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ABSTRACT

Bargaining models suggest that firm-specific variables play an important role in wage determination. Yet previous empirical studies of wage determination have largely ignored these variables. Our analysis of a large panel data set of U.S. wage contracts suggests that firm-specific variables suggested by bargaining models, such as the value of sales, the capital-labor ratio, and the financial liquidity of the firm, are important determinants of negotiated real wages.

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Institutional models of wage determination in the tradition of Dunlop (1944) and Hicks (1963) assign a central role to firm-specific variables. More recently, bargaining models of wage determination emphasize firm-specific variables which affect union and firm "threat points" -- the union's and employer's fallback positions in the event of a strike or lockout. Despite the theoretical importance of firm-specific factors in wage determination, previous empirical studies of wage determination have largely ignored these variables.[1]

This paper tests for the importance of firm-specific variables in the determination of the negotiated wage using a large panel data set of U.S. labor contracts. We motivate the empirical specification of the wage model using a simple Nash bargaining model. This bargaining model suggests that sales, the alternative wage, and the union's and firm's threat point should be included in an empirical wage model. We use the level of inventories, the capital-labor ratio, and the financial liquidity of the firm to proxy the firm's threat point. The unemployment rate and the average industry wage is used to proxy the union's threat point.

This study also differs from previous studies by using the wage level rather than the wage change as the dependent variable in the wage equations. Bargaining models predict that it is the real wage level and not the change in the nominal wage that the firm and union care about. Most previous wage studies using micro data have estimated the effect of the level of unemployment on the nominal wage change -- the Phillips curve.[2]

In a final departure from the previous literature, we include a fixed effect for each firm-union pair in the model. The literature on unexplained inter-industry and firm-level wage differentials (Kreuger and Summers, 1988 and Brown *et al.*, 1990) suggests that it is important to control for unobserved sources of variation in the wage. Controlling for fixed effects allows us to isolate the effects of the firm-specific variables on the outcome of wage negotiations.

I. A Bargaining Model

Since the wage is determined by bargaining between two monopolies the outcome is indeterminate. One approach to solving this problem is to postulate axioms and find a solution which satisfies these axioms. The Nash solution is a unique solution which satisfies certain reasonable axioms. It is found by maximizing the product of each agent's utility over his or her threat point. Binmore, Rubinstein, and Wolinsky (1986) show that the Nash solution can also be rationalized as the outcome of a strategic, non-cooperative bargaining game in which players make alternative offers and agreement is reached because a delay in reaching an agreement is costly. This suggests that the threat point of each party should be interpreted as the utility they achieve during a work stoppage.

To illustrate the role of firm-specific variables in wage determination, consider a model in which the firm is assumed to maximize profit,

$$\Pi(A,w,L) = S(A,L) - wL \tag{1}$$

where w is the wage, L is employment, and S(A,L) is a revenue or sales function which satisfies $S'_L \geq 0$ and $S''_{LL} \leq 0$. The parameter, A, represents shifts in the sales function due to a change in demand or productivity. The union has a utility function which depends on w, L, and the alternative wage available to union members, w_a,

$$U(w,w_a,L) \tag{2}$$

and $U_w \geq 0$, $U_{wa} \leq 0$, and $U_L \geq 0$. The Nash bargaining solution is found by solving,

$$\underset{w}{\text{Max}} \quad [U(w,w_a,L) - U_o][\Pi(A,w,L) - \Pi_o] \tag{3}$$

where U_o is the union's utility and Π_o is the firm's profit during a work stoppage. The first order condition is

$$U(w,w_a,L) - U_o = \Pi(A,w,L) - \Pi_o = S(A,L) - wL - \Pi_o. \tag{4}$$

The form of the wage equation implicit in equation (4) depends on the specification of the union utility function and the firm's sales function. As an example, if $U=(w - w_a)L$, and $S=A\cdot S(L)$,

then

(5) $$w = 1/2\,[w_a + A \cdot S(L)/L + U_o/L - \Pi_o/L].$$

We use this example to illustrate two properties of Nash bargaining models of wage determination. First, the alternative wage and the value of sales enter the wage equation positively. Intuitively, the wage increases with the minimum the union will accept--its alternative wage--and the maximum the firm will pay -- sales per employee. Second, the wage is increasing in the union's threat point and decreasing in the firm's threat point. The party which is best able to withstand a breakdown in negotiations will have the advantage during bargaining.

In order to implement the model empirically, we must specify the determinants of the firm's and union 's threat points (U_o and Π_o). The firm's threat (Π_o) should vary positively with its holdings of inventories and liquid assets since these can be used to buffer the firm against the effects of a strike. As the firm must continue to pay rental on its capital equipment during a strike, the more capital-intensive the firm, the lower its profits during a strike.

The union's threat point (U_o) depends on the opportunities available to striking workers. The higher the unemployment rate, the less likely a striking worker will be able to find a temporary job and the more likely other members of the striker's family will be unemployed. The cost of a strike to the worker will also depend on the wage they can earn in any job they can find during a strike. Hence, the union's threat point should depend positively on alternative wages and negatively on the unemployment rate.

II. A Description of the Data

Information on U.S. labor contracts is available from the Current Wage Developments (CWD) Contract tape, provided by the Bureau of Labor Statistics (BLS). This tape lists private sector contracts which cover 1,000 or more workers. It gives the name of the firm and the union involved in the negotiations, the dates at which negotiations took place, and the number of workers

covered by the contract.

