Unexpected Inflation, Real Wages, and Employment Determination in Union Contracts

By David Card*

This paper examines the effect of nominal contracting provisions on employment determination in union contracts. In most contracts the nominal wage rate is wholly or partially predetermined. Real wage rates therefore contain unanticipated components that reflect unexpected price changes and the degree of indexation. The empirical analysis, based on a large sample of indexed and nonindexed contracts, suggests that unexpected real wage changes are associated with systematic employment responses in the opposite direction. I conclude that nominal contracting provisions play a potentially important role in the cyclical properties and persistence of employment movements in the union sector. (JEL 130, 820)

What role do nominal wage contracts play in the determination of employment and the characteristics of the business cycle? An influential series of papers by Stanley Fischer (1977), Edmund S. Phelps and John B. Taylor (1977), and John B. Taylor (1980) argued that fixed wage contracts create a link between employment and aggregate demand. More recent models of macro fluctuations stress other channels for the transmission and persistence of aggregate shocks. Real business cycle models (for example, Finn E. Kydland and Edward C. Prescott, 1982) assume that supply and demand in the labor market are equilibrated at Walrasian levels and ignore the institutional structure of wage determination. Recent models in the Keynesian tradition, on the other hand, have shifted attention from nominal wage rigidities to real wage rigidities (for example, Olivier J. Blanchard and Lawrence H. Summers, 1986) or nominal price rigidities (for example, N. Gregory Mankiw, 1985; Olivier J. Blanchard and Nobuhiro Kiyotaki, 1987).

This shift in interest reflects dissatisfaction with both the theoretical underpinnings and empirical performance of nominal contracting models. One the one hand, there are as yet no convincing theoretical explanations for the existence of nominally fixed contracts. Many of the models developed over the past decade predict constant real wages or constant real earnings.[1] On the other hand, the evidence in support of nominal contracting models is also weak. The simplest of these models asserts that aggregate demand shocks lead to real wage changes that induce movements along a downward-sloping demand schedule. Although unanticipated price increases are apparently correlated with real economic activity (see the review by Jo Anna Gray and David Spencer, forthcoming), the absence of a clear negative correlation between aggregate employment and real wages (Patrick T. Geary and John Kennan, 1982) poses a serious challenge to models of nominal wage rigidity.

This paper presents new evidence on the consequences of nominal contracting provisions for employment determination in the unionized sector of Canadian manufacturing. The analysis, based on data for 1300

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[1]See the survey of implicit contracting models by Sherwin Rosen (1985). A concise summary of the implications of these models from a macroeconomic perspective is presented by Stanley Fischer (1987, pp. 42–50).

indexed and non-indexed contracts written between 1966 and 1982, suggests that nominal contracting provisions play an important role in the link between aggregate demand and employment. As predicted by the simple models of Fischer (1977) and Jo Anna Gray (1976), I find that real wage changes induced by aggregate price surprises lead to systematic employment responses in the opposite direction. Unexpected real wage changes also affect subsequent wage determination: the empirical results suggest that roughly one-third of such changes carry over to the following contract. Unanticipated price increases therefore generate short-run employment responses and persistent wage changes among firms in the union sector.

Two features of the empirical analysis distinguish these results from earlier attempts to measure the effects of nominal wage rigidities. First, the analysis is based on individual contract data rather than aggregate or industry-level data.[2] Since union contracts differ in their negotiation dates and degrees of indexation, it is possible to calculate contract-specific measures of unexpected price increases and unexpected real wage changes, and to estimate the separate effects of price surprises and real wage surprises. Variation in contract lengths and the staggering of expiration dates also make it possible to control for aggregate-level disturbances that affect all contracts at a point in time. Second, the analysis pays special attention to the issue of endogenous wage determination.[3] Even in a simple Fischer-Gray contracting framework this is a potentially serious problem, insofar as the bargaining parties have information on future employment demand that is unavailable to an outside data analyst. If predictable components of future employment demand affect wages, they create a simultaneity bias in ordinary least-squares estimates of the elasticity of employment with respect to realized wage rates.

To solve this problem I use the unexpected component of real wages as an instrumental variable for the level of wages. By assumption, unexpected changes in real wages are correlated with wages but uncorrelated with information known at the negotiation date of the contract. Unexpected wage changes therefore form a valid instrumental variable for a structural analysis of employment demand. This procedure also provides a direct test of the role of nominal wage rigidities in generating employment responses to nominal shocks. The instrumental variables estimate of the elasticity of labor demand is nonzero if and only if employment is correlated with unexpected real wage changes.

