NBER WORKING PAPER SERIES

COST-OF-LIVING ADJUSTMENT CLAUSES IN UNION CONTRACTS

Ronald G. Ehrenberg

Leif Danziger

Gee San

Working Paper No. 998

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

October 1982

Professor of Economics and Labor Economics at Cornell University and Research Associate at the National Bureau of Economic Research; Visiting Assistant Professor at Cornell University, and Ph.D. candidate at Cornell University, respectively. Our research has been supported by a grant to Ehrenberg from the National Science Foundation. Earlier versions of the paper were presented at workshops at the NBER, the University of Rochester, and the University of Pennsylvania, as well as at the Summer 1982 Econometric Society Meetings. Without implicating them for what remains, we are grateful to the many participants at those sessions for their comments. The research reported here is part of the NBER's research program in Labor Studies. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #998
October 1982

Cost-of-Living Adjustment Clauses in Union Contracts

ABSTRACT

Our paper seeks to provide an explanation for why the prevalence of COLA provisions and their characteristics vary widely across U.S. industries. We develop models of optimal risk sharing between a firm and union that allows us to investigate the determinants of a number of characteristics of union contracts. These include the presence of wage indexation, the degree of wage indexation if it exists, the magnitude of deferred noncontingent (on the price level) wage increases, the duration of labor contracts and the trade-off between temporary layoffs and wage indexation. Preliminary empirical tests of some of the implications of the model are conducted using industry data on both the prevalence of COLA provisions and layoff rates, and using contract level data on the characteristics of COLA provisions and contract duration. One key finding is that the level of unemployment insurance benefits appears to simultaneously influence the level of layoffs and the extent of COLA coverage.

Ronald G. Ehrenberg
Leif Danziger
Gee San
New York State School of
Industrial and Labor Relations
Cornell University
P.O. Box 1000
Ithaca, NY 14853
607-256-3026

I. INTRODUCTION

Cost-of-living escalator clauses in union contracts tie, or index, workers' wages to some index of prices, such as the Consumer Price Index. The first major U.S. labor contract to contain such a provision was the 1948 contract between General Motors and the United Automobile Workers.[1] The prevalence of such provisions spread during the inflation that accompanied the Korean War, but interest in them waned as the economy experienced stable prices during the early 1950s. As a result, by January 1955, only 23 percent of those workers covered by major collective bargaining agreements, agreements that covered 1,000 or more workers, were also covered by contracts that included cost-of-living provisions (Table 1). When prices rose during the late 1950s coverage expanded, as large national contracts in steel, aluminum and can, railroads, and electrical equipment incorporated such provisions. The relative price stability of the early 1960s led to a reduction in coverage; indeed the cost-of-living provision was dropped from the steel contract in 1962. Since 1966, however, high rates of inflation have been associated with steady increases in coverage and during the 1976-1981 period roughly 60 percent of workers covered by major union contracts were also covered by cost-of-living provisions (Table 1).

The growth in the prevalence of cost-of-living provisions (COLA's), has led to a rekindling of both academic and public interest in the topic and this interest has taken a number of forms.[2] First, attention has been directed towards the role of COLA's in the inflationary process. During the 1970s the wages of employees in heavily unionized industries who were covered by COLA's grew significantly relative to the wages of other employees in the economy.[3] In addition, the growing prevalence of multi-year contracts with COLA provisions has been shown to reduce the responsiveness of the aggregate rate of wage inflation to the aggregate unemployment rate; increases in the rate of unemployment now "buy" less of a reduction in wage inflation than they did in the 1960s.[4] Because of these facts COLA's are thought by some to be one of the causes of the persistent high rates of inflation we have experienced in the United States; this even though COLA's typically provide workers with much less than 100 percent protection against inflation.[5]

Second, attention has been directed to the role that COLA's may play in reducing the level of strike activity in the economy. One reason that a collective bargaining negotiation may not be settled prior to a strike is that an employer and a union's forecasts and perceptions about future rates of inflation may substantially differ. The presence in a contract of a COLA provision, which ties the wage over the course of a contract to future prices, reduces the need for the employer and the union's price forecasts to coincide and thus may reduce the likelihood of a strike occurring.[6] Since strike activity involves lost output, the presence of COLA's may well have a positive effect on aggregate output.

Third, numerous economists have focused on the implications of COLA's for macroeconomic stabilization policy.[7] Among the questions they ask are "Can indexing schemes protect the aggregate economy from real and/or monetary shocks?","How does the degree of indexing influence government stabilization policy?", and "What is the optimal degree of indexation, from the perspective of macro-stabilization or aggregate efficiency policy?". Their objective is to show that in a world of uncertain future outcomes, where the establishment of contingent contracts that cover every possible state of the world is impossible, the presence of COLA's does lead to welfare gains.

Finally, another stream of research has focused on the implications of COLA's for microeconomic efficiency, in particular the sharing of risks of uncertain outcomes by firms and workers. These papers are in the tradition of the "implicit contract" literature and they focus on the optimal degree of indexation from the perspective of a micro-level decision making unit.[8] In particular, they examine the effects of such variables as the expected rate of inflation, uncertainty, employee risk aversion, the cost of indexing and nonlabor income on the optimal degree of indexing.

Somewhat surprisingly, although the latter two streams of literature have focused on the determination of the optimal degree of indexation at the aggregate and micro levels, there have been only a few attempts to see if these theories can be used to explain either the varying prevalence of COLA's in the aggregate U.S. economy over time or why the prevalence of COLA's and their characteristics varies across industries at a point in time.[9] Table 2 presents data for November of 1980 that indicate quite clearly that the prevalence of COLA's in major collective bargaining agreements varies widely across industries. Moreover, one can not attribute these differences solely to differences in union strength; for example, a strong national union exists in bituminous coal mining and strong local unions exist in construction, but in neither industry are there many contracts with COLA's.

Our paper seeks to provide an explanation for why the prevalence of COLA provisions and their characteristics vary widely across U.S. industries.

We do this in the context of models of optimal risk sharing between a firm and a union that allow us to investigate the determinants of a number of characteristics of union contracts. In addition to focusing on the degree of wage indexation, we focus on the determinants of deferred nominal or real wage increases in multiperiod contracts that are not contingent on the realized price level, on the determinants of the duration of labor contracts, and, to integrate our research more fully into the implicit contract literature, on the influence of parameters of the unemployment insurance (UI) system on the extent of indexation and the level of temporary layoffs.

We begin in the next section with a simple one-period model in which employment is predetermined and indexation is assumed to exist and ascertain the factors that determine the extent of indexation. Section III relaxes the assumption that indexed contracts exist and focuses on the forces that influence the probability of observing indexed contracts. In Section IV we move to a two-period model with indexation and predetermined employment and analyze how the extent of indexation varies across periods, what factors determine the size of deferred wage increases and how such increases vary with the extent of indexation. Section V addresses the issue of the choice of contract duration. The final theoretical section, Section VI, returns to a one-period model with indexation, but allows employment to be variable across states-of-the-world. This section provides an explanation of the forces that simultaneously influence both the extent of indexation and the level of temporary layoffs, highlighting the role of parameters of the UI system.

The major message of the theoretical sections is that even in rather simple models, there are a large number of variables that influence these contract provisions. The following two sections attempt to test some of the hypotheses that these models generated. Section VII uses pooled cross-section time-series data at the two-digit manufacturing industry level to ascertain the determinants of both the proportion of unionized workers who are covered by COLA's and industry layoff rates. Section VIII uses individual contract data to ascertain the determinants of COLA coverage, the characteristics of COLA's when they exist, and the determinants of the duration of contracts. Finally, Section IX summarizes what we have learned from the paper and provides some concluding remarks.

II. A ONE-PERIOD MODEL WITH FIXED EMPLOYMENT

Consider first the following simple one-period model. A union and an employer must decide on the provisions of a collective bargaining agreement before the aggregate price level is known. At the time negotiations take place, the aggregate price level p, is equal to unity, but during the period that the contract will cover the price level is uncertain; the expected value of p during the period is denoted by $\bar{p}$ and its coefficient of variation by $\phi_p > 0$. We also treat the firm's production function, its demand curve, and the prices of its nonlabor inputs as being uncertain, in a manner to be specified below.

In principle, an optimal risk sharing arrangement would make both the wage and the employment level contingent on the realized outcomes of the aggregate price level, the firm's productivity, its demand curve (as proxied perhaps by its output price level), and the price of its nonlabor inputs. For now, however, we assume that the employment level is predetermined and equal to the number of union members, N. Thus, there is no temporary layoff unemployment in this model; in Section VI we relax this assumption and allow the employment level to vary across states of the world.

In addition, we assume that when the employer and the union negotiate a wage schedule w, this wage is contingent upon, or indexed <u>only</u> to the aggregate price level

$$(1) \qquad w = w(p).$$

Virtually all contracts with COLA's in the United States are structured in this manner and only rarely are wages explicitly tied to future productivity, industry price levels, or input price levels.[10] Our failure to observe more contracts which also tie wages to these variables, undoubtedly reflects factors such as moral hazard (firms may have some control over their output prices) and the costs of obtaining information and enforcing such contracts (the difficulties involved in measuring productivity and demand shifts, etc.).[11] Later, however, we will indicate how allowing contracts to be contingent on these variables would alter the results.

Suppose that workers are risk averse and have cardinal utility functions of the form

$$(2) \qquad U = U[(w/p) + M] \qquad U' > 0 \qquad U'' < 0.$$

Utility depends on the worker's real income in a period, with M being the level of <u>real</u> nonwage labor income. For now we treat M as being identically equal to zero; later we will indicate how the extent that it varies with the price level effects the optimal degree of indexation of wages. Note that when M is equal to zero, for a given wage schedule, a worker's expected utility $(E_p U(w/p))$ depends only on the distribution of the price level during the period.

The firm uses labor (L) and a composite variable input (X) to produce output (Q) via the production function relationship

$$(3) \qquad Q = f(L,X,e_1).$$

Here e_1 is a random productivity shock whose realized value becomes known only after the contract is signed. That is, productivity is uncertain at the time of the negotiations. For simplicity, we assume that e_1 is independent of both the distribution and realization of the aggregate price level.

Demand for the firm's output is assumed to depend <u>both</u> on the price charged by the firm and on the amount of <u>unanticipated</u> inflation, with the latter defined by

$$(4) \qquad \hat{p} = p/\bar{p}$$

The notion is that unanticipated inflation in the aggregate price level may lead to increases in the demand for some firms' products and decreases in the demand for others.[12]

Specifically, we assume that the inverse demand function can be written

$$(5) \qquad q = pg(Q,\hat{p},e_2)$$

where q is the price of the firm's product, e_2 is a random demand shock whose realization becomes known only after negotiations are concluded and the inclusion of Q allows the firm to face a downward sloping demand curve. The demand shock is assumed to be independent of the distribution of the aggregate price level and accordingly we assume that the real price of its product (q/p) that the firm can charge for any specified output level is independent of the expected inflation rate.

The price of the variable input X is also assumed to depend on the amount of unanticipated inflation and is given by

$$(6) \qquad z = ph(\hat{p}, e_3),$$

where z is the price of the input and e_3 is a random cost shock. As with the other shocks, the realized value of e_3 becomes known only after the negotiations are completed and e_3 is assumed to be independent of the distribution of the aggregate price level (although it need <u>not</u> be independent of e_1 and e_2). The firm is assumed, in (6), to be a price taker in the market for the other input for expositional convenience only.

Since initially employment (L) is always equal to the number of union members, the firm's profit (π) is given by

$$(7) \qquad \pi = pg[f(N,X,e_1),\hat{p},e_2]f(N,X,e_1) - ph(\hat{p},e_3)X - wN$$

The variable input X is chosen after the realized values of all of the random variables are known and, conditional upon them, X is always chosen by the firm to maximize profits. Assuming an interior solution always exists, this requires that

(8) $\partial\pi/\partial X = 0 \qquad \forall\ p$ and e where $e = (e_1, e_2, e_3)$.

The firm's objective is to maximize its expected utility from real profit

(9) $$\underset{p,e}{E}\,[V(\pi/p)]$$

where V is a cardinal utility function, $V' > 0$, and $V'' < 0(=0)$ if the firm is risk averse (risk neutral). Given a wage schedule $w(p)$, the firm's expected utility obviously depends upon the distributions of all of the random variables in the model.

The goal of the union is to maximize the representative worker's expected utility, while the goal of the firm is to maximize its expected utility. It is beyond the scope of this paper to model the bargaining process and show how it may lead to an agreed upon contract.[13] The only assumption that we make here is that the parties will reach a contract that provides for efficient sharing of all risks stemming from unanticipated inflation. Such contracts can be obtained by choosing a wage indexation schedule that maximizes

(10) $$\mathcal{L} = \underset{p}{E}[U(w/p)] + \lambda \underset{p,e}{E}[V(\pi/p)]$$

where λ is a parameter that indicates the "share of the pie" that the employer receives. Other things equal, higher values of λ reflect greater employer bargaining power.

It is useful to define the following functions:

(11) $\varepsilon \equiv \frac{dw}{dp}\frac{p}{w}$ the elasticity of the wage rate, w, w.r.t. the aggregate price level, p,

$a \equiv \frac{\partial g}{\partial \hat{p}}\frac{\hat{p}}{g}$ the elasticity of the firm's demand curve, g, w.r.t. unanticipated inflation, $\hat{p}$,

$b \equiv \frac{\partial h}{\partial \hat{p}}\frac{\hat{p}}{h}$ the elasticity of other input prices, h, w.r.t. unanticipated inflation, $\hat{p}$,

$\eta \equiv -\frac{\partial Q}{\partial g}\frac{g}{Q}$ the (absolute value) of the elasticity of demand w.r.t. the firm's real price, q/p,

$\psi \equiv 1-\eta^{-1}$ the elasticity of total revenue w.r.t. the firm's output, Q,

$\beta \equiv \frac{\partial f}{\partial X}\frac{X}{f}$ the elasticity of output w.r.t. the other input, X,

$A \equiv \frac{a-b\psi\beta}{1-\psi\beta}$ the elasticity of the firm's real value-added w.r.t. the aggregate price level, p,

and $S \equiv -\frac{U''}{U'}\frac{w}{p}$ the workers' relative risk aversion.

In general each of these variables is a function and not a parameter. In what follows when we talk about a change in any one of them we mean a shift in the whole schedule.

The elasticity of the wage rate with respect to the aggregate price level, ε, is a measure of the extent to which the wage rate is indexed to the price level. It is straightforward to show (see Appendix A) that maximization of (10) subject to (1) - (9) yields that the optimal degree of indexation is given by

$$(12) \qquad \varepsilon = 1 - \frac{E_e V''A \frac{\pi + wN}{p}}{SE_e V' - \frac{wN}{p} E_e V''} .$$

That is, the optimal degree of wage indexation depends on both factors exogenous to the bargaining process (such as the extent of employer and employee risk aversion) and on the outcome of the bargaining process itself (such as the level of wages).

Note that if the firm is risk neutral $(V'' = 0)$ indexation is complete $(\varepsilon = 1)$. In this case, the real wage is independent of the aggregate price level and the firm fully insulates workers against inflation risks. Since collective bargaining agreements seldom call for complete indexation, throughout the rest of the paper we assume that the firm is risk averse.

It is apparent from (12) that the elasticity of the firm's real value added with respect to the aggregate price level, A, is a key variable in determining the extent of indexation. If A is greater (less) than zero, so that increases in the aggregate price level increase (decrease) the firm's real value added, then the firm shares the rewards (costs) of inflation by providing workers with a more than (less than) complete indexation. That is,

$$(13) \qquad \varepsilon \gtreqless 1 \qquad\qquad \text{as} \quad A \gtreqless 0 \quad .$$

That is, indexation is <u>not</u> necessarily less than full; optimal risk-sharing agreements may call for workers to be "overcompensated" for inflation. Of course, if inflation is neutral in the sense that the firm's demand and the price of nonlabor inputs are unaffected by unanticipated inflation $(a = b = 0$ for all $e)$, then $\varepsilon = 1$. In this special case inflation risk affects the firm only through its effect on real wages, and full indexation eliminates all inflation risk for both workers and firm. The firm is still exposed to other risks (e), but since these are not related to inflation they cannot be alleviated by indexation to the aggregate price level.[14]

The first column in Table 3 summarizes the main comparative static results that follow from equation (12); how changes in various factors influence the optimal degree of indexation. An increase in the elasticity of the demand curve with respect to unanticipated inflation (a) increases the degree of indexation since the larger the increase in real value-added that results from an unanticipated increase in prices, the larger the "pie" that is available to share with workers. Conversely, the larger the elasticity of other input prices with respect to unanticipated inflation (b), the more disadvantageous is the unanticipated inflation to the firm and therefore the smaller the degree of wage indexation that occurs.

The effect of the elasticity of the firm's demand curve with respect to its real price η, depends upon the relationship of a and b. To see this, consider first the special case where these two elasticities are equal (a = b). In this case, unanticipated inflation causes identical percentage changes in the real marginal revenue product of nonlabor inputs (MRP) and in the inputs' real price. Since the input level, x, is always chosen so that its real marginal revenue product equals its real price (eq. (8)), there will be no adjustment in the amount of the input used and hence in output. In terms of Figure 1a the firm will move from M to N. Consequently, the value of η does not affect the change in real value-added in this case and ε will be independent of η.

In contrast, if a is greater than b, a higher unanticipated inflation implies a higher percentage increase in MRP than in z. In order to maintain the equality between the variable input's marginal revenue product and its price the amount of the input and hence output must be higher. The magnitude of this effect will be larger the higher the elasticity of the marginal revenue product curve with respect to the input. This is illustrated in Figure 1b where we assume that a is greater than b. The firm will move from M to O with a less elastic demand curve and from M to P with a more elastic one. The latter case is associated with a greater increase in real value-added and thus we should observe a higher degree of indexation associated with it. Since, other things equal, higher values of the elasticity of the firm's demand curve with respect to its real price are associated with more elastic marginal revenue product curves for the variable input, higher elasticities of the demand curve will lead to higher values of wage indexation in this case.[15] In contrast, if a is less than b, similar reasoning shows that increasing the elasticity of the firm's demand curve with respect to its own price will reduce the extent of indexation.

The key point here, then, is that the firm's elasticity of demand with respect to its own real price (η) does affect the optimal degree of wage indexation, but that the direction of the effect depends upon the relationship of a and b, the elasticities of the firm's demand curve and its other input prices with respect to unanticipated inflation. If a is greater (less) than b, higher values of η lead to more (less) wage indexation. Since a higher elasticity of output with respect to the variable input (β) is also associated with a higher elasticity of the variable input's MRP curve, analogous results follow with respect to this variable. That is, increases in β are associated with increases (decreases) in the extent of indexation if a is greater (less) than b.