The BLS CWD bulletin details all wage changes, including the changes that occur during the life of the contract, so we were able to calculate the change in the wage at each month in the contract. Unfortunately, the CWD does not provide wage levels. To convert the wage change into a wage level we found a 'base' wage for each firm-union pair. We added the wage changes to this 'base' wage to find the wage level at every point in time. For nearly half the contracts the base wage was found from an independent contract listing published by the Bureau of National Affairs. For the remainder of the contracts, we used annual hourly earnings for the appropriate 4-digit Standard Industrial Classification (SIC) category (published in Employment and Earnings) as the base wage level.[3]

Accounting information about the firms in the sample was taken from Standard and Poors' Industrial Compustat. This source provides information on U.S. firms which trade on the New York, American, and some regional stock exchanges. The fact that only large firms trade on these stock exchanges imposes a restriction on the set of contracts with useable data. About 30 percent of the CWD contracts were negotiated between large unions and groups of small firms for whom financial data were unavailable.[4] The average firm in our sample has annual sales of 2,301 million (1967) dollars and 87,000 employees.

The wage equation is estimated using data from approximately 1,300 contracts negotiated in the U.S. between 1970 and 1981. They cover 28 different 2-digit SIC industries. The contracts were negotiated by 470 different firm-union bargaining pairs. The sample includes, on average, about three contracts per pair.

III. Measuring the Wage

The average contract in the sample lasts just under three years. Typically, a contract specifies an initial wage increase effective soon after the contract is signed, and a number of deferred, non-

contingent wage increases. About half of the contracts in the sample include cost of living adjustment (COLA) payments contingent on changes in the Consumer Price Index (CPI).

Deferred increases and COLA payments do not usually fully compensate for price inflation, so both the nominal and the real wage can change considerably during the contract. The real wage typically follows a saw-tooth pattern, increasing after each deferred payment and then falling due to inflation. Given this sort of pattern the correct measure of 'the' real wage to use in a wage determination model is not obvious.

The earlier wage determination literature used the difference between the nominal wage at the end of the contract and the nominal wage at the end of the previous contract as the dependent variable. The annualized percentage change in expected prices was included as an independent variable to control for expected inflation. The problem with this measure of the wage is that it is sensitive to the distribution of deferred payments throughout the contract and to the timing of the price changes.

We assume that the negotiators are interested in the expected discounted value of the stream of real wage payments over the life of the contract.[5] If the degree of discounting is negligible, the average of the nominal wage at each month of the contract deflated by the expected price level is a good approximation to the expected value of the real wage in a contract with no COLA clause.[6] We assume that the price level can be adequately forecast using twelve monthly lags and dummy variables for each month. This model captured over 90 percent of the variation in prices over the sample period.

The average expected real wage negotiated by bargaining pair i at time t, w_{it}^1, is given by

$$(6) \qquad w_{it}^1 = 1/S_{it}^e \left[\sum_{s=1 \text{ to } S_{it}^e} (W_{its}/p_s^e)\right]$$

where W_{its} is the nominal wage at s months after the negotiation of the contract (i.e. at t+s), p_s^e is the expectation of the CPI at time t+s formed at time t, and S_{it}^e is the expected length of the

contract.

If a COLA clause exists, the nominal wage, W_{its}, also depends on expected prices. We calculated the expected nominal COLA payments by substituting expected price changes into the COLA rule. For the majority of contracts in this sample the COLA rule is unknown and so the expected nominal COLA payments are calculated from an estimate of the COLA rule.[7] The expected duration of the contract, S_{it}^{e}, is measured as the number of months between the effective and expiration date of the contract.[8]

To test the sensitivity of the estimates of the wage equation to the choice of the dependent variable, we calculated two other measures of the wage. The first of these is the average realized real wage over the actual length of the contract, wit^2,

$$(7) \qquad w_{it}^{2} = 1/S_{it} \sum_{s=1 \text{ to } S_{it}} (W_{its}/p_s)$$

where W_{its} is the realized nominal wage and S_{it} is the number of months between the effective date of the current contract and the effective date of the next contract. If price expectations are unrealistic, or if the duration of the contract is different than expected, the realized wage could be different than the wage that both parties expect at the time the contract is signed. But, this measure does not require any assumptions about expected prices or estimates of the COLA rule.

The second alternative measure of the wage is the real wage at the beginning of the contract.[9] A problem with this measure is that many contracts do not have ex-ante full inflation protection and so the initial real wage is set at a level higher than the average expected wage level.

In this sample, the mean average expected wage is 3.20 dollars, only one cent higher than the mean average realized wage. But in seven of the twelve years, the realized wage was lower than the expected wage. The real wage at the beginning of the contract is higher on average at 3.63 dollars. This suggests that a high proportion of contracts were front-loaded -- the initial real wage is higher than the average real wage.

IV. Determinants of the Real Wage

We estimate the following wage model:

$$w_{jkt} = a_{jk} + B_1X_t + B_2X_{kt} + B_3X_{jkt} + u_{jkt}$$

where w_{jkt} is the logarithm of a measure of the wage negotiated between union j and firm k at time t; X_t includes economy-wide time-varying variables and year dummies; X_{kt} includes firm-specific time-varying variables; X_{jkt} includes contract-specific variables; B_1, B_2, and B_3 are parameters; and u_{jkt} is an error. A fixed effect for each bargaining pair, a_{jk}, is included to control for firm and union-specific factors which do not vary over time.