The empirical results confirm the value of this approach. In ordinary least-squares regressions, changes in employment are only weakly related to changes in contract wages. When unexpected real wage changes are used as an instrumental variable, however, employment is found to be systematically negatively related to wages. This finding continues to hold when unexpected price changes are added directly to the employment demand equation. It is also robust to the addition of unrestricted dummy vari-

[2]Much of the earlier literature on nominal contracting models focuses on their implications for aggregate price and wage dynamics: see Taylor (1980) and Orley Ashenfelter and David Card (1982). A recent study by Shaghil Ahmed (1987) correlates the degree of wage flexibility in an industry, measured by the elasticity of indexation among indexed labor contracts, with the slope of the industry-specific Phillips curve. Ahmed's measure of wage flexibility is based on a sample of only 98 contracts in 20 industries, and fails to take into account any of the characteristics of the nonindexed contracts in an industry. Furthermore, his measure of flexibility only pertains to workers in large union contracts and ignores variation across industries in the extent of unionization or the share of large firms. Thus, I do not interpret his findings as strong evidence for or against the hypothesis that nominal contract rigidities are important. The approach taken by Mark Bils (1989) is perhaps most similar to that in this paper. He compares the variability of industry employment growth in months with a significant number of contract negotiations to the variability in other months.

[3]John Kennan (1988) presents an illuminating analysis of the difficulties that arise in the interpretation of aggregate employment and wage data when the data are generated by a simple model of demand and supply.

ables representing each year of the sample. I conclude that nominal wage contracts play an important role in determining the cyclical properties and persistence of employment in the union sector.

I. Employment and Wages in a Simple Contract Model

A. *Interpreting the Correlation of Employment and Wages*

This section outlines a simple model of long-term contracting in which nominal wages are predetermined and employment is set unilaterally by the firm after aggregate prices and firm-specific demand shocks are observed. Even in this simple model the interpretation of the partial correlation of employment and real wages is clouded by the fact that the contracting parties may have better information on future demand shocks than is available to an outside data analyst. To develop this point more formally, suppose that wages are negotiated in some base period (period 0) for a contract of duration T. Let $n(t)$ and $w(t)$ denote the logarithms of employment and real wages in period t of the contract, respectively, and assume that hours per worker are fixed. The notion of "nominal contracting" is captured by the assumption that the bargaining parties do not set $w(t)$ directly: rather, they establish a series of nominal wage increases from the start of the contract, possibly in conjunction with an indexation formula.[4] Let $w^*(t)$ represent the parties' expectation of $w(t)$, conditional on their information in the negotiating period, and let $u(t)$ represent the forecast error $w(t)-w^*(t)$. The distribution of $u(t)$ depends on the length of the contract and whether or not it contains a cost-of-living escalation clause.[5]

Assume that $n(t)$ is determined by an employment demand schedule of the form

$$(1) \qquad n(t)=\alpha z(t)+\beta w(t)+\varepsilon(t),$$

where $z(t)$ is a vector of observable variables shifting the demand for labor, β represents the elasticity of labor demand ($\beta<0$), and $\varepsilon(t)$ is an unobservable component of employment variation. The specification of $z(t)$ and the corresponding interpretation of β are discussed in the next section. Note that supply considerations are explicitly ignored: there are assumed to be enough available workers to fill the firm's demand irrespective of the forecast error in real wages. This assumption is a plausible one in the context of the available data, which pertain to unionized manufacturing establishments.