Several other results are easier to explain. First, the more risk averse workers are, the greater is the value to them of smoothing variations in the real wage. Consequently, increased risk aversion (S) is associated with values of ε closer to unity. Note that if the optimal degree of indexation is initially less (greater) than unity because A is less (greater) than zero, increasing the extent of employee risk aversion will increase (decrease) the extent of indexation.[16]

Second, the optimal degree of indexation is independent of both the expected level of inflation $(\bar{p})$ and the uncertainty of inflation (ϕ_p). These results follow directly from the assumption that all real variables are unaffected by the distribution of p, as opposed to its realized value.[17]

Finally, the optimal degree of indexation also depends on the residual uncertainty in real value added; the uncertainty in real value added caused by shocks to productivity, demand, and other input prices. Unfortunately, its effect on the optimal degree of indexation depends upon many parameters in the model <u>and</u> how they change. If one further assumes, however, that a, b, η, β, A and R (where $R = -(V''/\dot{V})(\pi/p)$ is the firm's relative risk aversion) are constant, it can be shown (see Appendix A) that

$$(14) \qquad \partial\varepsilon/\partial\phi_V \lesseqgtr 0 \qquad \text{as} \quad A(S - R) \lesseqgtr 0$$

where ϕ_V, the coefficient of variation of real value added is used as a measure of the residual uncertainty in real value-added. If employee relative risk aversion (S) is greater than employer relative risk aversion, this implies that increased residual uncertainty makes indexation less perfect (further from unity).[18]

Before concluding this section, two extensions of the model warrant being briefly discussed. First, suppose that we relax the assumption that the employee's nonlabor income, M, is always zero. Assuming that the level of nonlabor income is positive, its effect on the optimal degree of wage indexation dependsupon how it varies with the price level. If the level of nonlabor income is fixed in nominal terms, then to stabilize the sum of real wages and real nonlabor income will require a greater degree of wage indexation than in the absence of the nonlabor income, assuming that indexation is positive. In contrast, if the nonlabor income is fixed in real terms (perfectly indexed), then any desired degree of real income stabilization (not equal to perfect stabilization) can be achieved with now less perfect wage indexation (ε further from unity).

Second, suppose we now allow wages to be indexed not only to the aggregate price level, but also to the shocks to the firm's productivity, demand curve, and input prices. In this case, one can show that

$$(15) \qquad \frac{dw}{w} = \left[1 + \frac{AR(\pi + WN)}{S\pi + RwN}\right]\frac{dp}{p} + \frac{R(\pi + wN)}{S\pi + RwN}\left[\alpha_1\frac{de_1}{e_1} + \alpha_2\frac{de_2}{e_2} + \alpha_3\frac{de_3}{e_3}\right]$$

where

$$\alpha_1 = \psi\varepsilon_{fe_1}/(1 - \psi\beta) \quad \text{and} \quad \varepsilon_{fe_1} = (\partial f/\partial e_1)(e_1/f)$$

$$\alpha_2 = \varepsilon_{ge_2}/(1 - \psi\beta) \quad \text{and} \quad \varepsilon_{ge_2} = (\partial g/\partial e_2)(e_2/g)$$

$$\alpha_3 = \psi\beta\varepsilon_{he_3}/(1 - \psi\beta) \quad \text{and} \quad \varepsilon_{he_3} = (\partial h/\partial \varepsilon_3)(e_3/h)$$

Observe that (15) suggests that if employers are risk neutral ($R = 0$) then wages are tied only to the aggregate price level (in this case recall that $\varepsilon = 1$) and not to the other forces. If firms are risk averse, in theory wages should be tied to all of the other forces. However, small values of the elasticity of the firm's total revenues with respect to its output (ψ), of the elasticity of its output with respect to other inputs (β), and of the elasticities of output, demand, and input prices with respect to the random shocks will reduce the extent to which wages are tied to the other forces. These factors, in addition to the ones we have described above, may explain why wages are typically not indexed to anything other than the aggregate price level.

III. THE DECISION TO INDEX

As Table 1 indicates, in recent years approximately 60 percent of all unionized workers covered by major collective bargaining agreements are also covered by COLA provisions. It would be coincidental if the optimal degree of wage indexation implied by (12) was zero for 40 percent of unionized employees. What factors are responsible then for such a large fraction of workers having contracts that are not indexed at all?

The answer hinges on the possibility that there may be fixed real costs per worker of negotiating or administrating indexation clauses that must be borne either by the union or the employer. These costs may arise from a number of factors. For example, if a contract is indexed, union leaders may not receive "credit" from their members for the periodic nominal wage increases that automatically arise due to inflation. As a result, to maintain their political positions in the union, union leaders may push during contract negotiations for additional periodic noncontingent money wage increases; this may make it more difficult to reach a contract settlement.

To take another example, in a world of heterogeneous workers of differing skill levels, employers would like to have the flexibility to alter relative wages in response to external shortages or surpluses of workers in particular skill classes. COLA provisions, however, typically are specified as a given percentage increase in wages for each percentage increase in prices, or as a given absolute increase in wages for each percentage point increase in prices. The former scheme rigidly preserves relative wage rates, while the latter causes skill differentials to be compressed. In either case, the employer loses the ability to alter relative wages during the period covered by the contract and this reduces his willingness to agree to COLA provisions.

Suppose that we can represent these fixed real costs per worker of having an indexed contract by c_i, then the total cost of indexation is $c_i N$. Indexation of course yields benefits to both the employer and the employees in terms of risk sharing. The monetary value of these benefits to them is the total amount in real terms that both parties would be willing to pay to have wages indexed. Appendix B shows that this real amount is approximately equal to

$$(16) \qquad \frac{1}{2}\,\bar{w}N\phi_p^2\varepsilon^2\,(S - \bar{w}N\underset{e}{E}V''/\underset{e}{E}V'),$$

where $\bar{w} = w(\bar{p})/\bar{p}$, $\pi = \pi(\bar{p})/\bar{p}$, ε is evaluated at $\bar{p}$, S is evaluated at $\bar{w}$ and V' and V'' are evaluated at $\bar{\pi}$.[19] Thus, the sum of the net benefits per employee to both parties from having an indexed contract is

$$(17) \qquad B = \frac{1}{2}\,\bar{w}\phi_p^2\varepsilon^2(S - \bar{w}N\underset{e}{E}V''/\underset{e}{E}V') - c_i$$

While in general one cannot observe the continuous variable B, one can observe whether a contract contains a COLA and it is reasonable to postulate in empirical implementations that

$$(18) \qquad \hat{B} = 1 \quad \text{if} \quad B + v > 0$$
$$= 0 \quad \text{otherwise}$$

Here $\hat{B}$ equals 1, if a contract has a COLA and is zero otherwise, and v is a random variable that summarizes all other unobservable forces that may influence COLA coverage.

From (17) and (18) it is straightforward to see how various forces influence the probability of a COLA's existing and these are summarized in Table 3. First, note that a, b, η and β influence B only through ε, thus their effect on the probability of observing a COLA is the same as their effect on the degree of indexation, given that indexation occurs and is positive. Second, one can show that the more risk averse workers are the greater the gain from indexation to them and thus the more likely one will observe an indexed contract.[20] Third, while the expected rate of inflation has no effect on the probability of indexation, given that workers are risk averse, the more uncertain inflation is the greater is the gain to them of indexation and thus the greater is the likelihood of indexation. Fourth, an increase in the costs of having an indexed contract obviously reduces the probability of having such a contract.[21] Finally, if one additionally assumes that a, b, η, β, A, R and S are constants and that the extent of employer risk aversion just equals that of employee risk aversion $(R = S)$, then an increase in residual uncertainty increases the probability of observing indexed contracts.[22]

In the main then, the same variables that affect the degree of indexation, if it occurs, also influence the probability of indexation. However, as Table 3 indicates, in several cases the effect of a variable on the former may be different than its effect on the latter, and one variable, the coefficient of variation of expected inflation, influences only the latter.

IV. A TWO-PERIOD MODEL, DEFERRED PAYMENTS, AND THE RELATIONSHIP BEWTEEN CONTRACT LENGTH AND COLA GENEROSITY

The models discussed in the previous two sections provide a number of insights into the determinants of COLA provisions in union contracts. They are not structured in a way, however, that enable us to address a set of related issues. These include, what determines the length of collective bargaining agreements? How do COLA provisions vary with contract duration? What determines the size of deferred wage increases that are not contingent on the price level in multiperiod contracts? Is there a trade-off between deferred increases and COLA provisions? To answer these questions one must move to a multiperiod model and we do so in this and the following section.

We consider for simplicity a two-period model in which neither firms nor workers can borrow or lend. Let a subscript 1 (2) denote period 1 (2). A representative worker's utility is given by

$$(19) \qquad U = U_1(w_1/p_1) + U_2(w_2/p_2)$$

and the firm's utility by

(20) $$V = V_1(\pi_1/p_1) + V_2(\pi_2/p_2)$$

where the within-period utility functions may differ to allow for discounting and other factors.

The production function in period i (for i equal to 1 or 2) can be written

(21) $$Q_i = f_i(L_i, X_i, e_{1i})$$

and this function may differ between periods to allow for productivity growth. Finally, the inverse demand functions and the prices of nonlabor inputs are assumed to be given by (22) and (23) respectively.

(22) $$q_1 = p_1 g_1(Q_1, \hat{p}_1, e_{21}),$$

$$q_2 = p_2 g_2(Q_2, \hat{p}_1, \hat{p}_2, e_{22}).$$

(23) $$z_1 = p_1 h_1(\hat{p}_1, e_{31})$$

$$z_2 = p_2 h_2(\hat{p}_1, \hat{p}_2, e_{32})$$

Note that this specification also both allows the demand function and input price schedules to change between periods and the effects of unanticipated inflation to persist over time, so that unanticipated inflation in period 1 may affect the demand curve and other input prices in period 2.[23] While the vector of error terms $e_1 = (e_{11}, e_{21}, e_{31})$ and $e_2 = (e_{12}, e_{22}, e_{32})$ are assumed to be independent of the realized values of p_1 and p_2, they are not required to be independent of each other.

The wage that will prevail in the second period of the contract can be written as

$$(24) \qquad w_2 = w_1 y(\tilde{p})$$

where w_1 is the wage that prevails expost in period 1, $\tilde{p}$ equal to p_2/p_1 is the actual relative increase in the price level in the second period, and $y(\tilde{p})$ is the multiplier that translates the wage in period 1 into the wage in period 2. We assume that the realization of $\tilde{p}$ is independent of the realization of p_1 and that its expected value (the expected inflation rate in period 2) is $\bar{p}$, the same expected rate as in period 1. It is straightforward to see that the deferred wage change, as a percentage of the wage that prevails in period 1 is given by D minus one where

$$(25) \qquad D = y(1).$$

When D is greater than (less than) unity a deferred increase (decrease) is called for in the contract.

As before, the firm will always choose the variable inputs in each period to maximize the profits in that period and, assuming that an interior solution exists,

$$(26) \qquad \partial\pi_1/\partial X_1 = \partial\pi_2/\partial X_2 = 0$$

and all contracts that optimally share inflation risks can be obtained by choosing indexation schemes $w_1(p_1)$ and $y(\tilde{p})$ to maximize

$$(27)\qquad \mathcal{L} = \underset{p_1}{E}\, U_1\left(\frac{w_1}{p_1}\right) + \underset{p_1\tilde{p}}{E}\, U_2\left(\frac{w_2}{p_2}\right) + \lambda\left[\underset{p_1,e_1}{E}\, V_1\left(\frac{\pi_1}{p_1}\right) + \underset{p_1\tilde{p},e_2}{E}\, V_2\left(\frac{\pi_2}{p_2}\right)\right]$$

As in Section II, it is useful to define the following expressions (remembering that in general each of these may vary and hence is not necessarily a parameter)

(28)

- ε_i the elasticity of the wage rate in period i w.r.t. the change in the price level in period i
- a_i the elasticity of the firm's demand curve in period i w.r.t. unanticipated inflation in that period
- a^* the elasticity of the firm's demand curve in period 2 w.r.t. unanticipated inflation in period 1
- b_i the elasticity of other input prices in period i w.r.t. unanticipated inflation in that period
- b^* the elasticity of other input prices in period 2 w.r.t. unanticipated inflation in period 1
- A_i the elasticity of real value added in period i w.r.t. a change in the price level in period i
- A^* the elasticity of real value added in period 2 w.r.t. a change in the price level in period 1

Using derivations similar to those found in Appendix A, one can obtain expressions for the optimal degree of indexation in each period

(29) $$\varepsilon_1 = 1 + \frac{\underset{e_1}{E} V_1'' A_1 \dfrac{\pi_1 + w_1 N}{p_1} + \underset{\tilde{p},e_2}{E} V_2'' A_1^* \dfrac{(\pi_2 + w_1 yN)y}{p_1 \tilde{p}^2}}{\dfrac{\dfrac{w_1}{p_1}\left(U_1'' + \underset{\tilde{p}}{E} U_2'' \dfrac{y^2}{\tilde{p}^2}\right)}{U_1' + \underset{\tilde{p}}{E} U_2' \dfrac{y}{\tilde{p}}} \left(\underset{e_1}{E} V_1' + \underset{\tilde{p},e_2}{E} V_2' \dfrac{y}{\tilde{p}}\right) + \dfrac{w_1 N}{p_1}\left(\underset{e_1}{E} V_1'' + \underset{\tilde{p},e_2}{E} V_2'' \dfrac{y^2}{\tilde{p}^2}\right)}$$

(30) $$\varepsilon_2 = 1 + \frac{\underset{p_1,e_2}{E} V_2'' A_2 \dfrac{(\pi_2 + w_1 yN) w_1}{p_1^2 \tilde{p}}}{\dfrac{\underset{p_1}{E} U_2'' \dfrac{w_1^2 y}{p_1^2 \tilde{p}}}{\underset{p_1}{E} U_2' \dfrac{w_1}{p_1}} \left(\underset{p_1,e_2}{E} V_2' \dfrac{w_1}{p_1}\right) + \dfrac{yN}{\tilde{p}} \underset{p_1,e_2}{E} V_2'' \dfrac{w_1^2}{p_1^2}}$$

Note that we have restricted the way in which inflation in period 1 may affect the wage rate in period 2 by the specification of (24). Efficient sharing of inflation risks would in general require the second period wage to depend directly on inflation in period 1, not only indirectly via the latter's effect on wages in period 1. In the more general case the expressions for ε_1, ε_2, and the elasticity of wages in period 2 with respect to prices in period 1 would be similar to equation (12), the optimal degree of indexation in the one-period model. The complexity of (29) and (30) arises for two reasons. First, since unanticipated inflation in period 1 affects the real value added in both periods, the degree of indexation in period 1 depends on both A_1 and A^*. Second, since the elasticity of wages in period 2 with respect to inflation in that period must (by (24)) be independent of the actual inflation rate in period 1, optimal risk sharing requires that the elasticity of wages with respect to inflation in each period depend upon the distribution of inflation in the other period.

While it is possible for one to analyze the determinants of wage indexation in each of the two periods in this general case, for our purposes it is much more useful to make a set of further simplifying assumptions. Suppose, first, that p_1 and $\tilde{p}$ are identically and independently distributed, as are e_1 and e_2. Next, suppose that the workers' and the firm's utility functions both exhibit equal constant relative risk aversion (S) and can be written

$$\text{(19a)} \quad U = U(w_1/p_1) + \rho U(w_2/p_2) \qquad \text{and}$$

$$\text{(20a)} \quad V = V(\pi_1/p_1) + \rho V(\pi_2/p_2)$$

where $\rho(>0)$ is a discount factor common to both workers and firms.

Suppose, also, that the firm's production function can be written as a Cobb-Douglas function

$$\text{(21a)} \quad Q_i = L_i^{\alpha} X_i^{\beta} t_{1i} e_{1i}$$

where t_{1i} equals one in period 1 $(t_{11}=1)$ and t_{1i} equals $t_1(>0)$ in period 2 $(t_{12}=t_1)$. Larger values for t_1 indicate higher expected rates of productivity growth in this formulation.

Finally, suppose the inverse demand functions and the input price functions are of constant-elasticity type and are given respectively by

$$\text{(22a)} \quad q_1 = p_1 Q_1^{-1/\eta} \hat{p}_1^{a} e_{21}$$

$$q_2 = p_2 Q_2^{-1/\eta} \hat{p}_1^{\gamma a} \hat{p}_2^{a} t_2 e_{22} \qquad \text{and}$$

(23a) $z_1 = p_1 \hat{p}_1^{b} e_{31}$

$z_2 = p_2 \hat{p}_1^{\delta b} \hat{p}_2^{b} t_3 e_{32}$.

Here $\gamma(\delta)$ is the degree of serial correlation in the effect of unanticipated inflation on the demand function (input prices). If $\gamma(\delta)$ equals zero, unanticipated inflation in period 1 has no effect on the demand curve (input prices) in period 2. In contrast if $\gamma(\delta)$ equals unity then unanticipated inflation in period 1 has the same effect on demand (input prices) in period 2 as unanticipated inflation in period 2 does. The expected growth between periods in real demand is given, in the absence of any unanticipated inflation by t_2 and the expected growth in input prices is similarly given by t_3.

Solving equation (26) for the optimal input levels, X_1 and X_2, and substituting these into the expressions for the realized profit levels, one obtains

(31) $\pi_1 = p_1 \hat{p}_1^{A} C v_1 - w_1 N$

$\pi_2 = p_2 \hat{p}_1^{A^*} \hat{p}_2^{A} C t v_2 - w_2 N$

where $A = \frac{a-b\psi\beta}{1-\psi\beta}$ $(=A_1=A_2)$ is the now constant elasticity of real value added w.r.t. the increases in the aggregate price level in the same period,

$A^* = \frac{a\gamma-b\delta\psi\beta}{1-\psi\beta}$ $(=A_1^*)$ is the now constant elasticity of the real value added in period 2 w.r.t. the increase in the aggregate price level in the previous period,

$v_i = \left(e_{1i}^{\psi} e_{2i} e_{3i}^{-\psi\beta}\right)^{1/(1-\psi\beta)}$ is the composite random multiplicative shock to real value added in period i

$t = \left(t_1^{\psi} t_2 t_3^{-\psi\beta}\right)^{1/(1-\psi\beta)}$ is the expected growth in real value added when unanticipated inflation is zero in both periods

and

$C = (1-\psi\beta)(N^{\alpha}\psi^{\beta}\beta^{\beta})^{\psi/(1-\psi\beta)}$ is a constant.

Moreover, Appendix C shows that the magnitude of the deferred payment is given by

$$(32) \qquad D = t\bar{p}^{-A}.$$

Finally, substituting (31) and (32) into (29) and (30), and making use of the other specific assumptions we have made, one can show that the formulas for the optimal degree of indexation become

$$(33) \qquad \varepsilon_1 = 1 + ((A + kA^*)/(1 + k)) \qquad \text{for } p_1 = \bar{p}$$ [24]

$$\varepsilon_2 = 1 + A$$

where $k = \rho D^{1-S} \underset{\tilde{p}}{E} \tilde{p}^{A(1-S)}$ is the common, for workers and the firm, ratio of the expected marginal utility in period 1 from an increase in the wage in period 1 to the expected marginal utility in period 2 of an increase in the wage in period 1, when the rate of inflation in period 1 equals its expected value.

Equations (32) and (33) immediately highlight a number of points. First, with the assumptions we have made, the formula for the optimal degree of indexation in the second period is identical to the formula for the optimal degree of indexation in the one-period model (see footnote 22). Second, the deferred increase D is proportional to the expected growth in real value added which the firm faces (t) when unanticipated inflation is zero in both periods. While the expected rate of productivity growth (t_1) influences this variable, so does the expected growth in demand (t_2) and the expected growth in other input prices (t_3). Third, unless the elasticity of real value added with respect to the increase in the price level in the same period (A) is zero, the expected inflation rate influences the size of the deferred increase, with higher expected inflation rates leading to lower (higher) deferred increases if A is greater (less) than zero.[25] Moreover, any parameter that influences A (a, b, η, β) will have opposite effects on the size of the deferred increase and on the degree of wage indexation in the second period. There is, then, a trade-off between COLA provisions and deferred wage increases.