The firm-specific data are collected from firms' annual accounts. Ideally, we would like to use the most recent data that was available to the parties at the time of the negotiations. However, to avoid problems of simultaneity between wages and the independent variables, the data are taken from the accounts of the latest full financial year before the negotiations.[10]

Larger firms are likely to have larger sales, profits, inventories, and liquid assets. In the regressions reported below, we divide all financial variables by the number of employees (in the latest full financial year before the negotiations) so that the effect of firm size can be disentangled from the effects of other variables. All financial variables are measured in real 1967 dollars.

Since the union and firm may bargain over both wages and employment, we include the employment level in the financial year which includes the date of negotiation in the model and estimate the model using Two Stage Least Squares (TSLS). Current employment is instrumented using the third lag of employment, the producer price index, and the number of employees covered by the contract. These instruments explain about 11 percent of the within bargaining pair variation in employment. The hypothesis that they are valid instruments could not be rejected at a 95 percent significance level.[11]

Table 1 presents estimates of the wage model with the logarithm of the average expected real

wage as the dependent variable. We present estimates of a model that includes sales but not the other firm-specific variables in column 1; a model which includes all firm-specific variables except sales in column 2; a model with all firm-specific variables in column 3; and a model with profits instead of sales in column 4.

(a) The Role of Sales in Wage Determination

Sales may affect the negotiated wage in a number of ways. First, as the Nash model suggests, sales proxy for the size of the rent to be divided between the two parties -- the greater the sales, the more the firm is able to pay, and the higher the wage. This is also consistent with a more institutional model in which firms with high rents are expected to pay higher wages (Akerlof, 1984). Second, the level of sales may also affect the firm's threat point -- when sales are high, the firm has more to lose during a strike and so is more likely to concede to a higher wage.

The estimates in Table 1 suggest that sales can explain a significant proportion of the within bargaining-pair changes in real wages over time. Our estimates suggest that, at the average level of sales, a 10 percent increase in sales per employee (3,200 dollars), increases the real wage by just under 1 percent. This result is robust to various changes in the specification of the model.[12]

The maximum wage a firm can pay depends on predicted sales over the life of the contract and not current sales. But, measures of the predicted and actual sales averaged over the life of the contract when included in the model had no effect on the real wage.[13] The fact that current, but not predicted, sales affect the negotiated wage suggests that the level of sales affects wages via its effect on the cost of a strike to the firm and not via its effect on the firm's ability to pay a higher wage.

Profits have a negative but insignificant effect on the negotiated wage (see column 4 of Table 1). Hamermesh (1970) also found profits had little effect on wages in a sample of 180 wage negotiations. The lack of correlation between profits and wages may be because of measurement

error. We can only measure accounting profits which may bear little resemblance to economic profits or the size of the rent.

(b) Determinants of the Firm's Threat Point

Firms with inventories of finished products are in a better position to meet sales orders and delivery dates during a strike than firms which produce to order. Hence, a firm entering negotiations at a time of high inventories of finished goods should be able to negotiate a lower wage. Unfortunately, Compustat generally records only the total value of inventories including raw materials and work-in-progress as well as finished goods. Our estimates suggest that the negotiated wage is higher at times when inventories per employee are high, although the estimate of the coefficient on inventories is quite sensitive to the specification of the model and is not statistically significant.

If the level of inventories and the negotiated wage are both correlated with a variable not included in the model, the estimated coefficient on inventories will be biased. But, if the presence of inventories strengthens the position of the firm at negotiations, the firm has an incentive to stockpile finished goods before negotiations begin. So we can obtain indirect evidence on the role of inventories by examining the pattern of inventory accumulation. We use the complete twelve year accounting history of the firm to estimate a model of inventories in which the value of inventories is regressed on a fixed effect for each firm and an indicator for the year before negotiations take place. The firm fixed effects were included to capture determinants of inventories, specific to each firm, that do not change over time. Estimates of this model suggest that the level of inventories increases by 4 percent in the fiscal year before the new contract was negotiated.[14]

The firm's threat point may also depend on the liquidity of the firm. During a strike, receipts fall but the firm may still face large fixed costs such as management salaries, interest payments, and capital expenditures. In the absence of a perfect capital market, the liquidity of the firm will affect the firm's ability to meet these obligations. Hence, the greater the liquidity of the firm, the greater

its bargaining strength, and the lower the negotiated wage. Nickell and Wadhwani (1990), however, argue that the greater the liquidity of the firm, the lower the probability of bankruptcy, and the greater the ability of the firm to pay a higher wage.

Table 1 shows that a firm entering wage negotiations with larger reserves of liquid assets per employee (defined as cash, bank deposits, and short term investments) can negotiate a lower wage. This effect is statistically significant when the level of sales is included in the model, but small -- an increase in liquid assets per employee of about 10 percent (200 dollars) lowers the wage by about 0.2 percent. Controlling for firm-specific fixed effects, the level of liquid assets increases in the year before contract negotiations by about 3 percent (although the standard error is 2 percent). This suggests that the liquidity of the firm affects wages via its impact on the firm's threat point rather than its ability to pay a higher wage.

The estimates in Table 1 also suggest that a more capital-intensive firm is in a worse negotiating position that a less capital-intensive firm. An increase in the capital-labor ratio of about 10 percent (1,600 dollars) increases the real wage by between 0.6 and 0.9 percent.