This simple model is completed by a specification of the determinants of $w^*(t)$. Assume that the expected real wage rate in period t is determined at the negotiation date by variables known at that time, say $x(0)$, and by the parties' expectations of $z(t)$ and $\varepsilon(t)$, $z^*(t)$ and $\varepsilon^*(t)$, respectively:

$$(2) \quad w^*(t)=az^*(t)+bx(0)+c\varepsilon^*(t).$$

The realized real wage rate in the tth period of the contract is therefore

$$w(t)=az^*(t)+bx(0)+c\varepsilon^*(t)+u(t).$$

The presence of simultaneity bias in ordinary least squares (OLS) estimates of the employment demand equation (1) depends on two factors. If $\varepsilon^*(t)\equiv 0$, then the parties have no informational advantage and there is no simultaneity problem. Alternatively, if $c=0$, negotiated wages are unaffected by expected employment demand and again there is no simultaneity problem. If the parties are better able to forecast employment

[4]The nature of typical indexation formulas in North American labor contracts is described in my 1983 paper. The only case in which the real wage is set directly by the parties is the case of a contract in which nominal wages are indexed to the consumer price level with a formula that increases the wage by one percent for each percentage point increase in prices. Such formulas are rare, particularly in the manufacturing sector of the United States and Canada.

[5]This point is made by Wallace E. Hendricks and Lawrence M. Kahn (1987).

demand than an outside observer, however, and if higher forecasted demand leads to an increase in negotiated wage rates, then real wage rates will be positively correlated with the error in the employment equation, leading to a positively biased estimate of the wage elasticity β.

Irrespective of the parties' wage setting behavior, the elasticity β may be consistently estimated by considering the correlation between unanticipated wage rates and employment outcomes. The forecast error $u(t)$ forms a natural instrumental variable for $w(t)$: by definition, it is correlated with wages but uncorrelated with information available to the parties at the time of their negotiations.[6] Additional instruments may also be available if there are determinants of negotiated wages that can be legitimately excluded from the employment demand equation (the variables denoted as $x(0)$ in equation (2) above).

There are two important caveats to this procedure. The first is the possibility that forecast errors in real wages are directly correlated with unobservable determinants of labor demand. Suppose for example that employment demand shocks are positively correlated with unexpected price increases.[7] Then unexpected real wage increases are negatively correlated with employment demand shocks, leading to a negative bias in the instrumental variables estimate of the wage elasticity β. A simple way to control for this possibility is to include unexpected consumer price increases directly in the employment equation and to use variation across contracts in the degree of indexation to separately identify the effects of unexpected wage changes and unexpected price changes. A complementary approach is to include dummy variables representing the year in which employment is measured. These year effects absorb any aggregate demand shocks (or supply-side shocks) that affect all contracts in any given year.

A second difficulty may arise if unexpected changes in real wages during the term of a contract are immediately offset in subsequent negotiations. If this is the case then unexpected changes in real wages are inherently short-lived, and the presence of adjustment costs will substantially dampen the employment responses to such changes.[8] In the empirical analysis reported below I investigate the effect of real wage surprises on subsequent wage negotiations, and find that real wage rates in the subsequent contract move in the same direction as unexpected wage changes occurring during the previous contract. Thus, unexpected changes in real wages generate persistent effects on the cost of contractual labor, and should be expected to generate significant employment effects if the wage elasticity β is nonzero.

B. *Specification of the Employment Demand Function*

This section discusses the specification of the employment demand function (1) introduced above. An important limitation of the contract-based data set used in the empirical analysis is the absence of firm-specific price or output data. Selling prices, intermediate input prices, and output indexes are only available at the three-digit industry level. Nevertheless, these industry-level data may be used as proxies for the underlying firm-specific variables. To derive an interpretation of the resulting specification, suppose that output is produced from three

[6]It is interesting to compare this procedure to the one suggested by Bennett T. McCallum (1976) for the estimation of a structural equation that contains the expected value of a future endogenous variable. McCallum's procedure replaces the expected future value by its actual value and uses the predicted value (from a linear forecasting equation) as an instrumental variable. His procedure therefore eliminates simultaneity bias induced by a correlation between the dependent variable and the unexpected component of the explanatory variable. In the present context, the simultaneity bias arises from a correlation between the dependent variable and the expected value of the explanatory variable. Hence, the proposed instrument is the unexpected component of the explanatory variable.

[7]This may arise if employers have imperfect information on their relative demand shocks.