What about the extent of wage indexation in the first period of the two-period contract? Is it larger or smaller than the extent of indexation that would prevail in a one-period contract (1 + A)? With workers and firms having the same relative risk aversion, perfect sharing of p_1 - risks <u>in the first period</u> would require that w_1 and π_1 have the same elasticity with respect to p_1, and hence that ε_1 would equal 1 + A. On the other hand, due to the serial correlation in the effect of unanticipated inflation on demand and on input prices, unanticipated inflation in period 1 also affects the wages and profit in period 2, and perfect sharing of p_1 - risks <u>in the second period</u> would require that w_2 and π_2 have the same elasticity with respect to p_1, and hence that the elasticity of w_2 with respect to p_1 would equal $1 + A^*$. However, since w_2 may depend on p_1 only through w_1, the elasticity of the wage with respect to p_1 is constrained to be the same in the two periods, and unless $A = A^*$, some inefficiency in the sharing of p_1 - risks is unavoidable.

Equation (33) shows that a weighed average of $1 + A$ and $1 + A^*$ is chosen, where the weights when p_1 equals $\bar{p}$ depend only on k.[26]

It is clear that the degree of indexation is larger in the first period of the two-period contract than it is in the one-period contract (recall the latter equals the degree of indexation in the second period of the two-period contract) only if A is less than A^*. The latter requires that

$$(34) \qquad a\gamma - b\delta\psi\beta > a - b\psi\beta$$

Is this likely to occur? While no general theoretical statements can be made, we can consider two special cases. First, suppose that b equals zero, so that unanticipated inflation does not influence input prices. If the degree of indexation in period 2 is less than complete $(\varepsilon_2 < 1)$, which is typically the case, then A and hence a will be less than zero. In this case, (34) will be satisfied as long as $\gamma < 1$. That is, the extent of indexation will be greater during the first period of the two-period model as long as the effect of unanticipated inflation on the firm's demand curve depreciates over time $(\gamma < 1)$.[27]

Second, suppose that b is not equal to zero but that the effect of unanticipated inflation on the demand and input price curves depreciates at the same rate $(\gamma = \delta)$. In this case, again as long as indexation is less than complete, so that A and $a - b\psi\beta$ are both less than zero, it follows that if γ is less than unity the extent of indexation will again be greater during the first period of the two-period contract.

These special cases suggest that a reasonable hypothesis to test empirically is, that as long as the observed extent of indexation is less than unity in the second period of a two-period contract, the extent of indexation will be higher in the first period. Since the former equals the extent of indexation in the one-period contract, on average the extent of indexation will be higher in the two-period contract. Put more generally, one might expect to observe contracts of longer durations having more generous COLA provisions. Since the same factors that influence the generosity of a COLA also influence the probability of COLA coverage (see Section III), one should expect to observe the incidence of COLA's increasing with contract duration. In fact, this occurs.[28]

V. THE OPTIMUM DURATION OF LABOR CONTRACTS

The last section suggested that, other things equal, the extent of indexation will be greater in a multiperiod contract than in a single period contract. But, what determines the optimal duration of a collective bargaining agreement? Clearly the parties to the agreement must consider the benefits and costs of contracts of different lengths and it is to this question that we now turn. For expository purposes we shall continue to contrast one- and two-period contracts.

Consider first the benefit side. We have emphasized before that, because inflation in the first period (p_1) can affect wages in the second period (w_2) only through its effect on wages in the first period (w_1), inflation risks are generally not shared efficiently in the two-period contract. Straightforward calculation shows that efficient sharing of inflation risks in the two-period model would require that the optimal degree of wage indexation would be equal in the two periods

$$(35) \qquad \varepsilon_1 = \varepsilon_2 = 1 + A \ ,$$

and that the base wage in period two would be the base wage in period one multiplied by

$$(36) \qquad t\bar{p}^{A} p_1^{A^*-A} \ .$$

Suppose that instead of the two-period contract, the union and the firm negotiate a sequence of two one-period contracts that actually have the properties specified in (35) and (36). That is, they actually agree in each period to have the extent of indexation called for in (35) and agree at the time they negotiate the second contract to have a deferred increase called for by (36). Such a sequence of contracts might arise if they consider each contract negotiation as an incident in a long-term relationship, if they are concerned with total expected utility rather than expected utility for any single period, and if they seek to negotiate a contract in period two which insures that all inflation risks are shared efficiently, when considered as of the time of the first negotiation. Such a sequence of two one-period contracts would clearly be preferred to the two-period contract.

The sequence of two one-period contracts has costs as well as benefits, however. These costs are of two types. First, there are costs to the employer and the union of conducting collective bargaining negotiations. These are the explicit and implicit resource costs of the negotiations process including, but not limited to, the time diverted from production, contract administration, and planning activities. While lost output due to strikes is an example of such costs, we emphasize that these costs may be substantial even in the absence of a strike or threat of strike. Multiperiod contracts obviously reduce the frequency with which these costs are incurred.

Second, since the two one-period contracts are negotiated sequentially, there is invariably some uncertainty, as of period one, as to what the terms of the second contract will be. Even if, on average, the outcomes in the second contract correspond to (35) and (36), the uncertainty will generate costs for the parties if they are risk averse. Multiperiod contracts reduce this form of uncertainty.

The choice of contract duration obviously involves a weighting of the loss from inefficient sharing of inflation risks if a multiperiod contract is chosen with the loss from additional bargaining costs and the uncertainty about the second period contract if two one-period contracts are chosen. To see the implications of this point, let c_b be the fixed real bargaining costs of each round of contract negotiations. Suppose, for simplicity, that the uncertainty in period one about the period two contract occurs with respect to the base wage in period two and that this has an expected value (as of period one) that is implied by equation (36) and a coefficient of variation of ϕ_b. Then using the same techniques that are used in Appendix B, one can show that the total real amount H_i that the workers and the firm are jointly willing to pay in period i in order to have one two-period contract rather than two one-period contracts is given for each period by

(37) $$H_1 \cong -\frac{(A-A^*)^2 k^2 \phi_p^2}{(1+k)^2}\left(1 + \bar{w}_1 N \frac{E_{e_1} \bar{\pi}_1^{-S-1}}{E_{e_1} \bar{\pi}_1^{-S}}\right)$$

(38) $$H_2 \cong \left[\phi_b^2 - \frac{(A-A^*)^2 \phi_p^2}{(1+k)^2}\right]\left(1 + \bar{w}_1 N \frac{E_{e_1} \bar{\pi}_1^{-S-1}}{E_{e_1} \bar{\pi}_1^{-S}}\right) + c_b \, .$$

While in general one cannot observe the continuous variables H_1 and H_2, one can observe whether a contract is two periods long and it is reasonable to postulate in empirical implementations that

(39) $$H = 1 \text{ if } H_1 + H_2 + u > 0$$
$$= 0 \text{ otherwise}$$

Here H equals one if a two-period contract is chosen and zero if two one-period contracts are chosen, and u is a random variable that summarizes all other unobservable forces that may influence contract duration.

It immediately follows from (37) to (39) that

(40) (a) $\partial H/\partial c_b > 0$

(b) $\partial H/\partial \phi_b > 0$

(c) $\partial H/\partial \bar{p} = 0$

(d) $\partial H/\partial \gamma \gtreqless 0$ as $a(A - A^*) \gtreqless 0$

(e) $\partial H/\partial \delta \gtreqless 0$ as $b(A - A^*) \lesseqgtr 0$

An increase in the cost of concluding collective bargaining negotiations (c_b) or in the uncertainty in the first period associated with the sequence of two one-period contracts due to not knowing what the wage bargain will be in the second period (ϕ_b), both obviously increase the probability of observing a two-period contract. Since the expected inflation rate $(\bar{p})$ does not affect the expected utility from contracts of either duration, it does not affect the choice of contract length.

The results for serial correlation in the effects of unanticipated inflation on demand (γ) and other input prices (δ) can be explained as follows. We know that if A^* equals A, a two-period contract distributes inflation risk efficiently and dominates two one-period contracts. Given A, the more A^* deviates from A, in absolute value, the less efficient is the distribution of inflation risks in the two-period contract, and consequently, the smaller would be the net benefits from having such a contract. Since

$$(41) \qquad \partial A^*/\partial\gamma \gtreqless 0 \quad \text{as} \quad a \gtreqless 0 \quad \text{and}$$

$$\partial A^*/\partial\delta \gtreqless 0 \quad \text{as} \quad b \lesseqgtr 0$$

the results for the effects of serial correlation, in unanticipated inflation on demand and other inputs prices follow directly.

The remaining parameters unfortunately influence the length of contract in complicated ways. For example, the uncertainty about the aggregate inflation rate (ϕ_p) affects H both directly and through its effect on k. Without still further restrictive assumptions, unambiguous implications about the signs of the effects of ϕ_p, S (risk aversion), a and b (demand and input price elasticities with respect to unanticipated inflation), η (the firm's own price elasticity of demand), and β (the elasticity of output w.r.t. non-labor input) cannot be drawn. All of these parameters do affect, however, the optimum duration of contracts.

VI. TEMPORARY LAYOFFS AND COLA COVERAGE

In this final theoretical section, we return to a one-period model with indexation of wages, but allow employment to be variable across states-of-the-world. This section stresses that temporary layoffs and the extent of indexation are simultaneously determined and highlights the role that several parameters of the unemployment insurance (UI) system play.[29]

Suppose that the nominal unemployment benefits that a laid off worker receives in a period is w_b. The benefit level may be specified as a function of the individual's previous earnings; what is important for our purposes is that w_b is not contingent on the realized price level during the period.

To capture the essence of the imperfectly experience rated aspect of the UI system, we assume that the nominal unemployment insurance tax that the firm must pay in the period is $rw_b(N - L) + T$. Here L is the number of union members actually employed during a period which implies, given the union membership level N, that $N - L$ workers are on temporary layoff. If r is less than one, experience rating is said to be imperfect and the firm does not bear the full marginal cost of the UI benefits that its laid off workers receive. If r is equal to one, the system is perfectly experience rated. Finally, if the firm is paying either the minimum or maximum tax rate, so that laying off an additional worker will not increase its UI tax rate, then r will equal zero (and T will be positive).[30]

In the presence of UI taxes, the firm's profit function becomes

$$\pi = pg[f(L,X),\hat{p}]f(L,X) - ph(\hat{p})X - wL - rw_b(N - L) - T \tag{42}$$

where for simplicity we have assumed that there is no residual uncertainty in the demand (e_1), production function (e_2) or in the price of non-labor inputs (e_3).

Suppose that the utility of a laid off worker is $Z(w_b/p)$, with $Z' > 0$, and that the utility of an employed worker continues to be $U(w/p)$; Z can be sufficiently general to allow for nonwork time to yield positive utility. If each worker has the same, probability of being laid off $(1 - (L/N))$, a worker's expected utility, given the price level, wage rate and employment level is $(L/N)U(w/p) + (1 - (L/N))Z(w_b/p)$.

As before, we do not attempt to fully describe the bargaining process by which a firm and a union reach a contract settlement. Contracts which provide for efficient sharing of inflation risks, however, will require that both the wage rate and the employment level will depend upon the price level and all such contracts can be found by choosing wage and employment schedules $w(p)$ and $L(p)$ to maximize

$$(43) \qquad \mathcal{L} = \underset{p}{E}[(L/N)U(w/p) + (1 - (L/N))Z(w_b/p)] + \lambda \underset{p}{E}V(\pi/p) + \mu \underset{p}{E}(N - L)$$

where larger values of λ again indicate that the firm wins a greater share of the "pie", μ will be equal to (greater than) zero if we are in a layoff (full employment) state of the world, and we have assumed a unique solution exists.

It is straightforward to show that the optimum wage and employment schedules must satisfy (for $L(p) < N$ and all p)

$$(44) \qquad -[U(w/p) - Z(w_b/p)]/U'(w/p) = \partial(\pi/p)/\partial L$$

That is, the worker's loss of utility from being laid off, divided by the marginal utility from raising the wage rate when employed should be set equal to the marginal real profit that the firm obtains from increasing employment.

Now if we hold the wage schedule, $w(p)$, constant, as well as p, N, and w_b, partially differentiating (44) with respect to r implies that[31]

$$(45) \qquad \partial L/\partial r = -(w_b/p)/[\partial^2(\pi/p)/\partial L^2] > 0$$

As the second order conditions for a maximum require that the term in brackets be negative, it immediately follows that

$$(46) \qquad \partial L/\partial r > 0.$$

Because increased marginal experience rating increases the cost of a layoff to the firm, increases in r lead to higher employment, and hence to fewer layoffs being associated with each realization of the price level.

Similarly, holding w, p, N, and r constant and partially differentiating (44) with respect to w_b, one obtains that

$$(47) \qquad \partial L/\partial w_b = -(r - (Z'/U'))[\partial^2(\pi/p)/\partial L^2]$$

Since the bracketed term is negative, the effect of increasing UI benefits on the employment level is the same sign as $r - (Z'/U')$. With imperfect experience rating r is less than one and if the marginal utility of income does not depend on whether the individual is working, then risk aversion on the part of workers and UI benefits that are less than the wage in each state-of-the-world $(w_b < w(p))$ guarantee that Z'/U' is greater than 1.[32] As a result,

$$(48) \qquad \partial L/\partial w_b < 0$$

Higher UI benefit levels should lead to lower employment and hence more layoffs.

To obtain implications about the effect of changing UI system parameters on the optimal degree of wage indexation, we contrast a realization of the price level for which there are layoffs $(L(p) < N)$, with a realization in which all union members are employed. Assuming that the wage, but not necessarily the employment level, in the unemployment state is unchanged when the UI parameters are changed, we investigate what happens to the wage in the full employment state.

Let a subscript L indicate the unemployment state and an N the full-employment state. It is straightforward to show that the maximization of (43) requires that

$$(49) \qquad U_L'/U_N' = V_L'/V_N'$$

Differentiating with respect to r for a constant w_L, allowing L and w_N to change, one obtains that

$$(50) \qquad \partial w_N/\partial r = - \frac{(V_L''/V_L')(p_N/p_L)}{(U_N''/U_N') + (V_N''N/V_N')} \left[\frac{\partial \pi}{\partial L}\frac{\partial L}{\partial r} - w_b(N - L)\right]$$

Since $\partial\pi/\partial L$ is less than zero and $\partial L/\partial r$ is greater than zero (from (45)) it follows that increased experience rating leads to a higher wage in the full-employment state. Thus, as long as the price level in the full-employment state is less than (greater than) the price level in the underemployment state, increases in experience rating increase (decrease) the extent of wage indexation. That is

$$(51) \qquad \partial\varepsilon/\partial r \gtrless 0 \quad \text{as} \quad p_N \lessgtr p_L$$

Which of these situations is more likely to prevail? One can show that the answer hinges on the value of A, the firm's elasticity of real value added with respect to the aggregate price level. Other things equal,

$$(52) \qquad p_N \lesseqgtr p_L \quad \text{as} \quad A \lesseqgtr 0$$

From (13) we know that if $A < 0$ indexation will be less than complete ($\varepsilon < 1$). Hence,

$$(53) \qquad \partial\varepsilon/\partial r \gtrless 0 \quad \text{as} \quad \varepsilon \lesseqgtr 1$$

As long as indexation is less than complete, an increase in experience rating will lead to an increase in the extent of wage indexation.[33]

By similar reasoning, holding r constant and allowing L and w_N to vary, one obtains

$$(54) \qquad \frac{\partial w_N}{\partial w_b} = \frac{-(V''_L/V'_L)(p_N/p_L)}{(U''_N/U'_N) + (V''_N N/V'_N)} \left[\frac{\partial\pi}{\partial L}\frac{\partial L}{\partial w_b} - r(N - L)\right]$$

Substituting (47) into (54) and noting that the product of all of the terms outside the brackets in (54) is negative, it follows that

$$\text{(55)} \qquad \text{sign of } \frac{\partial w_N}{\partial w_b} = \text{sign of } \left[r(N - L) + \left(r - \frac{Z'}{U'}\right) \frac{\partial \pi}{\partial L} \left(\frac{\partial^2(\pi/p)}{\partial L^2}\right)^{-1} \right]$$

The two terms within the brackets have opposite signs and hence one cannot unambiguously determine the sign of $\partial w_N/\partial w_b$ without further assumptions. Note, however, that the smaller the extent of experience rating (the smaller r), the more the second (negative) term dominates. Indeed, if r equals zero, we unambiguously know that increasing UI benefits will lead to a lower wage in the full-employment state. Following the logic used before, one can conclude in this case that

$$\text{(56)} \qquad \partial \varepsilon/\partial w_b \lesseqgtr 0 \quad \text{as} \quad \varepsilon \lesseqgtr 1$$

That is, if experience rating is zero $(r = 0)$ an increase in UI benefits will decrease (increase) the extent of wage indexation, as long as indexation is less than complete. More generally, if experience rating is positive, but sufficiently small to leave (55) negative, the above result will continue to hold. While we have not formally modelled the forces that influence the decision to have an indexed contract in the variable employment model, Section III suggests that most parameters that influence the degree of indexation, if it exists, also influence the probability of observing an indexed contract in a similar manner. Thus, it also seems likely that increased UI benefits will reduce the probability of observing an indexed contract.

VII. EMPIRICAL ANALYSES: TWO-DIGIT MANUFACTURING INDUSTRY DATA

The preceeding sections have presented a series of theoretical models that sought to ascertain the variables that influence the existence and generosity of COLA provisions in union contracts, the magnitude of deferred wage increases that are not contingent on the price level, the duration of labor contracts, and the level of temporary layoffs. The variables that the models suggest may play important roles are summarized in Table 4; as one can see they are a varied lot encompassing characteristics of the firm's demand curve, employee and employer risk aversion, characteristics of the bargaining relationship, macroeconomic variables, and parameters of the unemployment insurance system.

This section and the following one provide initial empirical tests of a few of the hypotheses generated by these models. In this section we use data at the two-digit manufacturing industry level of aggregation and focus on the determinants of both the fraction of the workers covered by major collective bargaining agreements that are also covered by a COLA provision and the industry layoff rate. In the next section, we use data at the individual collective bargaining agreement level and analyze the determinants of COLA coverage, characteristics of COLA's (when they exist), and the duration of collective bargaining agreements.

Our approach in this section is to estimate equations of the form

$$(57) \qquad F_{it} = \sum_{j=1}^{13} \Theta_{j1} v_{jit} + \sum_{k=1}^{4} \phi_{k1} a_{kit} + \Gamma_1 UI_i + \sum_{m=1}^{3} D_{m1} d_{it} + u_{1it}$$

and

$$(58) \qquad \ell_{it} = \sum_{j=1}^{13} \Theta_{j2} v_{jit} + \sum_{k=1}^{4} \phi_{k2} a_{kit} + \Gamma_2 UI_i + \sum_{m=1}^{3} D_{m2} d_{it} + u_{lit}$$

Here F_{it} represents the fraction of the workers that are covered by major collective bargaining agreements in industry i in year t that are also covered by COLA provisions and ℓ_{it} represents the three-year average layoff rate in industry i in year t.[34] The v's are variables that reflect personal characteristics of unionized workers in the industry and the industry bargaining structure, the a's are estimates of several demand related variables (elasticity of industry demand w.r.t. unanticipated inflation (a_1), serial correlation in the effect of unanticipated inflation on industry demand ($a_2 = \gamma$), the expected growth of demand ($a_3 = t$), and pure random variations in demand and productivity ($a_4 = \phi_v$)), UI represents the average net unemployment insurance replacement rate in the industry -- the average weekly UI benefits divided by the average weekly net (after tax) loss of income incurred by laid-off unemployed workers in the industry, the d are industry and year dummy variables, the u random variables, and Θ, ϕ, Γ, and D parameters to be estimated. A more complete description of the data, including its sources, is found in Appendix D and a complete list of the explanatory variables is found in Table 5.