(c) Determinants of the Union's Threat Point

To capture the effect of the alternative wage, we include a variable which averages the wage previously negotiated by firms in the same industry in our sample.[15] This variable will pick up any industry specific effect on alternative wages not picked up by the year dummies. Table 1 shows that the industry wage level is an important determinant of the real wage. An increase in wages previously negotiated in the industry by 10 percent (35 cents) increases the real wage by nearly 3 percent.

Our results suggest that negotiated wages are lower when aggregate unemployment is higher. An increase in the unemployment rate by 10 percent decreases the negotiated wage by about 1.5 percent. This result is consistent with previous studies using North American contract data (Vroman, 1984, Christofides and Oswald, 1988, and Card, 1990).

(d) Contract Specific Determinants of the Real Wage

As contracts are rarely fully indexed, there may be an ex-post adjustment of the real wage to compensate for the loss of real income due to inflation during the previous contract. This is known as "catchup" and is often discussed explicitly in wage negotiations. To capture the effect of catchup, we include the difference between the average and expected CPI over the previous contract. The effect of catchup is small but precisely estimated. If the CPI is one point higher than expected over the previous contract, the wage increases by just less than 1 percent.

The number of employees in the firm has no statistically significant impact on the wage once we control for bargaining-pair fixed effects.

(e) Sensitivity of Results to Alternative Measures of the Wage

To show the robustness of the estimates, we present estimates of the wage model using the realized average wage as the dependent variables in the first two columns of Table 2, and the initial wage as the dependent variable in the last two columns of Table 2. The models presented in columns 1 and 3 include sales, while the models presented in columns 2 and 4 include profits instead of sales.

If actual and expected prices differ, using the realized rather than the expected wage will introduce measurement error into the model. Much of the difference between expected and actual prices will be captured by the year dummies, but the extent to which price surprises affect the real wage will depend on the degree of inflation protection provided by the contract. To control for the degree of inflation protection, we include a measure of the COLA elasticity -- the proportionate change in the nominal wage divided by the proportionate change in the CPI.

If a contract specifies full ex-ante protection against inflation, the real wage at the beginning of the contract will be a good approximation to the average expected real wage. However, most contracts have less than full inflation protection and compensate by front-loading the contract. The

extent to which contracts are front-loaded depends on the length of the contract, the number of payments, and the COLA elasticity.[16] These three variables are included in the model shown in columns 3 and 4 of Table 2.

The estimates of the determinants of the realized average real wage are remarkably similar to the estimates of the determinants of the expected average real wage shown in column 3 of Table 1. This suggests that our results are not sensitive to the assumptions made about price expectations.

Our estimates of the determinants of the initial real wage do, however, differ from those of the average wage. The level of sales, the financial liquidity of the firm, the capital-labor ratio, the unemployment rate, and the level of industry wages all have weaker effects on the initial real wage than on either measure of the average real wage. And while the level of inventories has a weak positive effect on the average wage, it has a negative effect on the initial wage. The level of profits, which has no effect on the average wage, increases the initial wage. The effect of catchup on the initial real wage is smaller than its effect on the average wage measures suggesting that catchup takes the form of deferred and COLA payments rather than a higher initial wage.

The differences between wage equations estimated using the initial wage and those estimated using either measure of average wages over the life of the contract highlight the importance of accounting for changes in nominal wages during the contract.

V. Conclusion

The principal finding of this paper is that firm-specific variables such as sales, the financial liquidity of the firm, and the capital-labor ratio are important determinants of negotiated wages in the unionized sector. Our findings provide some support for a simple Nash bargaining model in which the wage depends on the amount that each party will lose if negotiations break down.

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Endnotes

1. An exception is Nickell and Wadhwani (1990) which examined the effect of financial variables on wage determination in the U.K..

2. For example, Hamermesh (1970), Riddell (1979), Christofides *et al.* (1980a, 1980b), Mitchell (1980), Kaufman and Woglom (1984), and Vroman (1984). Christofides and Oswald (1988), McConnell (1989), and Card (1990) estimated models of the wage level.

3. An appendix available from the authors gives more details of the construction of the wage.

4. For example, The Ladies Handbag Manufacturers and the Window Cleaning Employers were employers excluded from our sample because of lack of firm-specific data.

5. Previous studies found the coefficient on expected inflation to be about 1 suggesting that money illusion is not important.

6. McConnell (1989) uses this measure of the negotiated wage.

7. The appendix available from the authors gives details of the estimation of the COLA rule.

8. Six percent of our contracts are scheduled to have negotiations reopen at a date before their expiration date. For these contracts the expected length of the contract is the number of months between the effective date and the renegotiation date.

9. Christofides and Oswald (1988) use a similar measure of the wage but add the deferred non-contingent wage payments to the initial wage level.

10. The results did not differ substantially when we estimated the wage models using data averaged over the two years before the contract negotiation.

11. These instruments passed a test of overidentification which involved regressing the residuals from the TSLS regression on the instruments. The R-squared from this regression multiplied by the degrees of freedom is distributed as a Chi-square with degrees of freedom equal to the number of overidentifying restrictions.

12. These alternative specifications include (1) including strike and contract duration as independent variables, (2) excluding the 20 percent of all contracts which involved a strike, (3) estimating separate equations for durable and non-durable goods industries, and (4) replacing firm-union fixed effects with industry fixed effects. As the calculation of the expected average wage requires an estimate of the COLA rule, we estimated a model with only contracts with no COLA. The estimate of the impact of sales in this subsample is smaller (0.143) and has a higher standard error (0.115).