[8]Unexpectedly low real wage rates could induce an increase in overtime hours, however.

factors: labor, capital, and intermediate inputs (raw materials and energy). Ignoring firm-specific constants, assume that the logarithm of employment at a given firm in a particular industry in period $t, n(t)$ is related to the logarithm of firm-specific output, $y(t)$, the logarithm of firm-specific wages, $w(t)$, the logarithm of firm-specific nonlabor input prices, $v(t)$, the user cost of capital in period $t, r(t)$ (assumed to be constant across firms and industries), and an error term $\eta(t)$:

$$(3) \quad n(t) = \beta_1 w(t) + \beta_2 v(t) - (\beta_1 + \beta_2) r(t) + \sigma y(t) + \eta(t).$$

This equation can be derived from an underlying Cobb-Douglas production function, or alternatively it can be interpreted as a loglinear approximation to an arbitrary employment demand equation. The restriction that the elasticities of employment demand with respect to the three factor prices sum to zero is a consequence of the homogeneity of the cost function. This restriction implies that the equation is invariant to the deflator used to index wages and other factor prices. The magnitude of the coefficient σ reflects the degree of returns to scale: constant returns to scale implies $\sigma = 1$.

Let $\bar{y}(t)$ represent the logarithm of industry output in period t, and let $\bar{w}(t)$ and $\bar{v}(t)$ represent weighted averages of wages and intermediate input prices in the industry. Ignoring constants, assume that the logarithm of the firm's relative share of industry output is given by

$$(4) \quad y(t) - \bar{y}(t) = \gamma_1(w(t) - \bar{w}(t)) + \gamma_2(v(t) - \bar{v}(t)) + \phi(t).$$

This equation can be derived by assuming that firms with identical Cobb-Douglas production functions act as price takers with respect to firm-specific selling prices.[9] Alternatively, equation (4) can be interpreted as an approximation to the output share equation arising from a simple differentiated product oligopoly model. In either case, the error component $\phi(t)$ represents a mixture of firm-specific relative demand shocks and firm-specific productivity shocks.

The combination of equations (3) and (4) leads to an expression for firm-specific employment in terms of firm-specific wages, industry-level output and intermediate input prices, the aggregate cost of capital, and industry wages:

$$(5) \quad n(t) = (\beta_1 + \sigma\gamma_1) w(t) + \beta_2 \bar{v}(t) - (\beta_1 + \beta_2) r(t) + \sigma \bar{y}(t) - \sigma\gamma_1 \bar{w}(t) + (\beta_2 + \sigma\gamma_2)(v(t) - \bar{v}(t)) + \sigma\phi(t) + \eta(t).$$

Under the assumption that increases in marginal cost at a particular firm lead to decreases in its relative share of industry output, the coefficients γ_1 and γ_2 are negative. Thus, the elasticity of employment with respect to firm-specific wages, holding constant *industry* output, is larger in absolute value than the elasticity holding constant *firm-specific* output. Under the assumption of price-taking behavior the elasticity holding constant industry output is the unconditional elasticity of employment with respect to wages, allowing for the effect of changes

[9]Specifically, the Cobb-Douglas assumption implies that the output supply equation of the ith firm can be written as

$$y(t) = \gamma_1 w(t) + \gamma_2 v(t) + \gamma_3 r(t) - (\gamma_1 + \gamma_2 + \gamma_3) q(t) + \theta(t).$$

where $q(t)$ is the selling price for the output of the firm and $\theta(t)$ represents a total factor productivity shock. Define industry output as a geometric weighted average of the outputs of the individual firms in the industry. Then aggregate output follows a similar equation, and equation (4) can be derived directly, with

$$\phi(t) \equiv \theta(t) - \bar{\theta}(t) - (\gamma_1 + \gamma_2 + \gamma_3)(q(t) - \bar{q}(t)).$$

in wages on the output supply decision of the firm. Under these same assumptions the predicted elasticity of employment with respect to industry wages is positive, reflecting the fact that as industry wages increase (holding constant the firm's wage) the firm's share of industry output will increase.

C. *Allowing for the Presence of Efficient Contracting*

The specification of equation (5) assumes that employment levels are determined by the firm taking the realized real wage rate as given. Except under very special circumstances, however, unilateral employment determination by the firm fails to provide an efficient allocation of employment between contractual and extra-contractual opportunities.[10] For this reason, the empirical relevance of simple nominal contracting models has been sharply criticized (see Robert J. Barro, 1977, and Robert E. Hall, 1980, for example). The efficient determination of contractual employment is formally addressed in the implicit contracting literature and also the more recent efficient contracting literature.[11] The point of both literatures is that a jointly optimal contract (i.e., one that maximizes profit subject to a utility constraint for workers) determines employment on the basis of a shadow wage that can differ from the contractual wage. A contracting model with homogeneous workers and unrestricted transfers between employed and unemployed workers implies that the appropriate shadow wage is the marginal productivity of workers in their best alternative job. Brown and Ashenfelter (1986) refer to this as the "strong form" efficient contracting hypothesis. Strong form efficiency implies that contractual wages (and contractual wage rigidities) are irrelevant for employment determination and serve only to transfer income between employers and employees.[12]