Several comments should be made about this specification. First, we use data pooled across three years. Since many labor contracts are long-term in nature, we do not use adjacent years' data which would allow for the possibility of the same contract influencing the industry "outcome" variables in more than one year. Rather, we use data for 1975, 1978 and 1981.

Second, it is difficult to make unambiguous predictions about the expected signs of many of the v variables because they do not always correspond neatly in a one-to-one fashion with the list of variables in Table 4. For example, bargaining structure variables such as the number of unions in the industry (v_2), the percentage of unionized workers (v_3), and the percentage of workers covered by multiemployer agreements (v_5) may all be proxies for the costs of having indexed contracts (c_i), the costs of concluding collective bargaining agreements (c_b), and the share of the "pie" that the employer wins (λ). Similarly, while personal characteristics of unionized workers such as mean age (v_7), percent married (v_8), percent white (v_9), percent male (v_{10}), percent residing in SMSA's (v_{11}), mean schooling (v_{12}), and mean number of children (v_{13}) may reflect employee relative risk aversion (S), some may also influence the costs of conducting negotiations, the costs of indexed contracts, and indeed employer and employee demands for long-term employment relationships. As such, we will not spend alot of time below discussing these variables' coefficients.

Third, the estimated parameters of the demand function were obtained as follows. Using quarterly data on the consumer price index (P_t) from 1970 to 1978, an expected consumer price index series $(E(P(t))$ was generated using a fourth-order autoregressive model.[35] For each two-digit manufacturing industry, equations of the form

$$(59) \qquad \log(S_{it}/P_t) = h_{11} + h_{12}\log(P_t/E(P_t)) + h_{13}T + u_{1t}$$

and

$$(60) \qquad \log(S_{it}/P_t) = h_{21} + h_{22}\log(P_t/E(P_t)) + h_{23}\log(S_{it-1}/P_{t-1}) + h_{24}T + u_{2t}$$

were then estimated using quarterly data from 1971 to 1978, where S_{it} is the value of shipments in industry i in year t, T is a time-trend term that is incremented quarterly and the u are random error terms. When equation (59) is used, which assumes that there is no serial correlation in the effects of unanticipated inflation, a_1, a_3 and a_4 are estimated respectively by $\hat{h}_{12}$, $\hat{h}_{13}$ and $\hat{\sigma}^2_{u1}$. Similarly, when equation (60) is used, which allows for serial correlation in the effects of unanticipated inflation on demand, one can show that a_1, a_2, a_3 and a_4 are given respectively by $\hat{h}_{22}$, $\hat{h}_{23}$, $\hat{h}_{24}/(1 - \hat{h}_{23})$, and $\hat{\sigma}^2_{u2}$.[36]

Fourth, a key explanatory variable is the average unemployment insurance net replacement rate (UI); the average weekly UI benefits divided by the average weekly net (after tax) loss of income by laid-off unemployed workers in the industry. These data are obtained from a large scale microsimulation model of the unemployment insurance system built by the Urban Institute, and are based on data from the Survey of Income and Education.[37]

Finally, dummy variables that indicate the year the data are from and whether the industry is in durable manufacturing are also included in the model. The former are meant to control for variations in expected inflation and in the coefficient of variation of expected inflation over time. The latter is another proxy for negotiations costs, the elasticity of the firms' demand curve w.r.t. its own price and the costs of indexed contracts.

Estimates of variants of equations (57) and (58) are found in Tables 5, 6 and 7. The dependent variables in these tables are the fraction of the workers under major collective bargaining agreements who are covered by a COLA, the fraction of such agreements that contain COLA's, and the three-year average of the industry layoff rate, respectively. Quite strikingly a number of key implications of the models are confirmed.

For example, as suggested in Section VI, higher UI replacement rates in an industry are associated with a lower probability of observing an indexed contract (Tables 5 and 6) and a higher level of industry layoffs (Table 7). These results support the notion that cost of living indexation and the level of temporary layoffs are simultaneously determined.

To take another example, an increase in the elasticity of the demand curve w.r.t. unanticipated inflation (a_1) does appear to be associated with an increase in the probability of observing an indexed contract (Tables 5 and 6), as suggested in Section III. Furthermore, the effect of an increase in the serial correlation of unanticipated inflation on the probability of observing an indexed contract can be shown, from equation (33), to be the same sign as the elasticity of the demand curve w.r.t. unanticipated inflation. If indexation is less than complete $(\varepsilon < 1)$, which is what one typically observes, ceteris paribus this elasticity will tend to be less than zero (from (31), which implies that an increase in the serial correlation parameter should decrease the probability of observing an indexed contract. In fact (Tables 5 and 6), this is what we do observe.

An increase in residual uncertainty does appear to reduce the probability of observing indexed contracts (Tables 5 and 6); this result is consistent with the theoretical result that degree of indexation declines with increased residual uncertainty when the optimal degree of indexation is less than unity and employee relative risk aversion is greater than employer relative risk aversion (see equation (14)).[38] Where statistically significant, increased residual uncertainty also increases the industry layoff rate (Table 7); a result consistent with one's a priori expectations.

Also, an increase in the expected growth of demand does reduce the industry layoff rate (Table 7), as might be expected and, where significant, appears to increase the probability of observing indexed contracts (Tables 5 and 6). One can show, from (33), that the effect of an increase in the expected growth of demand is of the same sign as $(A^* - A)(1 - S)$. Since it is likely that $A^* > A$, this result is consistent with employees' relative risk aversion (S) being less than unity.[39]

Numerous associations between the other explanatory variables, COLA coverage and the layoff rate are also found. High quit rates, which suggest less permanent attachment of workers and firms, are associated with less COLA coverage and higher layoff rates. With respect to the bargaining structure variables, an increase in the number of unions in an industry, which reduces the bargaining power of each union, reduces COLA coverage, while an increase in the proportion of workers covered by unions increases it. The latter also is associated with higher layoff rates; a result consistent with the evidence presented by James Medoff (1979). Finally, increased coverage by multiemployer contracts, which tends to reduce wage competition among firms in an industry also leads to a greater probability of observing COLA's.

Where statistically significant, the greater the percentage of family income attributable to the wage earnings of the union member, the greater the probability of observing COLA coverage. In terms of the discussion in Section II, this suggests that other forms of family income tend to be fixed in real rather than nominal terms.

Finally, increases in the mean age of union members and their mean education level, and decreases in the percentages of them who are married, white, or reside in an SMSA, all are (where significant) associated with increased COLA coverage. The result for whites may reflect their greater access to capital markets and thus less need for COLA's to stabilize consumption over time. Similarly individuals residing in SMSA's may face more stable alternative earnings opportunities than individuals residing in smaller labor markets, again reducing the former's need for COLA coverage. Finally, higher levels of schooling may reflect higher levels of specific human capital and increased desire by firms and workers for long-term employment relations. This would lead to both increased COLA coverage and lower layoffs; the latter result is observed in Table 7.

In sum, while the results presented in this section can not be described as being totally unambiguous, they do generate some support for the relevance of the models that we developed in earlier sections.

VIII. EMPIRICAL ANALYSES: INDIVIDUAL CONTRACT DATA

This section provides further empirical tests of our models using data on COLA coverage, on the characteristics of COLA's when they exist, and on the duration of contracts, for individual manufacturing collective bargaining agreements covering more than 1,000 workers that were on file with the Bureau of Labor Statistics in 1981. The data on the characteristics of COLA's are of interest because contrary to popular impression, COLA provisions vary widely across union contracts, on a number of dimensions. For example, they vary in the frequency of review. Some contracts call for quarterly reviews and adjustments of wages, some for semi-annual reviews, and still others for annual ones.[40] Some allow for a COLA increase in the initial year of the contract, while others do not. Other things equal, the earlier the first cost-of-living adjustment and the more frequent the reviews, the greater the "yield" of the COLA. That is, the more complete indexation will be.

To take another example, COLA provisions also vary in their generosity per review. Some specify minimum price increases before any cost-of-living wage increase is granted. Others specify maximum cost-of-living adjustments, or "caps". Still others specify bands of price increases (e.g., 5 to 7 percent) for which no COLA wage increases will be granted. Clearly, such provisions affect the yield of a COLA.

Increases are typically specified as a one-cent increase in wages for each fractional point increase in the consumer price index. Among 102 major union contracts in 1979, this fraction varied between .3 and .6.[41] Larger fractions obviously represent less generous COLA's. The generosity of a COLA provision also depends upon the level of earnings of the covered employees. Since COLA's typically are specified in absolute terms (so many cents/hour), the higher the earnings of employees, other things equal, the less generous a COLA will be.[42]

When seeking to ascertain the generosity of a COLA provision, there are a number of strategies one might follow. First, one might estimate the <u>exante</u> degree of indexation by the <u>expost</u> degree of indexation; the elasticity of wages with respect to inflation that actually occurred. This is the approach followed by Hendricks and Kahn (1981).

Its weakness is that given the complex way COLA's are formulated, this number will typically depend nonlinearly on both the actual level of inflation and the various COLA provisions. Since the elasticity of wages with respect to inflation typically varies with the level of inflation, it is unclear whether one should attempt to summarize the provisions of a COLA by this single number. Furthermore, such a number at best would be an average expost elasticity; it would tell us nothing about the marginal effect of inflation on wages. Indeed, it is not difficult to think of circumstances in which contract A shows a greater COLA increase than contract B, given the actual inflation rate that occurred, but where the marginal COLA increase for increments of inflation would be larger in B than in A because of a cap on the COLA increase in A. It is unclear in such a case which contract one would want to argue has the more generous COLA provision.

A second approach is to argue that it is difficult to disentangle COLA increases and the portion of deferred noncontingent wage increases that are implicitly based on expectations of inflation. Indeed, if intracontract real wage changes are generally small, one might treat them as being zero and argue that the sum of the percentage deferred wage increases and the COLA increases that occurred expost, divided by the expost inflation rate, is a good measure of the exante elasticity of wages with respect to prices.

The theoretical models we presented in Sections IV and V suggest that such an approach may be incorrect; it <u>is</u> possible to model both the determinants of COLA increases and of deferred increases. Moreover, a simple numerical example illustrates the empirical difficulties inherent in such an approach. Consider two contracts. Suppose that the first calls for a five percent deferred increase and no COLA increase, while the second calls for no deferred increase, but a one percent COLA increase for each one percent increase in prices. If the expost increase in prices was five percent, the two would yield equal percentage increases in wages and, if the exante increase in prices was also five percent, the two would also yield equal expected wage increases. However, the former would provide workers with no protection against unanticipated inflation, while the latter would provide them with complete protection. Since we, and Card, have argued that a major motivation for COLA's is their risk sharing provisions, in particular the sharing of risks due to unanticipated inflation, it seems strange to argue that the two contracts offer equal COLA protection.[43]

A third approach, followed by David Card (1982), is to argue that because of the interdependence between deferred and COLA increases, it makes little sense to focus on the overall expost change in wages. Rather, Card measures the exante elasticity by the marginal elasticity of the wage escalator; the cents per point increase in the CPI that the escalator yields (while active) divided by the real contractual wage at the start of the contract. The weakness of this approach, of course, is that it ignores the presence of CAPS, nonlinearities, etc. For example, two contracts may initially offer the same COLA payment per point increase in the CPI, but if one has a CAP on the maximum size of the COLA payment and the other does not, one would not want to argue that both offer equal COLA protection. The weakness of his measure then lies in the restriction "while active".

The discussion above suggests that it may be inappropriate, indeed nearly impossible, to summarize all of the information about the generosity of a contract's COLA provisions in a single number. Hence, the strategy we follow in this section is to use information on a whole vector of contract provisions and to estimate a set of eleven equations of the form

(61) $Z_i = F_i(X) + u_i \qquad i = 1,2,\ldots 11$

Here Z_1 is a dichotomous variable that takes on the value of unity if there is a COLA provision and zero otherwise, Z_2 is a polytomous variable for contracts with COLA's that takes the value of one if the frequence of COLA review after the first year is monthly, two if it is quarterly, three if it is semi-annually, and four if it is annually, Z_3 is a dichotomous variable that is unity if there is a COLA review in the first year and zero otherwise, and Z_4 and Z_5 are variables that, for contracts with COLA's, show the number of cents that workers would receive for each one-point increase in the CPI and an estimate of the percentage point increase in wages the workers would receive for each percentage point increase in the CPI. For contracts with COLA's, Z_6 is the natural logarithm of the number of months until the first COLA review, while Z_7 is the logarithm of the contract duration (in months) for all contracts. Again for contracts with COLA's, Z_8 and Z_9 are dichotomous variables that capture the presence of guaranteed minimum COLA increases and caps, or maximum permissable COLA increases, respectively. Finally, Z_{10} and Z_{11} are variants of Z_4 and Z_5 that assign the value of zero to contracts in which COLA's do not exist. The latter two measures combine information on both the existence of a COLA provision and its generosity.

Each of these variables provides information on either the existence of a COLA, its generosity, or the duration of the underlying contract. A stringent test of our models then, is to look at the coefficients of a given explanatory variable across equations and to see if a consistent pattern of results is present. That is, does it appear that a given variable is influencing each of the outcomes in a way that is consistent with the underlying theoretical models?[44]

The explanatory variables (the X's) in this specification are similar to those used in the previous section and are meant to capture the same forces described there. With the exception of the number of employees covered by the contract, another proxy for the cost of concluding collective bargaining negotiations, all are specified at the two- or three-digit industry level and merged in from other sources. Three variables not used in the previous section, but included here, are the eight firm concentration ratio, the import/sales ratio in an industry, and wages as a share of shipments in the industry. The former two are meant to capture competitive pressures that the firm faces; increased product market competition; might lead to a reduced willingness to grant COLA's. The latter is a proxy for the share of labor in total costs. Also included, since the starting dates of the various contracts span a three-year period, are direct measures of the expected rate of inflation as of the contract date and the coefficient of variation of forecasters' expected inflation rates. These are obtained from the Livingston survey forecasts.[45]

The effect of unanticipated inflation on industry demand, the magnitude of the general trend in industry demand and productivity, and the magnitude of residual uncertainty are obtained from within three- or four-digit industry regressions of the form

$$(62) \qquad \log(PPI_{jt}/P_t) = \alpha_{0j} + \alpha_{1j} \log(P_t/E(P_t)) + \alpha_{2j}T + \varepsilon_{jt} .$$

where PPI_{jt} is the producer price index for industry j in period t, P_t is the consumer price index in period t, $E(P_t)$ is the expected consumer price index (which is generated as before), and T is a time trend term.[46] These equations are estimated using quarterly data for the 1973-1978 period.[47] Because of the small number of observations involved, it proved impossible to also estimate the parameter that reflected the serial correlation in the effects of unanticipated inflation on demand.

Table 8 presents estimates of each of the eleven equations. Depending upon the sample (all contracts or only those with COLA's) and the form of the dependent variables used, the estimation method is either probit (Z1, Z3, Z8, Z9), ordered probit (Z2), ordinary least squares (Z4, Z5, Z6, Z7), or Tobit (Z10, Z11). A list of explanatory variables appears in the table, while a more complete description of the data appears in Appendix D.

The results in this table can best be described as mixed. For example, an increase in the elasticity of the demand curve with respect to unanticipated inflation (X11), where significant, is associated with more frequent COLA reviews (Z2) and larger COLA increases (Z10), as suggested in Section II. Increased residual uncertainty, however, is also associated with more frequent COLA reviews (Z2), shorter duration until the first review (Z6), and larger COLA increases (Z5); Section II suggests that these results should obtain only if the optimal elasticity of wages with respect to prices is greater than one--a result rarely observed in these data. To take another example, where significant, higher UI replacement rates are associated with larger COLA increases; this contrasts both with our theoretical expectations and the estimates of the effects of UI on the probability of COLA coverage observed in the previous section.[48]

Some variables perform in a more consistent manner, either across equations or with respect to our hypotheses. For example, increases in the import/sales ratio (X7) are associated with decreases in both the probability of COLA coverage (Z1) and the size of COLA increases (Z10, Z11). Similarly, increases in wages as a share of shipments (X4) are associated with decreases in the probability of coverage (Z1) and the size of COLA increases (Z5, Z10, Z11). As long as the effect of unanticipated inflation on demand is larger than its effect on other input prices, these latter results are consistent with the theoretical prediction summarized in Table 3. Finally, as in the macro results reported in the last section, an increase in the share of total family income due to the wages of the union members (X25) is associated with an increase in the COLA payment.

The results for other variables, however, are more ambiguous. For example, increased unionization in an industry (X5), is associated with either lower (Z4) or higher (Z10) COLA payments, depending upon the estimation method used. Similarly, some demographic variables, such as age (X16), marital status (X17), and SMSA status (X20) affect the probability of COLA coverage in this micro data set in exactly the opposite direction that they did in the macro results reported in the previous section.

Table 8 also reports results for a contract duration equation. Contract length (Z7) is positively associated with the extent of unionization (X5), durable goods industries (X8), and the trend in productivity and demand (X12). It is negatively associated with industry concentration (X3) and the import/sales ratio (X7). Finally, several of the demographic characteristics variables appear to influence it; percent white (X18) and percent in SMSA (X20) positively and mean age (X16), percent male (X19), and percent craftsmen (X22) negatively. While many of these results are in accord with our prior expectations (from Section V), some are not. For example, one might have expected situations in which skilled workers were involved (high values for X22) to be ones in which both firms and workers pushed for long-term contracts. Apparently, however, this does not occur.

In sum, the results of this section at best can be described as mixed. They are sufficiently ambiguous that they cannot be said to provide strong support for the validity of our theoretical models. A possible explanation for the ambiguity may lie in our method of testing. It may be unreasonable to expect that one can estimate the effect of an explanatory variable on ten dimensions of a COLA provision and hope to observe a consistent pattern of coefficients across equations. After all, the theoretical models provide hypotheses about the elasticity of wages with respect to prices, not about timing of reviews, minimum increase, caps, etc. While we believe our criticisms of the approaches of previous investigators are valid, our approach in this section obviously has its own problems.[49]

IX. CONCLUDING REMARKS

This paper has presented a series of theoretical models that sought to ascertain the determinants of COLA provisions in union contracts, the generosity of these provisions when they exist, the magnitude of deferred wage increases that are not contingent on the price level, the duration of labor contracts and the level of temporary layoffs. The factors that we highlighted were a varied lot and encompassed characteristics of the firm's demand curve (including how it responds to unanticipated inflation), employee and employer risk aversion, characteristics of the bargaining relationship (including the costs of concluding negotiations), macroeconomic variables, and parameters of the unemployment insurance system.