13. We estimated predicted sales from a forecasting equation using three lags of past sales. The estimate of the effect of average predicted sales was -0.04 with a standard error of 0.14.

14. The standard error is 1 percent.

15. In constructing these variables we followed Christofides, *et al.* (1980b).

16. These are all endogenous variables, but we were unable to find suitable instruments for them. The results in Table 1 and columns 1 and 2 of Table 2 are robust to the inclusion of these variables.

Table 1

Firm-Specific Determinants of the Real Wage [a]

	Dependent Variable: Log. of the Average Expected Real Wage			
	(1)	(2)	(3)	(4)
Sales per Employee (100,000 1967 $)	0.209 (0.059)[b]	-	0.203 (0.065)	-
Profit per Employee (100,000 1967 $)	-	-	-	-1.164 (0.599)
Inventories per Employee (100,000 1967 $)	-	0.398 (0.367)	0.018 (0.386)	0.543 (0.368)
Liquid Assets per Employee (100,000 1967 $)	-	-0.902 (0.312)	-1.181 (0.322)	-0.557 (0.341)
Capital-Labor Ratio (100,000 1967 $)	-	0.447 (0.123)	0.365 (0.120)	0.540 (0.118)
Industry Wage (log)	0.271 (0.052)	0.282 (0.052)	0.266 (0.051)	0.279 (0.051)
Unemployment (log)	-0.153 (0.060)	-0.147 (0.060)	-0.166 (0.059)	-0.155 (0.059)
Catchup	0.007 (0.001)	0.007 (0.002)	0.007 (0.002)	0.007 (0.002)
Employment [c] (100,000)	0.024 (0.113)	0.040 (0.106)	0.043 (0.030)	0.043 (0.030)
R-squared	0.263	0.271	0.278	0.275
Degrees of Freedom	1,293	1,291	1,290	1,290
F-test of significance of firm specific variables [d]	10.08	9.21	9.65	8.64

Notes:

a. All variables are measured as deviations from means. The models are estimated using TSLS. Year dummies are included in each model.

b. Standard errors are in parentheses.

c. Employment is instrumented using the third lag of employment, the producer price index, and the number of employees covered by the contract as instruments.

d. Tests the joint hypothesis that the coefficients on the firm-specific variables are zero. This hypothesis is strongly rejected in all models.

Table 2

Determinants of Alternative Measures of the Real Wage [a]

	Dependent Variable:			
	Realized Average Real wage		Initial Real Wage	
	(1)	(2)	(3)	(4)
Sales per Employee (100,000 1967 $)	0.201 (0.065)[b]	-	0.115 (0.027)	-
Profit per Employee (100,000 1967 $)	-	-1.288 (0.593)	-	0.660 (0.250)
Inventories per Employee (100,000 1967 $)	0.132 (0.384)	0.669 (0.366)	-0.323 (0.163)	-0.151 (0.971)
Liquid Assets per Employee (100,000 1967 $)	-1.152 (0.319)	-0.498 (0.338)	-0.537 (0.135)	-0.523 (0.143)
Capital-Labor Ratio (100,000 1967 $)	0.405 (0.119)	0.585 (0.117)	0.046 (0.050)	0.078 (0.050)
Industry Wage (log)	0.262 (0.050)	0.275 (0.050)	0.113 (0.021)	0.116 (0.021)
Unemployment (log)	-0.137 (0.059)	-0.126 (0.059)	-0.052 (0.025)	-0.043 (0.025)
Catchup	0.008 (0.002)	0.007 (0.002)	0.003 (0.001)	0.003 (0.001)
Employment [c] (100,000)	0.050 (0.030)	0.001 (0.0003)	-0.017 (0.013)	0.0002 (0.0001)
COLA Elasticity	0.106 (0.023)	0.110 (0.023)	-0.030 (0.010	-0.027 (0.010)
Number of Payments	-	-	-0.005 (0.002)	-0.005 (0.002)
Contract Duration (months)	-	-	0.001 (0.0004)	0.001 (0.0004)
R-squared	0.265	0.262	0.231	0.225
Degrees of Freedom	1,289	1,289	1,287	1,287
F-test of significance of firm specific variables [d]	12.78	12.04	7.78	6.53

Notes: See Table 2.

Data Appendix: Calculation of the Average Expected Real Wage

This appendix describes in detail the construction of the average expected real wage measure used in this study. It also gives a listing of data definitions and sources as well as the means and standard deviations for all the variables listed in this study.

Wage changes for most of the contracts listed on the situation tape are published 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 effective together with non-contingent deferred wage increases effective later in the contract. Many contracts 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 contingent 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. For nearly 40 percent of the bargaining pairs a base wage level was available from contract and wage data collected by the Bureau of National Affairs (BNA). Wage levels for the remaining bargaining pairs were calculated from the hourly wage in their respective four-digit SIC industry (taken from Employment and Earnings). The complete history of wage levels for each bargaining pair was calculated by adding the wage changes to the base wage level if the change occurred after the effective date for the base wage level and subtracting the wage changes from the base wage level otherwise.

1. Specification of the Negotiated Real Wage Rate

The wage rate that should matter to the parties in a contract negotiation is the average expected real wage rate over the contract period. In the simplest cases, the expected real wage rate is just the nominal wage level deflated by the expected price level. In the following three situations, however, this will not be correct.