In light of the differing implications of efficient contracting models and models with unilateral employment determination, it is important to adopt an empirical framework that encompasses either possibility. In principle this can be accomplished by including a measure of the appropriate shadow wage of labor in the employment demand function. A convenient assumption is that the shadow wage in an efficient contract is a weighted average of the observed contract wage and some measured alternative wage.[13] This leads to a specification of employment demand that includes both the contract wage and the measured alternative wage. Even though this procedure cannot provide a definitive test against the efficient contracting hypothesis,[14] it can provide useful evidence for or against the unilateral employment determination model, when the alternative is a testable version of the efficient contracting hypothesis.

II. Data Description and Measurement Framework

The empirical analysis in this paper is based on a sample of 1293 contracts negotiated by 280 firm and union bargaining pairs in the Canadian manufacturing sector.[15] The available information for each contract in-

[10]See Robert E. Hall and David Lilien (1979).

[11]The implicit contracts literature is reviewed by Sherwin Rosen (1985). See Ian M. McDonald and Robert M. Solow (1981) for a theoretical treatment of efficient contracting and James N. Brown and Orley Ashenfelter (1986) for a concise summary of the empirical implications of simple efficient contracting models.

[12]See John M. Abowd (1989) for an attempt to test this hypothesis using stock market data on negotiating firms.

[13]This hypothesis can be motivated formally by assuming that employees' preferences are represented by a Cobb-Douglas utility function defined over employment and the difference between the contractual wage and the alternative wage: see Brown and Ashenfelter (1986, p. S54).

[14]See Thomas E. MaCurdy and John H. Pencavel (1986), especially p. S13.

[15]The data set only includes contracts with 500 or more workers. The sample is drawn from a public use tape distributed by Labour Canada. A complete description of the sample and its derivation is presented in the Data Appendix. Louis N. Christofides and Andrew J. Oswald (1987) have also analyzed employment and wage data drawn from this source.

TABLE 1—CHARACTERISTICS OF EXPIRING CONTRACTS BY YEAR

Year	Number of Contracts (1)	Average Duration (2)	Percent with Escalation Clause (3)	Real Wage Index[a] 1971 = 100 (4)	Employment Index[b] 1971 = 100 (5)	Average Forecast Error[c] Prices (6)	Average Forecast Error[c] Real Wages (7)
1968	5	11.2	0.0	87.6	104.4	−0.1	0.1
1969	23	21.9	0.0	89.5	101.8	−0.9	0.9
1970	87	26.9	12.6	94.1	108.0	−2.0	1.8
1971	68	29.0	17.6	100.0	100.0	−4.6	3.8
1972	76	26.3	14.5	104.6	103.6	−3.0	2.8
1973	90	28.9	11.1	104.8	103.3	1.1	−1.1
1974	82	29.4	28.0	104.5	110.4	7.1	−6.1
1975	92	26.9	32.6	106.2	105.9	7.0	−6.3
1976	104	25.6	52.9	115.2	108.1	1.9	−1.2
1977	113	23.7	50.4	118.9	105.7	−2.2	1.8
1978	134	22.1	27.6	118.5	105.6	0.1	−0.3
1979	81	22.7	34.5	118.2	112.8	1.1	−0.9
1980	114	24.8	37.7	117.8	112.1	1.9	−1.2
1981	64	25.9	40.6	115.9	109.9	4.5	−3.3
1982	85	27.4	38.8	119.1	111.7	4.9	−3.8
1983	75	28.5	65.3	122.2	104.6	−0.5	1.2
Overall	1293	25.9	32.9	–	–	1.2	−0.9

Source: See Data Appendix.

[a]Estimated wage index for level of real wages at the end of expiring contracts.

[b]Estimated employment index for level of employment at the end of expiring contracts.