Two initial empirical tests of the hypotheses generated by the models were provided. The first test used data at the two-digit manufacturing industry level of aggregation and focused on the determinants of the fraction of workers covered by COLA provisions and on the industry layoff rate. This analysis, which made use of pooled cross-section time-series data, appeared to confirm a number of key implications of the models. In particular, higher UI replacement rates were associated both with lower probabilities of observing indexed contracts and higher levels of layoffs in an industry. The second test used data at the individual collective bargaining agreement level and focused on the determinants of COLA coverage, the characteristics of COLA agreements when they exist, and the duration of labor contracts. Unfortunately, the results here were much more mixed and did not provide strong support for the models.

In spite of the mixed nature of these empirical results, we believe that this paper has demonstrated the usefulness of analyzing the determinants of these union contract provisions in the context of risk-sharing models. Numerous extensions suggest themselves. At the empirical level, it is clear that better measures of the "exante degree of indexation" must be devised. Neither the single parameter measures used by Card (1981) and Hendricks and Kahn (1982) that are based on exante marginal elasticities over an initial range and expost wage increases respectively, nor the multiple (10) parameter measures used by us seems to be appropriate. Using a single parameter measure based on the COLA increase that would have resulted if the expected price increase at the time of the negotiations actually occurred, seems equally inappropriate for reasons we discussed in Section VIII. At the very least, what is required is a two-parameter measure that contains information on both the expected COLA wage increase and the marginal change in the wage increase that would result from unanticipated inflation.

We have also only begun to test the implications of the models. One productive line of testing would focus on the trade-off between COLA increases and deferred noncontingent wage increases that was discussed in Section IV and see if the models proved useful in explaining such splits. Much more work also needs to be done on the determinants of contract duration and on the effects of UI parameters (both replacement rates and experience rating) on the COLA-layoff trade-off.

At the theoretical level, an important unresolved issue is why COLA provisions typically take the form of "X cents per one point increase in the CPI" rather than "X percent increase in wages for each percentage increase in the CPI"? As is well known, the former type scheme will tend to compress wage differentials within a firm, while the latter will keep them constant? What is needed here are models of union decision-making processes that highlight how heterogeneity of union members and different voting schemes will lead to different types of contract provisions. Ultimately, such theoretical modelling would lead to empirical research on the determinants of the type of COLA provision adopted.

Similarly, the existence of minimum price level increases that are required before COLA coverage starts in some contracts, and caps or maximum increases in others, suggests that risk-sharing agreements often exist only over a subset of possible states of the world. It may be useful to try to model the conditions that lead such restrictions to occur and then to empirically test the usefulness of such models.

Table 1

Coverage of Cost-of-Living Escalator Provisions in Major Union Contracts[a]

Date	Number of Workers Covered by Major Union Contracts (millions)	Number Covered by Cost-of-Living Provisions (millions)	Percent Covered by Cost-of-Living Provisions	Annual Percent Change in the Consumer Price Index in the Previous Year[b]
1/55	7.5	1.7	23	-.5
1/57	7.8	3.5	45	2.9
1/58	8.0	4.0	50	3.0
1/59	8.0	4.0	50	1.8
1/60	8.1	4.0	49	1.5
1/61	8.1	2.7	33	1.5
1/62	8.0	2.5	31	1.7
1/63	7.8	1.9	24	1.2
1/64	7.8	2.0	26	1.6
1/65	7.9	2.0	25	1.2
1/66	10.0	2.0	20	1.9
1/67	10.6	2.2	21	3.4
1/68	10.6	2.5	24	3.0
1/69	10.8	2.7	25	4.7
1/70	10.8	2.8	26	6.1
1/71	10.6	3.0	28	5.5
1/72	10.4	4.3	41	3.4
1/73	10.5	4.1	39	3.4
1/74	10.3	4.0	39	8.8
1/75	10.2	5.1	50	12.2
11/75	10.2	5.9	58	7.0
11/76	10.0	6.0	61	4.8
11/77	9.7	5.8	60	6.8
11/78	9.6	5.6	58	9.0
11/79	9.4	5.5	59	13.3
11/80	9.3	5.3	57	12.4
10/81	9.0	5.1	56	8.9

Table 1 (continued)

Source: H.M. Douty, Cost-of-Living Escalator Clauses and Inflation (Council on Wage and Price Stability, August 1975), Table 1 (for data through January 1975).

Monthly Labor Review, January issues for 1976-1982 (for data from November 1975 on). 1982 Economic Report of the President (Washington, D.C., 1981), Table B55 (consumer price index).

. . . .

[a]Contracts covering 1,000 or more workers in private industry. Prior to 1966 the construction, service, finance, and real estate industries were excluded.

[b]CPI changes are measured from December to December for all years. Hence, the 1/55 figure covers the 12/53-12/54 period, the 1/75 figure covers the 12/73-12/74 period. The 11/75 figure covers the 12/74-12/75 period, etc.

Table 2

Prevalence of Cost-of-Living Adjustment (COLA) Clauses in Major Collective Bargaining Agreements, November 1980

SIC Code/Industry		All Contracts		Percent	
		Workers Covered (000's)	Number of Contracts	Workers Covered by COLA's	Contracts With COLA's
	Total	9,333	1,989	57.0	38.8
10	Metal Mining	56	14	79.5	78.6
11	Anthracite Mining	2	1	100.0	100.0
12	Bituminous Coal Mining	160	1	0.0	0.0
15	Building Construction, General Contractors	685	170	7.2	5.3
16	Construction Other than Building Const.	471	118	14.5	9.3
17	Construction-Special Trade Contractors	432	201	11.7	10.4
20	Food & Kindred Prods.	313	99	31.6	34.3
21	Tobacco Manufacturing	28	8	88.0	75.0
22	Textile Mill Prods.	46	19	6.5	10.5
23	Apparel and Other Finished Products	486	55	32.2	18.2
24	Lumber and Wood Prods.	66	15	4.2	13.3
25	Furniture & Fixtures	28	17	35.9	41.2
26	Paper & Allied Prods.	98	66	3.8	3.0
27	Printing & Publishing	63	33	34.7	24.2
28	Chemicals & Allied Products	83	44	27.4	27.3
29	Petroleum & Related	37	19	0.0	0.0
30	Rubber & Misc. Prods.	83	15	81.5	66.7
31	Leather	38	16	0.0	0.0
32	Stone, Clay, Glass and Concrete Products	91	36	73.2	63.9
33	Primary Metals	476	118	94.6	87.3
34	Fabricated Metals	116	59	78.5	71.2
35	Machinery, Except Electrical	289	93	93.4	88.2
36	Electrical Mach.	448	103	90.9	77.7

Table 2 (continued)

SIC Code/Industry		All Contracts: Workers Covered (000's)	All Contracts: Number of Contracts	Percent: Workers Covered by COLA's	Percent: Contracts With COLA's
37	Trans. Equip.	1,209	107	94.3	81.3
38	Instruments and Related Prods.	49	16	57.3	43.8
39	Misc. Manufacturing	23	13	15.9	15.4
40	Railroad Trans.	432	18	100.0	100.0
41	Local & Urban Transit	16	4	93.3	75.0
42	Motor Freight Trans.	476	20	98.3	85.0
44	Water Transportation	95	19	37.5	36.8
45	Trans. by Air	176	43	78.6	62.8
48	Communications	734	42	90.2	61.9
49	Electric, Gas & Sanitary Services	224	77	14.2	15.6
50	Wholesale Trade-Durables	44	26	27.5	30.8
51	Wholesale Trade-Nondurables	17	4	13.2	25.0
53	Retail Trade-General Merchandise	85	23	34.2	26.1
54	Food Stores	532	105	62.7	48.6
55	Automotive Dealers & Service Stations	18	11	8.2	9.1
56	Apparel & Accessory Stores	8	5	0.0	0.0
58	Eating & Drinking Places	80	25	0.0	0.0
59	Misc. Retail Stores	18	7	43.4	42.9
60-65	Finance, Insurance, Real estate	126	21	36.5	42.9
70-89	Services	376	83	5.4	12.0

Source: Douglas LeRoy, "Scheduled Wage Increases and Cost-of-Living Provisions in 1981," Monthly Labor Review, January 1981.

Table 3

Summary of Main Results:
One-Period Fixed Employment Model

Increase in Parameter	Degree of Indexation (ε)	Probability of Indexation ($\hat{B}$)
elasticity of demand curve w.r.t. unanticipated inflation (a)	+	+
elasticity of other input prices w.r.t. unanticipated inflation (b)	-	-
elasticity of firm demand w.r.t. its real price (η)	$\overset{+}{\underset{-}{0}}$ as $a \overset{>}{\underset{<}{=}} b$	$\overset{+}{\underset{-}{0}}$ as $a \overset{>}{\underset{<}{=}} b$
elasticity of output w.r.t. other input (β)	$\overset{+}{\underset{-}{0}}$ as $a \overset{>}{\underset{<}{=}} b$	$\overset{+}{\underset{-}{0}}$ as $a \overset{>}{\underset{<}{=}} b$
employee risk aversion (S)	$\overset{+}{\underset{-}{0}}$ as $A \overset{<}{\underset{>}{=}} 0$	+
expected inflation ($\bar{p}$)	0	0
coefficient of variation in expected inflation (ϕ_p)	0	+
costs of indexation (c_i)	**	-
pure random variation in demand, productivity and other input prices (ϕ_v)	$\overset{-}{\underset{+}{0}}$ as $A(S-R) \overset{<}{\underset{>}{=}} 0$*	+*

*See the text for the specific assumptions necessary to obtain these results.

**The effect will depend on the distribution of the cost between workers and firm as well as on many parameters of the model.

Table 4

Variables That Influence COLA Provisions, Deferred Increases, Contract Duration, or Temporary Layoffs

Symbol	Variable
a	elasticity of demand curve w.r.t. unanticipated inflation
b	elasticity of non-labor input prices w.r.t. unanticipated inflation
η	elasticity of firm's demand w.r.t. its real price
β	elasticity of output w.r.t. nonlabor inputs
S	employee relative risk aversion
R	employer relative risk aversion
$\bar{p}$	expected aggregate inflation rate
ϕ_p	coefficient of variation in expected inflation
c_i	costs of having indexed contracts
ϕ_v	coefficient of variation of the pure random variation in demand, productivity and other input prices.
M	nonlabor income (family income other than the employee's labor income)
γ	serial correlation in the effect of unanticipated inflation on the demand curve
δ	serial correlation in the effect of unanticipated inflation on other input prices
t	expected growth in real valued added when unanticipated inflation is zero
c_b	cost of each round of collective bargaining negotiations
ϕ_b	coefficient of variation of the uncertainty about the size of non-contingent wage increases in future short-term contracts
r	extent of experience rating in the UI system
w_b	level of UI benefits
λ	share of the "pie" that the employer wins

Table 5

Determinants of Fraction of Workers Covered by a COLA, By 2-Digit Manufacturing: 1975, 1978, 1981 (absolute value of t-statistic)[a]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
v1	-.117. (2.9)	-.054 (1.8)	-.056 (1.5)	-.039 (1.2)	.008 (0.1)	.014 (0.3)	.142 (1.6)
v2	-.008 (1.5)	-.002 (0.4)	-.017 (3.3)	-.007 (1.4)	-.012 (2.2)	-.007 (1.6)	-.009 (1.1)
v3	.087 (1.7)	.040 (0.9)	.268 (4.7)	.141 (2.7)	.222 (3.6)	.133 (2.5)	.144 (1.8)
v4	-.001 (0.1)	-.008 (1.1)	-.007 (0.8)	-.011 (1.5)	-.011 (1.2)	-.011 (1.5)	-.012 (1.3)
v5	.559 (1.5)	.769 (2.9)	.440 (1.4)	.696 (2.6)	.220 (0.7)	.540 (1.8)	.263 (0.6)
v6	4.315 (2.9)	5.123 (4.3)	.422 (0.3)	2.795 (2.0)	-.192 (0.1)	1.980 (1.2)	.290 (0.1)
v7	.048 (1.8)	.114 (4.5)	.031 (1.3)	.098 (3.9)	.054 (2.0)	.100 (4.0)	.089 (2.4)
v8	-6.357 (3.5)	-4.325 (3.1)	-6.127 (4.2)	-5.010 (3.7)	-3.789 (1.8)	-3.524 (1.9)	-1.255 (0.5)
v9	-1.983 (1.1)	-6.597 (3.1)	1.255 (0.7)	-4.914 (2.3)	1.522 (1.0)	-3.432 (1.4)	-2.162 (0.7)
v10	-.933 (1.7)	-.146 (0.4)	.152 (0.3)	.524 (1.2)	.653 (1.1)	.685 (1.5)	1.072 (1.9)
v11	.185 (0.1)	.688 (0.7)	-4.176 (3.2)	-2.172 (1.6)	-3.053 (2.1)	-1.634 (1.1)	-1.365 (0.7)
v12	.329 (1.0)	.360 (1.2)	.759 (2.6)	.732 (2.3)	.390 (1.0)	.442 (1.1)	.193 (0.4)
v13	1.187 (1.2)	1.091 (1.2)	-2.061 (2.0)	-1.084 (1.0)	-1.481 (1.3)	-.685 (0.6)	-.607 (0.4)
a_1	.078 (2.6)	.044 (1.6)	.065 (2.6)	.056 (2.2)	.031 (1.0)	.003 (1.0)	.000 (0.0)
a_2		-.995 (3.0)		-.606 (1.7)		-.664 (1.9)	-.834 (2.0)
a_3	27.120 (1.5)	1.006 (0.7)	33.506 (2.2)	1.891 (1.3)	10.794 (0.5)	1.752 (1.2)	1.111 (0.6)
a_4	-59.172 (2.2)	-5.914 (0.2)	-75.091 (3.3)	-25.556 (1.0)	-43.323 (1.4)	-7.547 (0.2)	1.144 (0.0)
UI					-1.754 (1.6)	-1.226 (1.2)	-2.637 (1.8)
D1			.731 (4.8)	.413 (2.8)	.724 (4.9)	.431 (3.0)	.435 (2.5)
D2			.066 (1.1)	.091 (1.9)	.099 (1.6)	.112 (2.2)	-.063 (1.0)
D3			.093 (1.4)	.085 (1.6)	.138 (2.0)	.127 (2.0)	
LD							.121 (0.7)
R^2	.771	.872	.870	.904	.869	.908	.945
n	60	60	60	60	60	60	40

Table 5 (continued)

where	v1	3-year average of the quit rate
	v2	number of unions in the industry
	v3	percentage of unionized workers in the industry
	v4	3-year average of the profit rate
	v5	percentage of workers covered by multiemployer agreements in the industry
	v6	percentage of income due to wage earnings of the union member
	v7	mean age of union members
	v8	percentage of union members who are married
	v9	percentage of union members who are white
	v10	percentage of union members who are male
	v11	percentage of union members residing in SMSA's
	v12	mean schooling level of union members
	v13	mean number of children in married union members' families
	D1	1=durable goods industry, 0=not
	D2	1=1981, 0=not
	D3	1=1978, 0=not
	UI	average UI net replacement rate = average weekly UI benefits/average weekly net (after tax) loss of income by laid-off unemployed workers in the industry
	LD	lagged (3 years) dependent variable
	a_1	estimate of elasticity of industry demand w.r.t. unanticipated inflation
	a_2	estimate of serial correlation in the effect of unanticipated inflation on industry demand
	a_3	estimate of expected growth in demand
	a_4	estimate of pure random variation in demand, productivity, and other input prices
	a	See Appendix D for a description of data sources.

Table 6

Determinants of the Fraction of Contracts that Contain COLA's, By 2-Digit Manufacturing Industries: 1975, 1978, 1981 (absolute value of t-statistic)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
v1	-.104 (3.0)	-.052 (1.9)	-.041 (1.3)	-.031 (1.2)	.022 (0.5)	.006 (0.1)	.116 (2.1)
v2	-.007 (1.6)	-.001 (0.2)	-.016 (3.8)	-.007 (1.8)	-.012 (2.5)	-.007 (1.9)	-.010 (2.2)
v3	.064 (1.5)	.012 (0.3)	.231 (5.0)	.129 (3.0)	.188 (3.8)	.123 (2.9)	.168 (3.5)
v4	.002 (0.2)	.005 (0.8)	-.004 (0.5)	-.008 (1.3)	-.008 (1.0)	-.008 (1.4)	-.004 (0.7)
v5	.337 (1.0)	.617 (2.6)	.207 (0.8)	.507 (2.3)	-.001 (0.0)	.396 (1.7)	-.012 (0.1)
v6	4.048 (3.2)	4.982 (4.6)	.478 (0.4)	2.283 (2.0)	-.106 (0.1)	1.697 (1.3)	-.102 (0.1)
v7	.038 (1.7)	.104 (4.6)	.023 (1.2)	.085 (4.2)	.045 (2.1)	.086 (4.3)	.049 (1.9)
v8	-5.813 (3.8)	-4.740 (3.8)	-5.573 (4.7)	-5.432 (5.1)	-3.354 (2.0)	-4.363 (3.0)	-2.051 (1.3)
v9	-1.308 (0.9)	-6.130 (3.3)	1.754 (1.3)	-4.063 (2.4)	-2.007 (1.6)	-2.996 (1.5)	-1.392 (0.7)
v10	-1.068 (2.3)	-.314 (0.9)	-.084 (0.2)	.043 (1.3)	.392 (0.8)	.547 (1.5)	.593 (1.7)
v11	.034 (0.3)	.468 (0.5)	-3.603 (3.5)	-2.756 (2.5)	-2.538 (2.2)	-2.368 (2.0)	-2.169 (1.9)
v12	.258 (0.9)	.392 (1.5)	.631 (2.7)	.798 (3.3)	.281 (1.0)	.590 (1.9)	.421 (1.3)
v13	1.319 (1.5)	1.018 (1.3)	-1.594 (1.9)	-1.425 (1.5)	-1.044 (1.2)	-1.137 (1.2)	-1.158 (1.3)
a_1	.068 (2.7)	.053 (2.2)	.056 (2.8)	.066 (3.2)	.024 (1.0)	.047 (1.7)	.019 (0.7)
a_2		-.656 (2.2)		-.230 (0.9)		-.272 (1.0)	-.486 (1.9)
a_3	21.984 (1.4)	1.915 (1.4)	28.046 (2.3)	2.862 (2.4)	6.492 (0.4)	2.763 (2.3)	1.744 (1.5)
a_4	51.388 (2.2)	-8.182 (0.3)	-66.145 (3.6)	-30.104 (1.4)	-35.998 (1.5)	-17.134 (0.7)	-12.428 (0.4)
UI					-1.664 (1.9)	-.883 (1.0)	-1.632 (1.8)
D1			.665 (5.5)	.467 (4.0)	.659 (5.6)	.480 (4.1)	.420 (3.6)
D2			.079 (1.7)	.101 (2.6)	.111 (2.3)	.116 (2.8)	-.087 (2.2)
D3			.117 (5.1)	.105 (2.4)	.161 (2.9)	.136 (2.6)	
LD							.220 (1.5)
R^2	.790	.878	.886	.929	.896	.924	.972
n	60	60	60	60	60	60	40

See Table 5 for variable definitions.