(i) Contingent Wage Increases

Firstly, if there are wage increases contingent on price increases then the expected nominal wage will depend on expected prices. The correct method to calculate the expected contingent nominal wage increases is to substitute expected prices into the actual COLA formula specified by the contract. Unfortunately, while the CWD publishes realized COLA payments, it rarely gives the exact COLA formulas which are, in practice, often rather complicated. Instead, a linear COLA formula is estimated for each contract with a COLA clause using the realized COLA payment and the change in the CPI-W (1967=100) over the two months prior to the preceding COLA payment. The two month lag is used because the current CPI is not published immediately. While some contracts backdate their COLA payments so that they can be based on the current price level, using lagged prices resulted in a better fit of the linear COLA equations.

The linear COLA rule is a good approximation to most COLA formulas. The exceptions are those COLA formulas that specify a limit, or "cap," on the total COLA payment that can be awarded and those that specify that the price index must reach a certain level, or "trigger," before a COLA payment is made.[1] Hendricks and Kahn (1985), however, found that over 63 percent of the contracts with COLA payments in their large sample of contracts contained no maximum or minimum

[1]In a few contracts a cap or trigger was clearly in effect and binding. For those COLA payments truncated by a cap the expected COLA payment was set equal to the realized COLA payment.

COLA payment. When the COLA payment is recorded in the CWD in cents, I assume that the actual COLA formula is in terms of absolute changes in the price index and estimate the COLA rule using cent increases in wages and absolute increases in the price index. Similarly, when the COLA payment is recorded as a percentage wage change, I estimate the COLA rule using percentage wage and price increases.[2]

The average coefficients for the two COLA rules estimated are given below. The standard deviations of the coefficients are given in parentheses.

COLA payment in cents= 3.3 (9.5) + 2.3 (1.5) * absolute change in price index

COLA payments in percent= 0.4 (1.4) + 62.1 (65.0) * percent change in price index

Although the estimated coefficients differ quite considerably from contract to contract, the average coefficients seem reasonable.[3]

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 COLA formula. Price expectations are formed at the time the contract is negotiated, so some price forecasts are made over three years in advance. Expected future prices are estimated on the assumption that the price level can be explained by twelve lags plus monthly dummies, and that knowledge of this relationship is used to forecast future

[2]COLA payments recorded in cents were much more frequent, occurring in 89% of the contracts. In the few cases in which the COLA payment is given in two parts -- a percent increase plus a cent increase -- the realized wage increase was converted to a percentage increase.

[3]A "typical" COLA formula pays one cent for between a 0.25 and 0.4 point movement in the price index. See Hendricks and Kahn (1985) for a good discussion of the different types of COLA contracts.

prices.[4]

The extent to which realized and expected COLA payments differ depends primarily on the difference between expected and actual future prices. During 1974, for example, prices were higher than expected and a realized COLA payment was on average two cents more than expected. On the other hand, in 1983, when prices actually fell, estimated COLA payments remained positive while many realized COLA payments were negative. The total COLA payment per contract with a COLA clause is, on average, only five cents higher than was expected, although this varies from $1.54 higher to $1.74 lower for some contracts.

(ii) The actual and expected length of the contract

Secondly, some contracts are replaced before their expiration date. The calculation of the average real wage will be affected and more seriously, some expected deferred wage increases may not be realized during the life of that contract. Although a labor contract gives a date when it will expire, it is not infrequent for a contract to be replaced before the expiration date is reached. The terms of the old contract could also extend past the expiration date if no new settlement is reached

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[4]The estimated price equation is

$$P_t = \underset{(0.18)}{0.13} + \underset{(0.08)}{1.56}P_{t-1} - \underset{(0.14)}{0.59}P_{t-2} + \underset{(0.15)}{0.04}P_{t-3} + \underset{(0.15)}{0.004}P_{t-4}$$

$$+ \underset{(0.15)}{0.04}P_{t-5} - \underset{(0.15)}{0.14}P_{t-6} + \underset{(0.15)}{0.18}P_{t-7} - \underset{(0.15)}{0.12}P_{t-8} + \underset{(0.15)}{0.24}P_{t-9}$$

$$- \underset{(0.15)}{0.24}P_{t-10} + \underset{(0.14)}{0.12}P_{t-11} - \underset{(0.08)}{0.10}P_{t-12} + \underset{(0.6)}{0.08}\text{Feb} - \underset{(0.07)}{0.07}\text{Mar}$$

$$+ \underset{(0.05)}{0.05}\text{Apr} + \underset{(0.04)}{0.04}\text{May} + \underset{(0.03)}{0.03}\text{Jun} - \underset{(0.03)}{0.07}\text{Jul} + \underset{(0.03)}{0.02}\text{Aug} + \underset{(0.02)}{0.01}\text{Sep}$$

$$- \underset{(0.02)}{0.01}\text{Oct} - \underset{(0.02)}{0.02}\text{Nov} - \underset{(0.02)}{0.01}\text{Dec}$$

where P_{t-i} is the CPI-W (1967=100) lagged i months and Feb - Dec are the respective monthly dummies. The standard errors are in parentheses.

before the old contract expires. This is often the case if there is a strike. To calculate the expected wage rate over the new contract, it is necessary to determine how long the parties to the agreement expect the agreement to be in effect.