[c]Average percentage difference between price level (or real wage) at the end of contract and expected price level (or real wage) as forecast at the signing date of contract. See text.

cludes its starting (or effective) date, its ending (or expiration) date, and the base wage rate in each month of the contract.[16] The number of employees covered by the agreement is only available at renegotiation dates. I associate this level of employment with the expiring agreement. Thus, each sample point consists of an end-of-contract employment observation and a series of wages, including the beginning-of-contract and end-of-contract wage rates.

Some summary characteristics of the sample are presented in Table 1. The expiration dates of the contracts span a 16-year period between 1968 and 1983, with relatively few contracts in the first 2 years. The average duration of the contracts is 26 months, although durations vary somewhat by year, with relatively shorter contracts in the mid-1970s. The fraction of contracts with escalation clauses shows a steadily increasing trend until the mid-1970s and then varies erratically, with an overall average of 33 percent.

An indication of the trends in employment and wages in the sample is provided by the indexes in columns (4) and (5) of the table.[17] Real wage rates among expiring contracts show significant growth until 1977 and then remain relatively constant. Average employment shows no secular trend but reflects cyclical downturns in 1971, 1975, and 1983.

The empirical strategy of this paper is to fit regressions based on equation (5) to end-

[16]The base wage rate is typically the wage paid to the lowest-skill group covered by the collective bargaining agreement. An important assumption for the analysis in this paper is that variation over time in intracontract wage differentials is small enough to be safely ignored.

[17]The wage and employment indexes represent estimated year effects from regression equations for contract-to-contract percentage changes in end-of-contract wages and employment. These indexes therefore control for the composition of the set of expiring contracts in each year.

of-contract observations on employment and wages for each contract. Assuming that the employment demand function is homogeneous of degree zero in factor prices, the analysis is invariant to the choice of deflators for wages and intermediate input prices. Given the nature of wage indexation clauses, however, it is particularly convenient to work with real wages deflated by the consumer price index. In the remainder of the paper, wages and industry prices are therefore expressed as real variables, deflated by the consumer price index.

The real wage rate at the end of each contract is measured directly. This rate differs from its expectation as of the negotiation date of the contract by a component that depends on the indexation provisions of the contract and the deviation between actual and expected prices at the end of the contract. Following the notation above, let $w^*(T)$ represent the expected value of the logarithm of the real wage at the end of the contract. In a nonindexed contract, the logarithm of the actual real wage rate at the end of the contract, $w(T)$, is related to $w^*(T)$ by

$$(6) \quad w(T) = w^*(T) - (p(T) - p^*(T)),$$

where $p(T)$ represents the logarithm of the consumer price index at the end of the contract, and $p^*(T)$ represents the parties' expectation of $p(T)$, formed T months ago at the negotiation date of the contract.

In an indexed contract, unexpected changes in prices generate unexpected changes in real wage rates only to the extent that indexation is incomplete. For example, if an escalation clause increases nominal wages by e percent for each one percent increase in the consumer price index, then $w(T)$ and $w^*(T)$ are related by

$$(7) \quad w(T) = w^*(T) - (1-e) \times (p(T) - p^*(T)).$$

Although most escalation clauses in North American labor contracts do not specify a fixed elasticity of indexation, this equation is approximately correct when e is defined as the marginal elasticity of indexation evaluated at the expected level of prices at the end of the contract.

Given an estimate of the elasticity of indexation, $\hat{e}$, and an estimate of the parties' expected price level at the end of the contract, $\hat{p}(T)$, it is possible to decompose the real wage rate at the end of a contract into an estimate of its expected component, $\hat{w}(T)$, and an estimate of its unexpected component:

$$w(T) = \hat{w}(T) + \hat{u}(T),$$

where

$$\hat{w}(T) \equiv w(T) + (1-\hat{e})(p(T) - \hat{p}(T)).$$

Using the definition of $\hat{w}(T)$, the estimated unexpected component of real wages can be written as

$$\hat{u}(T) = u(T) + (\hat{e} - e) \times (p(T) - p^*(T)) + (1-\hat{e})(\hat{p}(T) - p^*(T)).$$

This estimate differs from the true value $u(T)$ by two terms: one that depends on the difference between the actual and measured elasticity of indexation (and is therefore identically zero in a nonindexed contract), and another that depends on the difference between measured price expectations and the parties' true expectations. Provided that the measurement errors in the indexation elasticity and the expected price level are orthogonal to unmeasured components of employment demand, however, these errors do not preclude the use of $\hat{u}(T)$ as an instrumental variable for the level of wages at the end of the contract.

