66*, 661–65.

U.S. Department of Labor, Bureau of Labor Statistics, Washington: *Current Wage Developments*, various issues.

_____, Washington: *Employment and Earnings*, various issues.

_____, Washington: *Geographic Profile of Employment and Unemployment*, various issues.

_____, Washington: *Monthly Labor Review*, various issues.