A contract may be replaced or reopened before its expiration date either because a reopening was scheduled in the original contract or because at some time during the contract the parties agree that they would both be better off with a new contract.[5] A scheduled reopening typically occurs between one third and two thirds of the way through the life of a contract. Some contracts stipulate that only wages and benefits can be renegotiated at this time, but many contracts also change the expiration date of the contract. For the purpose of calculating the average expected wage per contract I treat the scheduled date of the contract reopening rather than the contract expiration date as the date the contract is expected to end. Any deferred increases that occur after the scheduled reopening date are counted as part of the new contract and not as part of the replaced contract.[6]

Some contract reopenings are, however, unscheduled and unexpected at the time of the original contract negotiation. For these contracts, the expected duration of the contract is the number of months between its effective date and the planned expiration date. While the CWD sometimes states that a contract has a scheduled reopening, there is often no indication of whether or not a reopening is scheduled. In this sample the reopenings which the CWD reports as scheduled

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[5]Some contracts even schedule reopenings contingent on a specified change in the price index.

[6]An example may clarify this point. In June 1973 the Container Corporation of America and the Paperworkers agreed upon a three year contract with an initial wage increase of 27 cents, a 28 cent wage increase in the second year and a further 28 cent wage increase in the final year. The contract also specified that the contract could be reopened for negotiation in June 1974. The contract was reopened for negotiation in 1974 and a further seven cents was added to the wage increase of 28 cents originally due that year and the 28 cents due in 1975 was changed to a ten percent wage increase. The contract was extended one more year and a further 40 cent wage increase was added for 1976. To calculate the average expected wage per contract, the original contract is viewed as a one year contract with a 27 cent wage increase. The renegotiated contract is viewed as a new three year contract with an initial wage increase of 35 cents (28 cents plus 7 cents) and a deferred increase of ten percent in 1975 and 40 cents in 1976.

never occur after the contract has been in existence for more than two thirds of its duration. With this in mind, I treat all contract reopenings before two-thirds of the contract period has elapsed as expected at the time of the original contract negotiations and those that occur after the two-thirds mark as unscheduled and unexpected. Eight percent of all contracts in this sample are reopened before two thirds of the contract period is over[7] and nine percent of the contracts are reopened in the last third of the contract period.

Any time lag between the formal expiration date of the contract and its replacement by a new contract is assumed to be unexpected. This lag is frequently more than one month long, especially if there is a long strike.[8] For over 40 percent of the contracts in the sample the new contract is not made effective until more than one month after the old contract expires.

Despite the fact that the expected contract duration and the actual contract duration[9] differed by as much as ten months in some cases, the mean realized contract duration and the mean expected contract duration in this sample were both 30 months.

(iii) Pay Board reversals

Finally, during the first two phases of the Nixon wage and price controls (August 1971 to December 1972), wage increases had to be approved by the Pay Board before they could become effective. In some cases these were not approved and it is unclear whether or not this was expected

[7]On average these occur just over one half of the way through a contract.

[8]For example, the contract between the Iowa Beef Processors and the Food and Commercial Workers that officially expired in April 1973 was not replaced until May 1974.

[9]By actual or realized contract duration I mean the number of months between the effective date of the contract and the effective date of the next contract.

by the parties involved. In 1971 and 1972, the Nixon Pay Board reversed a number of wage increases.[10] For example, Champion International and the Woodworkers negotiated a 32 cent wage increase in June 1972. This was sent for approval to the Pay Board which reduced the wage increase by six cents. In this study I assume that the parties did not expect the wage increase to be reversed.

2. Calculation of the Average Expected Real Wage

After calculating the expected nominal wage level at each point in the contract, this is deflated by the expected price level to find the expected real wage rate at each point in the contract.

Both the real wage rate and the expected real wage rate can vary throughout the length of the contract because of deferred wage increases and changes in the price level. Hence, the question arises as to which single wage rate or change in the wage rate to associate with each contract. The most frequent approach used in the literature is to take the change in the nominal wage rate between the end of the last contract and the end of the current contract and compare this with the expected change in the price level over the contract.[11] This is equivalent to comparing the expected real wage rate at the end of the contract to the real wage rate at the end of the previous contract.[12]

Card (1987), however, compares the real wage rate at the beginning of the contract to the real wage rate at the beginning of the previous contract. If it is assumed that deferred nominal wage changes and COLA payments are set to maintain a constant expected real wage rate, then the real wage rate at the beginning of the contract provides a good measure of the expected real wage rate without the need to estimate price expectations.

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[10]This is, however, rather unimportant in this study as only seven contracts in the sample were affected.

[11]See, for example, Christofides, Swidinsky and Wilton (1980), Riddell (1979) and Vroman (1984).

[12]See Card (1987) for a discussion of this point.

However, if there is not full, ex-ante provision for inflation and the expected real wage rate varies during the contract, then picking just one wage rate from the contract, whether from the beginning or the end of the contract, may not fully capture the results of the negotiation. Casual evidence would suggest that in many contracts, especially in those which do not contain COLA clauses, there is "front loading," i.e., the expected real wage rate is at its highest at the beginning of the contract.

Since the data set used in this study allows the construction of expected wage rates for each month of a contract, the measure of the wage rate used is the weighted average of the expected real wage rate over the expected duration of the contract. The weight applied to each level of the wage rate is the fraction of the length of the contract over which it is in effect.[13]

The first two tables which follow show (1) time series patterns in the movement of the expected real wage over the contract, the actual real wage over the contract, and the real wage at the beginning of the contract, and (2) wages by industry. The last two tables give a list of data definitions and sources, and the means and standard deviations of the variables used in this study.