Table 7

Determinants of the Industry Layoff Rate (3-Year Average), By 2-Digit Manufacturing Industry: 1975, 1978, 1981 (absolute value of t-statistic)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
v1	.006 (6.3)	.006 (7.5)	.004 (4.9)	.004 (5.7)	.003 (2.2)	.001 (0.8)	.000 (0.0)
v2	.000 (0.6)	-.000 (0.9)	.000 (1.5)	.000 (0.9)	.000 (0.6)	.000 (1.4)	.000 (1.6)
v3	.004 (3.1)	.005 (4.2)	.003 (2.6)	.002 (1.8)	.004 (3.0)	.003 (2.5)	.003 (1.9)
v4	-.001 (0.4)	.000 (0.1)	-.000 (1.6)	-.000 (1.2)	-.000 (1.2)	-.000 (1.3)	-.000 (1.2)
v5	-.024 (2.8)	-.021 (2.8)	-.015 (2.1)	-.007 (1.0)	-.011 (1.3)	.004 (0.6)	.011 (1.1)
v6	-.028 (0.8)	-.025 (0.7)	-.030 (0.9)	.026 (0.7)	-.017 (0.5)	.086 (2.4)	.127 (2.4)
v7	-.000 (0.5)	-.001 (1.4)	-.000 (0.3)	-.000 (0.1)	-.001 (1.0)	-.000 (0.4)	.000 (0.4)
v8	-.002 (0.0)	.022 (0.5)	-.016 (0.5)	-.014 (0.4)	-.066 (1.4)	-.122 (2.9)	-.197 (3.0)
v9	.215 (5.2)	.268 (4.7)	.189 (5.0)	.171 (3.1)	.184 (4.9)	.065 (1.1)	.043 (0.5)
v10	-.021 (1.7)	-.038 (3.4)	-.014 (1.2)	-.037 (3.3)	-.025 (1.8)	-.049 (4.8)	-.063 (4.0)
v11	.042 (1.5)	.057 (2.0)	.023 (0.8)	.074 (2.0)	-.000 (0.0)	.035 (1.0)	.031 (0.7)
v12	-.025 (3.2)	-.031 (3.6)	-.020 (3.0)	-.026 (3.1)	-.012 (1.4)	-.005 (0.6)	-.002 (0.1)
v13	.064 (2.7)	.083 (3.3)	.046 (1.9)	.091 (3.0)	.033 (1.3)	.062 (2.3)	.074 (2.1)
a_1	-.001 (1.9)	-.002 (2.4)	-.001 (2.1)	-.001 (1.8)	-.000 (0.6)	.001 (0.9)	.001 (1.2)
a_2		-.029 (3.0)		-.024 (2.6)		-.020 (2.5)	-.018 (1.8)
a_3	-.076 (1.8)	-.107 (2.4)	-.686 (2.0)	-.085 (2.2)	-.202 (0.4)	-.075 (2.2)	-.085 (1.9)
a_4	1.106 (1.7)	.539 (0.6)	.967 (1.8)	.566 (0.8)	.291 (0.4)	-.739 (1.0)	-.805 (0.7)
UI					.037 (1.4)	.089 (3.7)	.124 (2.9)
D1			.003 (0.9)	-.004 (1.0)	.003 (0.9)	-.005 (1.5)	-.008 (1.8)
D2			-.001 (0.5)	-.000 (0.3)	-.001 (0.9)	-.002 (1.7)	.005 (2.1)
D3			-.006 (4.2)	-.006 (4.2)	-.007 (4.4)	-.009 (6.1)	
LD							-.284 (1.5)
R^2	.749	.788	.857	.866	.860	.903	.921
n	60	60	60	60	60	60	40

See Table 5 for variable definitions.

Table 8

Determinants of COLA Provisions and Contract Duration in Major Collective Bargaining Agreements: BLS Contract File (absolute value t statistics)

Dep. Var. Est. Meth.	Z1 Prob	Z2 NPro	Z3 Prob	Z4 OLS	Z5 OLS	Z6 OLS	Z7 OLS	Z8 Prob	Z9 Prob	Z10 Tob	Z11 Tob
Ind. Var.											
X1	.011(1.5)	-.001(0.2)	-.000(0.1)	.006(1.8)	.002(1.1)	.001(0.3)	-.000(0.0)	-.203(4.1)	.174(3.7)	.009(0.6)	.002(0.3)
X2	-.053(0.9)	.307(3.4)	.273(2.6)	-.071(2.0)	.043(3.2)	.112(2.2)	-.012(1.4)	-.026(0.2)	.067(0.5)	-.186(1.5)	.008(0.2)
X3	.471(1.8)	-1.240(3.4)	-1.190(2.7)	-.045(0.3)	-.001(0.0)	-.801(3.7)	-.143(4.0)	.392(0.8)	-.430(0.9)	.153(0.3)	-.000(0.0)
X4	-2.640(2.5)	3.028(1.9)	2.703(1.5)	-1.630(2.7)	-.301(1.2)	2.266(2.4)	.091(0.6)	6.056(2.7)	-5.070(2.3)	-10.100(4.5)	-3.060(4.4)
X5	.181(0.7)	.071(0.2)	-.175(0.4)	-.320(2.0)	-.027(0.5)	.109(0.5)	.157(4.4)	1.511(2.3)	-1.330(2.1)	1.248(2.3)	.212(1.3)
X6	.005(0.6)	-.012(0.8)	-.005(0.3)	.013(2.2)	.005(2.3)	.009(1.1)	-.001(0.5)	-.013(0.5)	-.016(0.7)	.028(1.5)	.004(0.7)
X7	-1.580(3.5)	-.183(0.3)	-.371(0.4)	-.051(0.1)	.055(0.4)	-.233(0.5)	-.144(2.3)	-1.560(1.0)	1.472(1.0)	-8.720(6.3)	-2.320(6.1)
X8	1.321(9.2)	-.094(0.4)	.242(0.9)	-.076(0.7)	-.041(1.0)	.106(0.8)	.091(4.4)	-.196(0.5)	-.037(0.1)	3.521(10.5)	1.118(10.5)
X9	-.026(0.8)	-.031(0.7)	-.019(0.3)	.034(2.2)	.002(0.3)	-.013(0.5)	.004(0.8)	-.142(2.4)	.129(2.3)	-.006(0.1)	-.008(0.4)
X10	2.998(1.6)	-.243(0.1)	-1.510(0.5)	.301(0.3)	.719(2.0)	-.346(0.2)	-.350(1.3)	1.236(0.3)	-1.940(0.5)	6.118(1.7)	2.644(2.3)
X11	.007(0.2)	-.184(2.3)	-.216(2.2)	.021(0.7)	-.008(0.6)	-.012(0.2)	.003(0.8)	-.099(1.0)	.153(1.5)	.153(1.8)	.037(1.4)
X12[a]	.710(3.5)	.791(2.3)	1.076(2.2)	.005(0.4)	.001(0.2)	.127(0.7)	.047(1.7)	.299(0.7)	-.292(0.7)	2.325(5.6)	.685(5.6)
X13[a]	-.007(0.0)	-1.181(1.8)	-2.974(2.4)	-.042(0.2)	.168(2.0)	-1.756(4.5)	.018(1.2)	.714(0.9)	-1.109(1.4)	.597(1.2)	.178(1.3)
X14	.507(0.5)	1.534(0.9)	-.481(0.2)	1.128(1.4)	.230(0.7)	-.107(0.1)	-.165(1.1)	-1.920(0.6)	2.678(0.9)	3.666(1.4)	1.313(1.7)
X15	.116(2.8)	.021(0.3)	-.008(0.1)	.074(2.9)	-.001(0.1)	-.029(0.8)	-.009(1.5)	-.294(2.9)	.242(2.4)	.251(2.9)	.077(2.9)
X16	-.068(2.4)	.040(0.9)	.075(1.4)	-.011(0.6)	.008(1.2)	.079(3.0)	-.013(3.0)	-.056(0.8)	.036(0.5)	-.251(4.1)	-.072(3.7)
X17	2.548(2.7)	-.238(0.2)	-.344(0.2)	1.051(1.7)	.054(0.2)	.052(0.1)	.174(1.3)	1.138(0.5)	-1.500(0.7)	5.315(2.5)	1.041(1.6)
X18	-2.620(3.1)	-.593(0.5)	-.648(0.4)	-1.410(3.1)	.009(0.5)	.235(0.3)	.351(2.9)	3.784(2.3)	-3.620(2.2)	-4.970(2.8)	-1.110(2.0)
X19	-1.550(3.1)	-2.110(2.7)	-1.510(1.7)	.445(1.3)	.147(1.2)	-1.090(2.3)	-.217(3.1)	-4.730(3.3)	4.006(3.1)	-.525(0.5)	.025(0.7)
X20	1.275(3.3)	-.750(1.2)	-.534(0.7)	.299(1.0)	.187(1.8)	-.375(1.1)	.235(4.3)	.640(0.6)	-.496(0.5)	3.318(3.7)	.949(3.5)
X21	-.120(1.0)	.511(3.0)	.343(1.7)	-.091(1.4)	.013(0.5)	.106(1.1)	-.007(0.4)	.506(2.3)	-.506(2.3)	-.259(1.0)	-.082(1.1)
X22	-.741(1.3)	-2.210(2.7)	-2.170(2.2)	-2.170(2.2)	-.247(0.8)	-.330(2.6)	-.748(1.6)	-.174(1.2)	2.503(1.8)	-1.880(1.5)	-2.200(1.9)
X23	-.206(1.1)	.641(1.7)	.404(0.9)	.104(0.8)	-.038(0.7)	.424(1.9)	.052(1.9)	-.057(0.1)	-.192(0.4)	.377(0.9)	.091(0.7)
X24	-.370(0.8)	.531(0.8)	1.682(2.1)	-.476(1.9)	.186(1.8)	.320(0.8)	-.263(3.8)	.560(0.5)	-1.060(1.0)	-1.090(1.2)	-.141(0.5)
X25	.239(0.3)	.629(0.4)	.016(0.0)	1.549(2.4)	-.152(0.6)	.472(0.5)	.146(1.3)	-.577(2.3)	3.410(1.4)	.839(0.4)	.543(0.9)
R^2				.366	.293	.287	.174				
ln(L)	-510.18	-364.02	198.86					-152.17	-159.01	-922.56	-590.018
DF	1011	445	445	306	329	431	1009	290	290	832	855

Table 8 (continued)

Dependent Variables (* sample includes only contracts with COLAs)

Z1	1 = contract has COLA, 0 = no COLA
Z2*	frequency of COLA review after first year: 1 =monthly, 2 = quarterly, 3 = semi-annual, 4 = annual
Z3*	1 = COLA review in first year, 0 = no review
Z4*	COLA formula - numbers of cents for each point increase in the CPI
Z5*	COLA formula - estimated percentage point increase in wages for each percentage point increase in the CPI
Z6*	logarithm of months until first COLA review
Z7	logarithm of contract duration (in months)
Z8*	1 = minimum COLA increase guaranteed, 0 = no minimum
Z9*	1 = maximum COLA increase or cap, 0 = no cap
Z10	COLA formula - number of cents per each point increase in the CPI. 0 if no COLA
Z11	COLA formula - estimated percentage point increase in wages for each percentage point increase in the CPI, 0 if no COLA

Estimation Methods

Prob	Probit
NPro	Ordered Probit
OLS	Ordinary Least Squares
Tobit	Tobit

Explanatory Variables**

X1	number of employees covered by the contract
X2	industry quit rate
X3	8 firm concentration ratio
X4	wages as a share of shipments in the industry
X5	percentage of production workers unionized in the industry (3 digit)
X6	number of different unions representing workers in the industry (2 digit)
X7	imports/total sales in the industry
X8	1 = durable goods industry, 0 = nondurable
X9	mean rate of expected inflation - Livingston survey forecasts - 6 month forecast prior to date of contract
X10	coefficient of variation of forecasters expected inflation rate
X11	estimate of α_{1j}
X12	estimate of α_{2j}
X13	estimate of residual variance
X14	average UI net replacement rate in the industry = average weekly UI benefits/average weekly net (after tax) loss of income of laid-off workers
X15	mean family income
X16	mean age
X17	percentage married
X18	percentage white
X19	percentage male
X20	percentage residing in SMSA's
X21	mean schooling
X22	percentage craftsmen
X23	mean number of children
X24	percentage residing in the south
X25	share of total family income due to wages of union member

X11–X13: from the within-industry regression

$$\log\left(\frac{PPI_{jt}}{P_t}\right) = \alpha_{0j} + \alpha_{1j}\log\left(\frac{P_t}{E(P_t)}\right) + \alpha_{2j}T + \epsilon_{jt}$$

X15–X25: union members in the 3-digit census industry

** Also included were dummy variables for nonreporting of import/sales ratio, producer price indices, and the concentration rate.

a Coefficient has been divided by 100

See Appendix D for a complete description of the data.

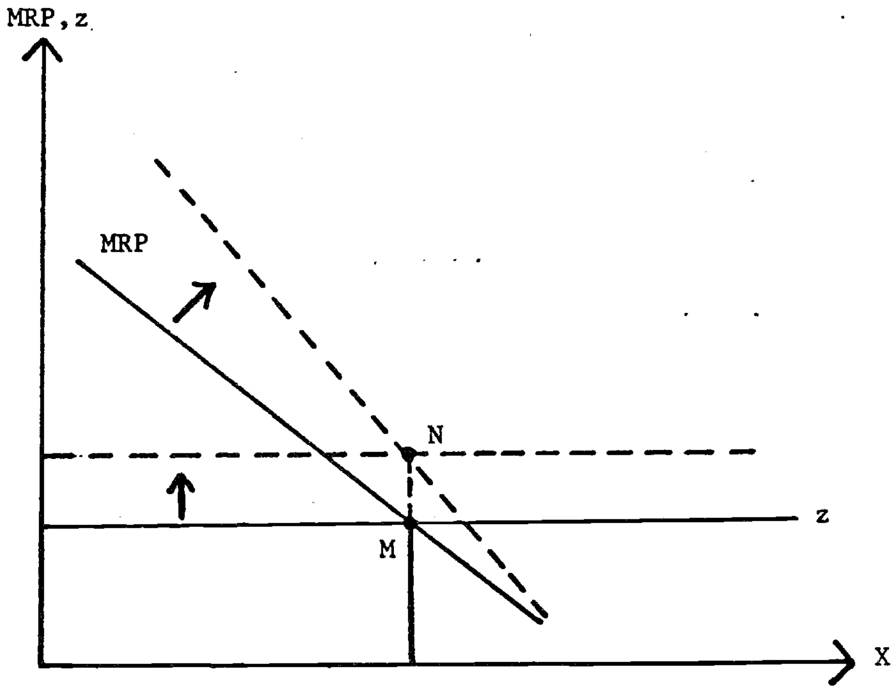

Figure 1a

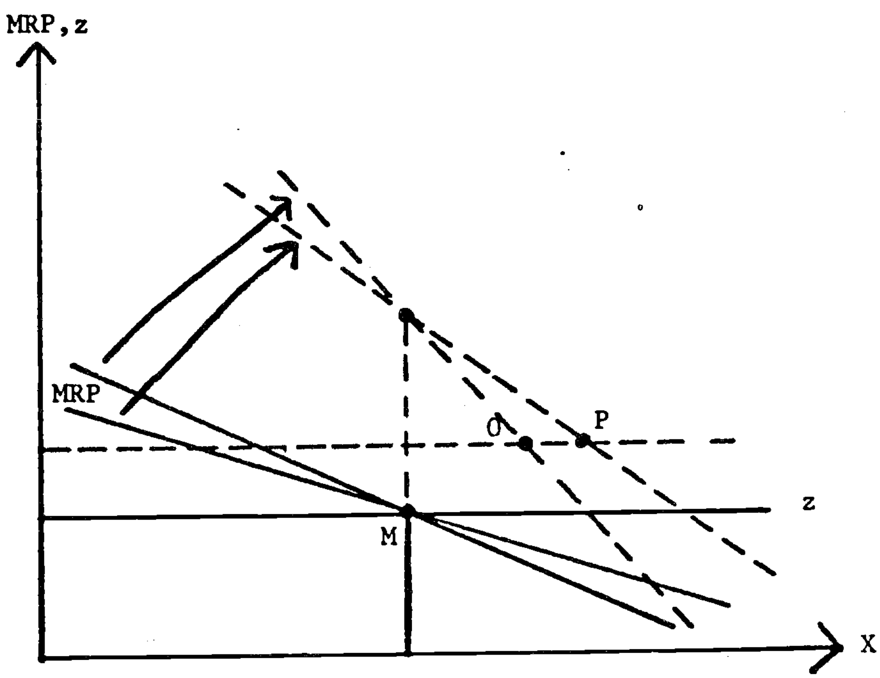

Figure 1b

FOOTNOTES

1. See H.M. Douty (1975) for a more complete discussion of the history of cost-of-living clauses in union contracts in the United States.

2. We say rekindling since academic interest in the effect of indexation schemes, such as COLA's, on the economy goes back at least as far as Alfred Marshall (1886).

3. See, for example, Daniel Mitchell (1980) and Marvin Kosters (1977).

4. On the growing insensitivity of the aggregate rate of wage inflation to unemployment, see James Tobin (1980). On the insensitivity of deferred wage increases, including COLA's, in union contracts to unemployment, see Daniel Mitchell (1978).

5. For evidence on the "yield" from COLA's, see Victor Shiefer (1979). We will return to this point below. Henry Farber (1981), Wallace Hendricks and Lawrence Kahn (forthcoming), Lawrence Kahn (1981), and Wayne Vroman (1982) have presented evidence on the role of COLA's in the inflationary process.

6. For details of this argument and aggregate evidence that the presence of COLA's reduce strike activity, see Bruce Kaufman (1981). See also Martin Mauro (1982) for a similar argument and empirical evidence using individual contract negotiation data.

7. Important contributions here include Robert J. Barro (1977), Olivier J. Blanchard (1979), Stanley Fisher (1977a; 1977b), and JoAnna Gray (1976; 1978).

8. The relevant papers here are Costas Azariadis (1978), Leif Danziger (1980), and Steven Shavell (1976). Important initial contributions to the "implicit contract" literature include Costas Azariadis (1975), Martin Baily (1974), Donald Gordon (1974), and Hershel Grossman (1977).

9. See David Estenson (1981), Wallace Hendricks and Lawrence Kahn (forthcoming), Lawrence Kahn (1981), and David Card (1981; 1982). The former three studies are primarily empirical in nature; they do not provide rigorous analytical models that permit them to identify all of the forces that influence COLA's. Our paper is more in the tradition of Card's work, although in some respects (which we note below) our model is more general than his, and his empirical analyses use Canadian contract data.

10. There are, of course, exceptions to this statement. The "ton tax" method of financing fringe benefits that prevailed for many years in the bituminous coal industry is an example of a contract where compensation is contingent upon productivity; as is well known, this scheme was designed to reduce employers' incentives to substitute capital for labor. Similarly, the recent UAW contract with Chrysler and the airline contracts with Eastern Airlines, that tie compensation to profits, implicitly are contingent on all uncertain events.

11. For more on this point, see the discussion between Robert Barro (1977) and Stanley Fisher (1977-a).

12. The key role of <u>unanticipated</u> inflation in the indexation decision has been previously noted by David Card (1981). Richard Parks (1978) showed that relative prices are affected by unanticipated inflation, but not by perfectly anticipated inflation.

13. See Jan Svejnar (1982) for an attempt to accomplish this objective.

14. Indexation to other variables is discussed below.

15. The elasticity of MRP w.r.t. x is $\psi\beta$, where from (11) $\psi = 1-\eta^{-1}$.

16. Hendricks and Kahn (1982) erroneously concluded that increased employee risk aversion always would lead to increased wage indexation.