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

Additional References

Card, David.
"Longitudinal Analysis of Strike Activity," National Bureau of Economic Research Working Paper no. 2263, NBER, May 1987.

Hendricks, Wallace and Lawrence Kahn.
Wage Indexation in the United States, Cola or Uncola?, Ballinger Publishing Company, Cambridge, MA, 1985.

Data Definitions and Sources

1. Wage variables

Average expected real wage, average realized real wage, and initial real wage constructed from wage data published in Current Wage Developments are measured in 1967 cents.

2. Aggregate unemployment rate

Monthly, seasonally adjusted unemployment rate for all workers 16 and over (Monthly Labor Review).

3. Sales

Annual data on net sales excluding cash discounts and returned sales (Industrial Compustat).

4. Profit

Annual, net after-tax profit defined as income after all expenses including tax and minority interest before provisions for dividends (Industrial Compustat).

5. Liquid assets

Annual data on the value of liquid assets which includes cash and short-term investments, government stocks and bonds, bank deposits and letters of credit (Industrial Compustat).

6. Inventories

Annual data includes materials and supplies, work-in-progress, and finished goods (Industrial Compustat).

7. Capital

Annual data on tangible fixed property, land, buildings and equipment (Industrial Compustat).

8. Employees

Number of workers employed by firm (Industrial Compustat).

9. Consumer Price Index

Consumer price index for wage earners (1967=100) (Monthly Labor Review)

10. Capital/Labor Ratio

The value of plant (see 7. above) divided by the number of employees.

11. Price Catch-up, number of non-contingent payments, COLA elasticity - Described in the text.

Appendix Table 1

Different Measures of the Negotiated Wage by Year: 1967 dollars

Year	(1) Number of Contracts	(2) Expected av wage	(3) Realized av wage	(4) Initial real wage	(5) Priv. sec Hourly earnings
70	60	3.43	3.48	3.48	2.78
71	116	3.53	3.53	3.54	2.84
72	112	3.86	3.80	3.84	2.95
73	171	3.15	3.13	3.48	2.96
74	173	3.18	3.21	3.73	2.87
75	120	3.12	3.11	3.81	2.81
76	174	3.04	3.01	3.52	2.85
77	169	3.55	3.48	4.16	2.89
78	109	2.90	2.84	3.51	2.91
79	124	2.94	2.94	3.50	2.83
80	139	2.95	2.96	3.41	2.70
81	71	2.82	2.86	3.35	2.66
Total	1538				
Average		3.20	3.19	3.63	2.84

Source: Wages in columns 2-4 are calculated from Current Wage Developments and the private sector hourly earnings in column 5 are taken from the Monthly Labor Review.

Appendix Table 2

Different Measures of the Negotiated Wage by Industry: 1967 dollars

Industry	(1) Number of Contracts	(2) Expected av wage	(3) Realized av wage	(4) Initial real wage	(5) Priv. sec hourly earnings
food	132	2.39	2.39	2.89	2.84
tobacco	16	3.09	3.09	3.23	2.87
textiles	35	1.40	1.40	2.25	2.22
apparel	12	1.53	1.52	1.86	2.01
lumber	35	2.35	2.32	2.94	2.69
furniture	2	2.96	2.89	3.20	2.35
paper	154	2.73	2.71	3.35	3.04
printing	11	3.57	3.54	4.15	3.34
chemicals	77	2.93	2.92	3.54	3.38
petroleum	50	3.59	3.59	4.40	4.05
rubber	26	3.16	3.22	3.30	2.76
leather	15	1.76	1.78	2.04	2.02
stone,clay, glass	55	3.11	3.12	3.54	3.09
primary metals	153	4.07	4.12	4.38	3.86
fabricated metals	81	3.21	3.19	3.51	3.13
machinery except electrical	103	3.27	3.24	3.52	3.35
electrical machinery	136	2.85	2.83	3.16	2.89
transport equipment	200	3.42	3.39	3.65	3.80
instruments	19	2.50	2.50	2.85	2.87
miscell. manufacturing	20	2.05	2.07	2.56	2.37
airlines	37	10.40	10.27	11.45	
commun-ications	120	3.23	3.26	3.65	

sanitary services	9	2.83	2.84	3.76	.
department stores	32	1.78	1.76	2.17	.
repair services	4	1.88	1.85	2.07	.
entertainment	2	1.88	1.85	2.07	.
local transit	1	3.85	3.89	3.93	.
trucking	1	4.10	4.06	4.23	.

Source: Wages in columns 2-4 are calculated from Current Wage Developments and the private sector hourly earnings are taken from the Monthly Labor Review.

Appendix Table 3

Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
log average expected wage (1967 dollars)	5.69	.36
log average realized wage (1967 dollars)	5.69	.36
log initial real wage (1967 dollars)	5.84	.28
aggregate unemployment rate (%)	6.5	1.1
average log wages by 3 digit SIC	5.85	.22
inventories per employee (100,000 $ 1967)	.05	.03
sales per employee (100,000 $ 1967)	.32	.26
profit per employee (100,000 $ 1967)	.02	.02
liquid assets per employee (100,000 $ 1967)	.02	.03
capital labor ratio (100,000 $ 1967)	.16	.19
employees (1000s)	86.6	182.9
COLA elasticity	.35	.41
price catch-up	.68	4.54
number of non-contingent payments	3.13	1.20