17. Although $\bar{p}$ and ϕ_p do not influence ε directly, it is conceivable that they influence the bargaining over the total pie available and thus affect ε through this route (see equation (12) and Martin Feldstein (1980) and Eytan Sheshinski and Yoram Weiss (1977) on this point).

18. Note further that if A is also less than zero, so that indexation is less than complete, this implies that increased residual uncertainty reduces the extent of indexation. This apparently is a hypothesis that Estenson (1981) and Hendricks and Kahn (1982) sought to test, although they did not distinguish between anticipated and unanticipated aggregate inflation.

19. In determining the monetary value of indexation, we assume that $\bar{w}$ and hence also $\bar{\pi}$ are the same for indexed and non-indexed contracts. As our discussion about c_i should indicate, this may not be an innocuous assumption and it should be viewed as a further approximation.

20. This assumes that $0 < \varepsilon < 2$. Differentiating B partially w.r.t. S and using equation (12) yields

$$\partial B/\partial S = \frac{1}{2}\,\bar{w}\phi_p^2\;\varepsilon[2\partial\varepsilon/\partial S(S-\bar{w}N\;E_e V''/E_e V') + \varepsilon]$$

$$= \frac{1}{2}\,\bar{w}\phi_p^2\;\varepsilon[2(1-\varepsilon) + \varepsilon] = \frac{1}{2}\,\bar{w}\phi_p^2\varepsilon(2-\varepsilon) > 0 \quad \text{if} \quad 0 < \varepsilon < 2.$$

21. The effect of these costs on the degree of indexation, if it occurs, is ambiguous and depends, among other things, on the distribution of the costs between the workers and the firm.

22. With the assumptions stated in the text, $\varepsilon = 1 + A$ and B becomes

$$B = \frac{1}{2}\,\bar{w}N\phi_p^2(1+A)^2\;S(1 + \bar{w}N E_e \bar{\pi}^{-R-1} / E_e \bar{\pi}^{-R}).$$

Since the term in the parentheses increases with ϕ_v it follows that $\partial B/\partial\phi_v > 0$ as long as $\varepsilon \neq 0$.

23. The demand and input prices may depend also on unanticipated inflation in periods before period 1. However, since there is no uncertainty about the unanticipated inflation in periods before period 1, this dependency needs not be made explicit.

24. The formula is more complex for $p_1 \neq \bar{p}$.

25. The reason that D is proportionate to $\bar{p}^{-A}$ is that although only the unanticipated change in the aggregate price level $(\hat{p}_2)$ has real effects, the wage gets indexed to the total change in the aggregate price level $(\tilde{p})$. To avoid the expected change in the aggregate price level having real effects y must therefore be proportional to $\bar{p}$ for all $\hat{p}_2$. Since $\tilde{p} = \hat{p}_2\bar{p}$ and $\varepsilon_2 = 1 + A$, this is obtained by multiplying t by $\bar{p}^{-A}$ in D. Consequently, assuming that $\bar{p} > 1$, the effects of a, b, η, and β on D are the opposite of their effects on ε_2.

26. Perfect sharing of $\tilde{p}$ risks requires only that w_2 and π_2 have the same elasticity with respect to $\tilde{p}$ and hence that $\varepsilon_2 = 1 + A$. Thus, there is no inefficiency in the sharing of $\tilde{p}$ - risks.

27. If a equals zero, and $\varepsilon_2 < 1$ one similarly can show that one requires that $\delta < 1$ to get the same result.

28. For example, Douty (1975) reports that in 1975 3.2 percent of all contracts with a duration of one year, 14.8 percent of all contracts with a duration of two years, and 50.0 percent of all contracts with a duration of three years contained a COLA (these figures refer to major collective bargaining agreements only).

Note that it may also be reasonable to assume that the effect of within-period unanticipated inflation on demand and input prices is closer to zero in the second period than in the first. If this is the case, it provides another reason for the degree of indexation being closer to complete in long-term contracts.

29. Martin Feldstein (1976) has stressed the effect of UI system parameters on temporary layoffs, but he does so in the context of a model in which both workers and firms are risk neutral so that the degree of indexation is indeterminate. See also Martin Baily (1977).

30. See Frank Brechling (1982) for a more detailed parameterization of the financing of the UI system.

31. In general, a change in UI system parameters may lead to changes in both the wage schedule w(p) and the employment schedule L(p). Without developing an explicit bargaining model or holding some variables constant, one cannot obtain implications about how a parameter change affects either schedule if both are allowed to freely vary. In what follows in this section then, we always must specify carefully what we are holding constant. When we look at parameter changes on employment, we will hold the whole wage schedule constant. When we look at parameter changes on the extent of indexation (below), we will hold the "full-employment" employment level and the wage rate associated with some arbitrary price level constant.

32. One could, of course, allow for utility from leisure by specifying that $Z(X) = U(X) + m$ where m is the utility the worker receives from leisure time (not working). This obviously satisfies the condition in the text.

33. This conclusion, and the one that follows, ignores that fact that whether $p_L \gtrless p_N$ will also depend upon the parameters of the UI system. For example, an increase in the price level decreases the real value of UI benefits; this makes layoffs more attractive to the firm, and less attractive to workers and, without full knowledge of the bargaining process, we cannot unambiguously ascertain how this will affect the layoff rate associated with each price level. We assume in what follows that this effect is small and that the relationship between p_N and p_L can be inferred solely from the sign of A.

34. As noted earlier, <u>major</u> collective bargaining agreements are those that cover 1,000 or more workers.

35. Simpler autoregressive structures yielded virtually identical results.

36. Suppose that $(S_{it}/P_t) = a_0 \prod_{r=0}^{\infty} [(P_{t-i}/E(P_{t-i}))]^{a_1 a_2^r} e^{a_3 t} e^{u_{it}}$

where a_1 represents the effect of unanticipated inflation on demand, a_2 the serial correlation in the effects of unanticipated inflation and a_3 the expected growth in demand. Taking logs of the equation, lagging it one period and multiplying the lagged equation by a_2 and then subtracting this from the unlagged equation, the result in the text immediately follows.

We should caution here that these parameters may actually represent parameters of the real value added function, not parameters of the demand curve. However, since the implications that result would essentially be the same, for expository convenience we continue in the text to refer to them as parameters of the demand function. An analogous problem arises with respect to the parameters of equation (62) below.

37. See Wayne Vroman (1980) for a description of the model and data. We are grateful to him for generously providing us with these data.

38. As Section III suggests, however, there are situations in which increased residual uncertainty would increase the probability of observing an indexed contract, which is <u>not</u> the empirical result we observe.

39. Some studies, however, find that relative risk aversion exceeds unity. See, for example, Henry Farber (1978) and Irwin Friend and Marshall Blume (1975).

40. For example, in 1981 45 percent of all major collective bargaining agreements with COLA's called for quarterly reviews, 21 percent called for semi-annual reviews, and 30 percent had annual reviews (see Douglas LeRoy (1981)).

41. See AFL-CIO (1979).

42. COLA's may also be excluded from wages for the purpose of computing certain nonwage benefits in some cases (e.g., vacation pay) and some contracts also permit COLA adjustments to be deferred to pay for nonwage benefits (e.g., COLA being used to finance improved benefits for retirees rather than increased pay for existing employees).

43. Our discussion of these two approaches should make it clear why we consider it equally inappropriate to use the expected COLA increase, valued at the expected level of inflation over the contract, as a measure of the generosity of a COLA. This measure, which Hendricks and Kahn inform us they plan to use in future work, tells us little about the response of wages to unanticipated inflation.

44. This test may be excessively stringent. To see this note that more generous COLA provisions are, ceteris paribus, those with frequent reviews, reviews in the first year, large wage increases for given CPI increases, a short number of months until the first review, minimum guaranteed COLA increases, and no maximum permissable increase (cap). If a variable, in theory, should increase generosity, we test if it has influenced each of the above in a way that increases, or does not affect, the COLA. A weaker test would allow some of the provisions to move in "opposite directions" as long as the net effect is to make the COLA more generous. This would require us, however, to reduce the COLA formula to a single number and, as we have argued in the text, we do not believe that this is a wise strategy.

45. We are grateful to John Carlson of Purdue for providing the unpublished data for the most recent years to us.

46. The Livingston Series could not be used here since the underlying survey is conducted every six months and we required quarterly expectations.

47. Producer price indices for many of the industries were not collected prior to 1973. 1978 was chosen as the end date because most of the contracts in the sample commenced at that date or later.

48. Of course, since only 1 of 11 UI coefficients is statistically significant, and that at less than the .05 level, this may reflect only a spurious correlation.

49. In any case, we did not receive the micro data in a form that would allow us to use the approaches of either Hendricks and Kahn (1982) or Card (1981).

APPENDIX A

The first order condition for maximization of $\mathcal{L}$ is

(A1) $$\frac{d\mathcal{L}}{dw} = \frac{U'}{p} - \frac{\lambda N}{p} \underset{e}{E}V' = 0 \iff U' = \lambda N \underset{e}{E}V'$$

Eq. (A1) is the condition for efficient sharing of inflation risks, and it implies that the workers and the firm have identical marginal rates of substitution between different realization of p. Differentiating eq. (A1) totally w.r.t. p,

$$U'' \frac{d(w/p)}{dp} = \lambda N \underset{e}{E}V'' \left[\frac{\partial(gf-hx)}{\partial p} - N \frac{d(w/p)}{dp} + \frac{\partial \pi}{\partial x} \frac{1}{p} \frac{dx}{dp} \right]$$

Multiplying by p and noting that the last term in the brackets vanishes due to eq. (8) in the text,

(A2) $$\frac{U''w}{p} (\varepsilon-1) = \lambda N \underset{e}{E}V'' \left[agf - bh\dot{x} - \frac{wN}{p} (\varepsilon-1) \right].$$

Eq. (8) implies that

(A3) $$\left(q + \frac{\partial g}{\partial f}\right) \frac{\partial f}{\partial x} = h \iff \psi\beta gf = hx,$$

which together with eq. (7) becomes

(A4) $$gf = \frac{\pi+wN}{p(1-\psi\beta)}$$

where $1 - \psi\beta > 0$ due to eq. (8). Substituting eqs. (A3) and (A4) into (A2),

$$\text{(A5)} \qquad \frac{U''w}{p}(\varepsilon-1) = \lambda N \underset{e}{E} V''\left[A\frac{\pi+wN}{p} - \frac{wN}{p}(\varepsilon-1)\right],$$

which shows that A is the elasticity of real value-added w.r.t. p. Dividing by eq. (A1) and rearranging,

$$\text{(A6)} \qquad \varepsilon = 1 - \frac{\underset{e}{E}V''A\,\frac{\pi+wN}{p}}{S\underset{e}{E}V' - \frac{wN}{p}\underset{e}{E}V''}$$

To derive results about how ε is related to the extent of residual uncertainty, we make the following assumptions:

$$f(N,X,e_1) = N^{\alpha}x^{\beta}e_1 \qquad \text{where } \alpha > 0,\ \beta > 0$$

$$g(Q,\hat{p},e_2) = Q^{-1/\eta}\hat{p}^{a}e_2$$

$$h(\hat{p},e_3) = \hat{p}^{b}e_3$$

$$V(\pi/p) = (1-R)^{-1}(\pi/p)^{1-R}.$$

Equation (A6) becomes

$$\varepsilon = 1 + A\frac{R + RwN\,\underset{e}{E}\pi^{-R-1}/\underset{e}{E}\pi^{-R}}{S + RwN\,\underset{e}{E}\pi^{-R-1}/\underset{e}{E}\pi^{-R}}.$$

Approximate π^{-R-1} and π^{-R} by the first three terms in a Taylor series expansion around $\ddot{\pi} = \underset{e}{E}\pi$. Accordingly,

$$\frac{\underset{e}{E}\pi^{-R-1}}{\underset{e}{E}\pi^{-R}} \simeq \frac{\underset{e}{E}[\ddot{\pi}^{-R-1}-(R+1)\ddot{\pi}^{-R-2}(\pi-\ddot{\pi}) + \frac{1}{2}(R+1)(R+2)\ddot{\pi}^{-R-3}(\pi-\ddot{\pi})^2]}{\underset{e}{E}[\ddot{\pi}^{-R-1}-R\ddot{\pi}^{-R-1}(\pi-\ddot{\pi}) + \frac{1}{2}R(R+1)\ddot{\pi}^{-R-2}(\pi-\ddot{\pi})^2]}$$

$$= \frac{\ddot{\pi}^2 + \frac{1}{2}(R+1)(R+2)(\ddot{\pi}+wN)^2\phi_v^2}{\ddot{\pi}[\ddot{\pi}^2 + \frac{1}{2}R(R+1)(\ddot{\pi}+wn)^2\phi_v^2]},$$

which increases in ϕ_v. The result in the text follows.

APPENDIX B

The real amount I a worker is willing to pay in order to have his wage indexed is defined by

$$\underset{p}{E}U\left(\frac{w_n}{p}\right) = U\left(\underset{p}{E}\frac{w}{p} - I\right),$$

where w_n is the constant wage if there is no wage indexation, and w, as previously defined, is the wage with wage indexation. An approximate value for I is given by

$$I \simeq \underset{p}{E}\frac{w}{p} - \underset{p}{E}\frac{w_n}{p} - I_1 + I_2,$$

where I_1 and I_2 are the risk premium a worker is willing to pay in order to obtain a certain real wage instead of w/p and w_n/p, respectively. That is,

$$\text{(B1)} \qquad \underset{p}{E}U\left(\frac{w}{p}\right) = U\left(\underset{p}{E}\frac{w_n}{p} - I_1\right).$$

$$\text{(B2)} \qquad \underset{p}{E}U\left(\frac{w_n}{p}\right) = U\left(\underset{p}{E}\frac{w_n}{p} - I_2\right).$$

Approximate $U(w/p)$ by the first three terms of a Taylor series expansion around $p = \bar{p}$,

$$\underset{p}{E}U(\frac{w}{p}) \simeq \underset{p}{E}(U(\bar{w}) + U'(\bar{w}) \frac{d(w/p)}{dp}\Big|_{p=\bar{p}} (p-\bar{p})$$

$$+ \frac{1}{2}\{U''(\bar{w})[\frac{d(w/p)}{dp}\Big|_{p=\bar{p}}]^2 + U'(\bar{w}) \frac{d^2(w/p)}{dp^2}\Big|_{p=\bar{p}}\}(p-\bar{p})^2)$$

$$= U(\bar{w}) + \frac{1}{2}[U''(\bar{w})\bar{w}^2(\varepsilon-1)^2 + U'(\bar{w})\bar{p}^2 \frac{d^2(w/p)}{dp^2}\Big|_{p=\bar{p}}]\phi_p^2, \tag{B3}$$

where ε is evaluated at $p = \bar{p}$.

Approximate $U(\underset{p}{E} \frac{w}{p} - I_1)$ by the first two terms of a Taylor series expansion around $\underset{p}{E}w/p - I_1 = \bar{w}$, and then w/p by the first three terms of a Taylor series expansion around $p = \bar{p}$,

$$U(\underset{p}{E} \frac{w}{p} - I_1) \simeq U(\bar{w}) + U'(\bar{w})(\underset{p}{E} \frac{w}{p} - I_1 - \bar{w})$$

$$\simeq U(\bar{w}) + U'(\bar{w})\{\underset{p}{E}[\bar{w} + \frac{d(2/p)}{dp}\Big|_{p=\bar{p}} (p-\bar{p}) + \frac{1}{2} \frac{d^2(w/p)}{dp^2}\Big|_{p=\bar{p}} (p-\bar{p})^2] - I_1 - \bar{w}\}$$

$$= U(\bar{w}) + U'(\bar{w})[\frac{1}{2} \frac{d^2(w/p)}{dp^2}\Big|_{p=\bar{p}} \bar{p}^2\phi_p^2 - I_1]. \tag{B4}$$

In view of eq. (B1) one therefore obtains from eqs. (B3) and (B4)

$$- U'(\bar{w})I_1 \simeq \frac{1}{2} U''(\bar{w})\bar{w}^2(\varepsilon-1)^2\phi_p^2$$

$$\Rightarrow I_1 \simeq \frac{1}{2} S\bar{w}(\varepsilon-1)^2\phi_p^2,$$

where S is evaluated at $w/p = \bar{w}$.

Since the unindexed wage is constant, a similar derivation based on eq. (B2) leads to

$$I_2 \simeq \frac{1}{2} S\bar{w}\phi_p^2,$$

and consequently,

$$I \simeq \underset{p}{E} \frac{w}{p} - \underset{p}{E} \frac{w_n}{p} + S\bar{w}\varepsilon \ (1-\frac{\varepsilon}{2})\phi_p^2.$$

Similarly, the real amount J the firm is willing to pay in order to index the wages is defined by

$$\underset{p,e}{E} V(\frac{\pi_n}{p}) = \underset{e}{E} V(\underset{p}{E} \frac{\pi}{p} - J),$$

where π_n is the profit if there is no indexation, and π, as previously defined, is the profit with indexation. An approximate value for J is given by

$$J \simeq \underset{p,e}{E} \frac{\pi}{p} - \underset{p,e}{E} \frac{\pi_n}{p} - J_1 + J_2,$$

where J_1 and J_2 are the risk premiums the firm is willing to pay in order to eliminate inflation uncertainty with indexed and unindexed wages, respectively. That is, (B5) $$\underset{p,e}{E} V(\frac{\pi}{p}) = \underset{e}{E} V(\underset{p}{E} \frac{\pi}{p} - J_1)$$

(B6) $$\underset{p,e}{E} V(\frac{\pi_n}{p}) = \underset{e}{E} V(\underset{p}{E} \frac{\pi_n}{p}) - J_2)$$

Approximating $V(\pi/p)$ by the first three terms of a Taylor series expansion around $p = \bar{p}$,

$$\underset{p,e}{E} V(\frac{\pi}{p}) \simeq \underset{p,e}{E} (V(\bar{\pi}) + V'(\bar{\pi}) \frac{d(\pi/p)}{dp}\Big|_{p=\bar{p}} (p-\bar{p})$$

$$+ \frac{1}{2}\{V''(\bar{\pi}) [\frac{d(\pi/p)}{dp}\Big|_{p=\bar{p}}]^2 + V'(\bar{\pi}) \frac{d^2(\pi/p)}{dp^2}\Big|_{p=\bar{p}}\}(p-\bar{p})^2)$$

(B7) $$= \underset{e}{E} V(\bar{\pi}) + \frac{1}{2} \underset{e}{E}\{V''(\bar{\pi})[(\bar{\pi}+\bar{w}N)A - \bar{w}N(\varepsilon-1)]^2 + V'(\bar{\pi})\bar{p}^{-2} \frac{d^2(\pi/p)}{dp^2}\Big|_{p=\bar{p}}\}\phi_p^2,$$

where ε is evaluated at $p = \bar{p}$.

Approximating $V(\underset{p}{E}\pi/p - J_1)$ by the first two terms of a Taylor series expansion around $\underset{p}{E}\pi/p - J_1 = \bar{\pi}$, and then π/p by the first three terms of a Taylor series expansion around $p = \bar{p}$,

$$\underset{e}{E} V(\underset{p}{E} \frac{\pi}{p} - J_1) \simeq \underset{e}{E} V(\bar{\pi}) + \underset{e}{E}[V'(\bar{\pi})(\underset{p}{E} \frac{\pi}{p} - J_1 - \bar{\pi})]$$

$$\simeq \underset{e}{E} V(\bar{\pi}) + EV'(\bar{\pi})\{\underset{p}{E}[\bar{\pi} + \frac{d(\pi/p)}{dp}\Big|_{p=\bar{p}} (p-\bar{p})$$

$$+ \frac{1}{2} \frac{d^2(\pi/p)}{dp^2}\Big|_{p=\bar{p}} (p-\bar{p})^2] - J_1 - \bar{\pi}\}$$

(B8) $$= \underset{e}{E} V(\bar{\pi}) + \underset{e}{E} V'(\bar{\pi})[\frac{1}{2} \frac{d^2(\pi/p)}{dp^2}\Big|_{p=\bar{p}} \bar{p}^2 \phi_p^2 - J_1].$$

Together with eq. (B5), eqs. (B7) and (B8) yield

$$- J_1 \underset{e}{E} V' \simeq \frac{1}{2} \underset{e}{E}\{V''[(\bar{\pi} + \bar{w}N)A - \bar{w}N(\varepsilon-1)]^2\}\phi_p^2$$

$$\Rightarrow J_1 \simeq - \frac{1}{2} \phi_p^2 \underset{e}{E}\{V''[(\bar{\pi} + \bar{w}N)A - \bar{w}N(\varepsilon-1)]^2\}/\underset{e}{E}V';$$

where V' and V'' are evaluated at $\bar{\pi}$. A similar derivation based on eq. (B6) leads to

$$J_2 \simeq - \frac{1}{2} \phi_p^2 \underset{e}{E}V''[(\bar{\pi} + \bar{w}N)A + \bar{w}N]^2/\underset{e}{E}V',$$

and consequently,

$$J \simeq \underset{p,e}{E} \frac{\pi}{p} - \underset{p,e}{E} \frac{\pi_n}{p} - \bar{w}N\varepsilon\phi_p^2 \underset{e}{E}\{V''[(\bar{\pi} + \bar{w}N)A + \bar{w}N(1 - \tfrac{\varepsilon}{2})]\}/\underset{e}{E}V'.$$

Note that $\underset{p,e}{E}\pi/p + N\underset{p}{E}\, w/p = \underset{p,e}{E}\pi_n/p + \underset{p}{E}\, w_n/p$; thus the total real amount the N workers and the firm are willing to pay in order to have the wage indexed is approximately

$$S\bar{w}N\varepsilon(1 - \tfrac{\varepsilon}{2})\phi_p^2 - \bar{w}N\varepsilon\phi_p^2 \underset{e}{E}\{V''[(\bar{\pi} + \bar{w}N)A + \bar{w}N(1 - \tfrac{\varepsilon}{2})]\}/\underset{e}{E}V'$$

$$= \bar{w}N\varepsilon\phi_p^2\{(1 - \tfrac{\varepsilon}{2})(S - \bar{w}N\underset{e}{E}V''/\underset{e}{E}V') - \underset{e}{E}[V''(\bar{\pi} + \bar{w}N)A]/\underset{e}{E}V'\}$$

which, by use of (12) in the text, may be written as

$$\frac{1}{2} \bar{w}N\phi_p^2\varepsilon^2(S - \bar{w}N\underset{e}{E}V''/\underset{e}{E}V').$$

APPENDIX C

Normalizing the utility functions such that $U'(1) = V'(1) = 1$, the first order condition for maximization of $\mathcal{L}$ are

$$\text{(C1)} \qquad \frac{\partial \mathcal{L}}{\partial w_1} = \frac{w_1^{-S}}{p_1^{1-S}} + \rho \underset{\tilde{p}}{E} \frac{w_1^{-S} y^{1-S}}{p^{1-S} \tilde{p}_2^{S-1}} - \lambda N \left(\underset{e_1}{E} \frac{\pi_1^{-S}}{p_1^{1-S}} + \rho \underset{\tilde{p}, e_2}{E} \frac{\pi_2^{-S} y}{p_1^{1-S} \tilde{p}^{1-S}} \right) = 0$$

$$\text{(C2)} \qquad \frac{\partial \mathcal{L}}{\partial y} = \rho \underset{p_1}{E} \frac{w_1^{1-S} y^{-S}}{p_1^{1-S} \tilde{p}^{1-S}} - \lambda \rho N \underset{p_1, e_2}{E} \frac{\pi_2^{-S} w_1}{p_1^{1-S} \tilde{p}^{1-S}} = 0$$

Multiplying (C1) by w and taking the expectation over $\tilde{p}$, and multiplying (C2) by y and taking the expectation over p_1,

$$\text{(C3)} \qquad \underset{p_1}{E} \left(\frac{w_1}{p_1}\right)^{1-S} + \rho \underset{p_1, \tilde{p}}{E} \left(\frac{w_1 y}{p_1 \tilde{p}}\right)^{1-S} = \lambda N \left(\underset{p_1, e_1}{E} \frac{\pi_1^{-S} w_1}{p_1^{1-S}} + \rho \underset{p_1, \tilde{p}}{E} \frac{\pi_2^{-S} w_1 y}{p_1^{1-S} \tilde{p}^{1-S}} \right)$$

$$\text{(C4)} \qquad \underset{p_1, \tilde{p}}{E} \left(\frac{w_1 y}{p_1 \tilde{p}}\right)^{1-S} = \lambda N \underset{p_1, \tilde{p}, e_2}{E} \frac{\pi_2^{-S} w_1 y}{p_1^{1-S} \tilde{p}^{1-S}}$$

Dividing (C3) by (C4) and rearranging,

$$\underset{\tilde{p}}{E} \left(\frac{y}{\tilde{p}}\right)^{1-S} \underset{p_1, u_1}{E} \frac{\pi_1^{-S} w_1}{p_1^{1-S}} = \underset{p_1, \tilde{p}, u_2}{E} \frac{\pi_2^{-S} w_1 y}{p_1^{1-S} \tilde{p}^{1-S}}$$

Substituting $y = D\tilde{p}^{1+A}$ and π_1 and π_2 from eqs. (31) and (32)

$$D^{1-S} \underset{\tilde{p}}{E}\, \tilde{p}^{A(1-S)} \underset{p_1,e_1}{E} (\hat{p}_1^{A}\, Cv_1 - w_1 p_1^{-1} N)^{-S}\, w_1 p_1^{-1}$$

$$= D^{1-S} \underset{\tilde{p}}{E}\tilde{p}^{A(1-S)} \underset{p_1,e_2}{E} (\hat{p}_1^{A*}\, Ct\bar{p}^{-A} D^{-1} v_2 - w_1 p_1^{-1} N)^{-S}\, w_1 p_1^{-1}$$

Since e_1 and e_2 are identically distributed,

$$\underset{p_1,e_1}{E} (\hat{p}_1^{A}\, Cv_1 - w_1 p_1^{-1} N)^{-S}\, w_1 p_1^{-1}$$

$$= \underset{p_1,e_1}{E} (\hat{p}_1^{A*}\, Ct\bar{p}^{-A} D^{-1} v_1 - w_1 p_1^{-1} N)^{-S}\, w_1 p_1^{-1}$$

which implies that $t\bar{p}^{-A} D^{-1} = 1 \Longrightarrow D = t\bar{p}^{-A}$.

APPENDIX D

Sources of Variables

<table>
<tr><th>Variable Name</th><th>Variable Description</th><th>Source</th></tr>
<tr><td>v1</td><td>3-year average of the quit rate</td><td>U.S. Bureau of Labor Statistics (BLS), Employment and Earnings, Washington, D.C.: Government Printing Office, 1979.</td></tr>
<tr><td>v2</td><td>number of unions in the industry</td><td rowspan="2">U.S. BLS, Directory of National Unions and Employee Associations, 1979, Washington, D.C., Gov't. Printing Office, 1980, Bulletin No. 1750.</td></tr>
<tr><td>v3</td><td>percentage of unionized workers in the industry</td></tr>
<tr><td>v4</td><td>3-year average of the profit rate</td><td>U.S. Federal Trade Commission, Quarterly Financial Report for Manufacturing Corporations, 1972-1977, Washington, D.C.: GPO.</td></tr>
<tr><td>v5</td><td>percentage of workers covered by multiemployer agreements in the industry</td><td>U.S. BLS, Characteristics of Major Collective Bargaining Agreements, January 1, 1978, Washington, D.C.: GPO, 1980, Bulletin No. 2065.</td></tr>
<tr><td>v6</td><td>percentage of income due to wage earnings of the union member</td><td rowspan="6">Authors' calculations from the May 1978 Current Population Survey data file.</td></tr>
<tr><td>v7</td><td>mean age of union members</td></tr>
<tr><td>v8</td><td>percentage of union members who are married</td></tr>
<tr><td>v9</td><td>percentage of union members who are white</td></tr>
<tr><td>v10</td><td>percentage of union members who are male</td></tr>
<tr><td>v11</td><td>percentage of union members residing in SMSA's</td></tr>
</table>

Variable Name	Variable Description	Source
v12	mean schooling level of union members	Authors' calculations from the May 1978 Current Population Survey data file.
v13	mean number of children in married union members' families	(same as v12)
P_t	quarterly data on consumer price index	U.S. BLS, Monthly Labor Review, 1972-1977, Washington, D.C.: GPO.
UI	average UI net replacement rate = average weekly UI benefit/average weekly net (after tax) loss of income by laid-off unemployed workers in the industry	Authors' calculations from the Urban Institute's unemployment insurance microsimulation data file. See Wayne Vroman, "A Simulation Model of Unemployment Insurance," National Commission on Unemployment Compensation, Washington, D.C.: GPO, 1980, Compendium, for further details.
F_{1t}	fraction of workers covered by a COLA	U.S. BLS, Monthly Labor Review, Washington, D.C.: GPO, January 1975, 1978 and 1981. Bulletin No. 1868.
F_{2t}	fraction of contracts with COLA provisions	(same as F_{1t})
l_{1t}	3-year average of the layoff rate	U.S. BLS, Employment and Earnings, Washington, D.C.: GPO, 1981.
Z1	1=contract has COLA, 0=no COLA	Unpublished data from BLS file of contract provisions in major collective bargaining agreements (agreements covering 1,000 workers or more).
Z2	frequency of COLA review after first year: 1=monthly, 2=quarterly, 3-semi-annual, 4=annual	(same as Z1)
Z3	1=COLA review in first year, 0=no review	(same as Z1)
Z4	COLA formula - number of cents for each point increase in the CPI	(same as Z1)
Z5	COLA formula - estimated percentage point increase in the wages for each percentage point increase in the CPI.	(same as Z1)
Z6	logarithm of months until first COLA review	(same as Z1)

Variable Name	Variable Description	Source
Z7	logarithm of contract duration (in months)	Unpublished data from BLS file of contract provisions in major collective bargaining agreements (agreements covering 1,000 workers or more).
Z8	1=minimum COLA increase guarantee, 0=no minimum	
Z9	1=maximum COLA increase or cap, 0=no cap	
Z10	COLA formula - number of cents per each point increase in the CPI, 0= no COLA	
Z11	COLA formula - estimated percentage point increase in wages for each percentage point increase in the CPI, 0=no COLA	
X1	number of employees covered by the contract	
X2	industry quit rate	U.S. BLS, Employment and Earnings, Washington, D.C.: GPO, 1981.
X3	8-firm concentration ratio	U.S. BLS, Concentration Ratios in Manufacturing, 1972, Washington, D.C.: GPO.
X4	wages as a share of shipments in the industry	U.S. BLS, Annual Survey of Manufacturers, 1977, Washington, D.C.: GPO.
X5	percentage of production workers unionized in the industry (3 digit)	Freeman, R.B. and J.L. Medoff, "New Estimates of Private Sector Unionism in the United States," Industrial and Labor Relations Review, January 1979.
X6	number of different unions representing workers in the industry	U.S. BLS, Directory of National Unions and Employee Associations, 1979, Washington, D.C.: GPO, Bulletin No. 1750.
X7	import/total sales in the industry	Import data from U.S. Important SIC-Based Products, U.S. Dept. of Commerce publication FT 210, 1977). Total sales data from 1977 Census of Manufacturing Industries, U.S. BLS, Washington, D.C.: GPO.

Variable Name	Variable Description	Source
X9	mean rate of expected inflation 6 months prior to date of contract	Livingston survey data as published in John Carlson, "A Study of Price Forecasts," Annals of Economic and Social Measurement, March 1977 (private correspondence from Carlson for later years).
X10	coefficient of variation of forecasters expected inflation rate	
X14	average UI net replacement rate in the industry	See UI variable source in Section VII.
X15	mean family income	Author's calculations from the May 1978 Current Population Survey data file.
X16	mean age	
X17	percentage married	
X18	percentage white	
X19	percentage male	
X20	percentage residing in SMSA's	
X21	mean schooling	
X22	percentage craftsmen	
X23	mean number of children	
X24	percentage residing in the south	
X25	share of total family income due to wages of union member	
P_t	quarterly data on consumer price index	U.S. BLS, Monthly Labor Review, 1972-1977, Washington, D.C.: GPO.
PPI_t	quarterly data on producer price index	

REFERENCES

AFL-CIO. Comparative Survey of Major Collective Bargaining Agreements, March 1979 (Washington, D.C., December 1979).

-------. Comparative Survey of Major Collective Bargaining Agreements, September 1974 (Washington, D.C., May 1975).

Costas Azariadis. "Implicit Contracts and Underemployment Equilibrium," Journal of Political Economy, 1975, 83-202.

-------. "Escalator Clauses and the Allocation of Cyclical Risks," Journal of Economic Theory, June 1978.

Martin B. Baily. "Wages and Employment Under Uncertain Demand," Review of Economic Studies, 1974, 37-50.

-------. "On the Theory of Layoffs and Unemployment," Econometrica, July 1977, 1043-1063.

Robert J. Barro. "Long-Term Contracting, Sticky Prices and Monetary Policy," Journal of Monetary Economics, 1977, 305-316.

Olivier Blanchard. "Wage Indexing Rules and the Behavior of the Economy," Journal of Political Economy, 1979, 798-815.

Frank Brechling. "Layoffs and Unemployment Insurance" in Sherwin Rosen, ed., Studies in Labor Markets (Chicago, Ill.: University of Chicago Press, 1982).

David Card. "Cost-of-Living Escalators in Major Union Contracts" (mimeograph, Princeton University, March 1982).

-------. "Wage Indexation in Labor Contracts and the Measurement of Escalation Elasticities" (mimeograph, Princeton University, October 1981).

John Carlson. "A Study of Price Forecasts," Annals of Economic and Social Measurement, March 1977.

Gary Chamberlain. "Analysis of Covariance With Qualitative Data," Review of Economic Studies, April 1980.

Alan Carter. Theory of Wages and Employment (Homewood, Ill., 1959).

Leif Danziger. "Risk Sharing in Labor Contracts," European Economic Review, 14, 1980, 323-340.

-------. "Partial Wage Indexation With Real Shocks," Economic Letters (forthcoming).

James Dertouzos and John Pencavel. "Wage and Employment Determination Under Trade Unionism: The International Typographical Union," Journal of Political Economy, 1981.

H. M. Douty. Cost-of-Living Escalator Clauses and Inflation (Washington, D.C.: Council on Wage and Price Stability, 1981).

David Estenson. "Relative Price Variability and Indexed Labor Agreements," Industrial Relations, Winter 1981.

Henry Farber. "Individual Preferences and Union Wage Determination: The Case of the United Mine Workers," Journal of Political Economy, October 1978.

-------. "The Determination of Negotiated Wage Changes: A Reference Wage Approach" (mimeograph, Massachusetts Institute of Technology, September 1981).

Martin Feldstein. "Temporary Layoffs in a Theory of Unemployment," Journal of Political Economy, October 1976.

-------. "Inflation and the Stock Market," American Economic Review, December 1980, 839-847.

William Fellner. "Prices and Wages Under Bilateral Monopoly," Quarterly Journal of Economics, August 1974.

Stanley Fisher. "Long-Term Contracting, Sticky Prices and Monetary Policy: A Comment," Journal of Monetary Economics, 1977, 317-324. (1977a)

-------. "Wage Indexation and Macroeconomic Stability," Journal of Monetary Economics, Supplement 1977. (1977b)

Irwin Friend and Marshall Blume. "The Demand for Risky Assets," American Economic Review, December 1975.

Wallace Hendricks and Lawrence Kahn. "Determinants and Effects of Cost-of-Living Allowance Coverage in U.S. Collective Bargaining Agreements," Industrial and Labor Relations Review (forthcoming).

Donald Gordon. "A Neoclassical Theory of Keynsian Unemployment," Economic Inquiry, December 1974, 431-459.

Jo Anna Gray. "Wage Indexation: A Macroeconomic Approach," Journal of Monetary Economics, April 1976.

-------. "On Indexation and Contract Length," Journal of Political Economy, February 1978.

Hershel Grossman. "Risk Shifting, Layoffs, and Seniority," Journal of Monetary Economics, 1977, 661-686.

Lawrence Kahn. "Wage Indexation and Wage Inflation in the U.S." (mimeo, May 1981).

Bruce E. Kaufman. "Bargaining Theory, Inflation and Cyclical Strike Activity in Manufacturing," Industrial and Labor Relations Review, April 1981.

Marvin Kosters. "Wage and Price Behavior: Prospects and Policies" in William Fellner, ed., Contemporary Economic Problems, 1977 (Washington, D.C., 1977).

Alfred Marshall. Reply to the Royal Commission on the Repression of Trade and Industry (1886) in Official Papers by Alfred Marshall (London, 1926).

Martin Mauro. "Strikes As a Result of Imperfect Information," Industrial and Labor Relations Review, July 1982.

James Medoff. "Layoffs and Alternatives Under Trade Unions in U.S. Manufacturing," American Economic Review, June 1979.

Daniel Mitchell. "Union Wage Determination: Policy Implications and Outlook," Brookings Papers on Economic Activity, 1978-3.

-------. Unions, Wages and Inflation (Washington, D.C., 1980).

Yair Mundlak. "On the Pooling of Time-Series and Cross-Section Data," Econometrica, January 1978.

Richard W. Parks. "Inflation and Relative Price Variability," Journal of Political Economy, 86, February 1978, pp. 79-96.

John Pencavel. "The Empirical Performance of a Model of Trade Union Behavior" (mimeograph, 1981).

Martin Prachowny. "Wage Indexation: Social Benefits and Private Incentives," Journal of Labor Research, Spring 1981.

Steven Shavell. "Sharing Risks of Deferred Payments," Journal of Political Economy, 84, 161-168.

Victor Sheifer. "Cost-of-Living Adjustments: Keeping Up With Inflation," Monthly Labor Review, June 1979.

Eytan Sheshinski and Yoram Weiss. "Inflation and Costs of Price Adjustment," Review of Economic Studies, April 1977, 287-303.

Jan Svejnar. "Bargaining Power, Fear of Disagreement and Wage Settlements: Theory and Empirical Evidence From U.S. Industry" (mimeo, Cornell University, June 1982).

James Tobin. "Stabilization Policy Ten Years After," Brookings Papers on Economic Activity, 1980-1.

Wayne Vroman. "A Simulation Model of Unemployment Insurance," National Commission on Unemployment Compensation, Compendium (Washington, D.C., G.P.O., 1980).

-------. "Escalator Clauses and Price-Wage Feedback in the U.S. Economy" (mimeo, Urban Institute, 1982).