In this paper I use a naive forecasting model to form estimates of the expected price level at the end of the contract, based on the average rate of inflation over the 12 months prior to the negotiation date.[18] This

[18]The forecasting equation predicts the one-year ahead inflation rate at the negotiation date t as $0.0144 + 0.7858\ DP(t-12)$, where $DP(t-12)$ is the actual

model was selected by comparing the noncontingent wage increases in the first year of 24–36 month nonindexed contracts to alternative forecasts of the 12-month inflation rate formed at the negotiation date of the contract. I have also experimented with more sophisticated forecasting equations and found few differences in the results. Since the forecasts are only used to form instrumental variables, the choice of an inefficient forecasting model should not bias the empirical results.

The other ingredient in the calculation of unexpected real wage changes is the elasticity of indexation e. Precise information on the actual indexation formulas in the sample is not readily available. I therefore use the ratio of total escalated increases over the life of the contract to the total increase in consumer prices over the life of the contract as a rough estimate of e. This measure is reasonably accurate for contracts with no restrictions on the escalation formula. For contracts with restricted escalation formulas that delay the start of indexation or specify a maximum escalated wage increase, this measure introduces some noise into the calculation of $\hat{u}(T)$.

Column 6 of Table 1 reports the average forecasting errors in the end-of-contract price level. The average annual forecast error is 1.2 percent, but it varies considerably by year, ranging from 7.0 percent for contracts expiring in 1974 and 1975, to -4.5 percent for contracts expiring in 1971. As the formulas in equations (6) and (7) imply, forecasting errors in end-of-contract real wage rates are negatively correlated with the forecast errors in prices. The average forecast errors in real wages in column 7 of the table are close to mirror images of the associated price forecasting errors. Relative to the forecasting errors in prices, however, the forecast errors in real wages are dampened by the indexation provisions of the escalated contracts. The average estimated elasticity of indexation among indexed contracts is 0.50, implying that the forecast errors in real wages among these contracts are about one-half as large as the corresponding forecast errors in prices.[19]

The average forecast errors in end-of-contract real wages are also negatively correlated with the employment index in column (5): the correlation coefficient over 16 annual observations is -0.54, and the regression coefficient of the employment index on unanticipated real wage changes is -0.70, with a standard error of 0.27. This provides some evidence that contractual employment outcomes are negatively related to unexpected changes in real wages. By comparison, the employment index is positively correlated with the index of real wage levels in column (4).

Contract-specific correlations between employment and wages are reported in Table 2. All the data in this table are measured as changes from the expiration date of the previous contract, using the sample of negotiations described in Table 1. Also presented in the table are the correlations of employment and wages with two measures of outside wages: the average real wage rate in the same (two-digit) industry, measured in the expiration month of the contract, and the average real wage for unskilled nonproduction laborers in the same province, measured in the expiration year of the contract.[20] Finally, the last two rows of Table 2 present the correlations of employment and wages with contract-specific measures of unexpected price changes and unexpected real wage changes.

percentage change in prices over the preceding 12 months. The two- and three-year-ahead inflation rate forecasts generated by this equation are $0.021 + 0.693\ DP(t-12)$, and $0.026 + 0.6135\ DP(t-12)$, respectively.

[19]The forecast error in end-of-contract real wages is $-(1-e)\rho$, where ρ is the forecast error in end-of-contract prices, and e is the elasticity of indexation. The average forecast error in real wages is therefore $-(1-\bar{e})\bar{\rho}+$ covariance(e,ρ), where $\bar{e}$ is the average elasticity of indexation and $\bar{\rho}$ is the average forecast error in prices.

[20]The provincial wage is measured from data collected annually by Labour Canada in its area wage survey. Data in this survey is collected by city. I have used the wage rate for the largest city in each province as a measure of the province-specific wage. See the Data Appendix.

TABLE 2—MEANS AND CORRELATION OF EMPLOYMENT AND WAGE CHANGES BETWEEN CONSECUTIVE CONTRACT[a]

	Mean	Standard Deviation	Employment (End of Contract)	Real Contract Wage (End of Contract)
1. Employment (End of Contract)	−0.017	0.201	1.00	−0.07
2. Real Contract Wage (End of Contract)	0.052	0.075	−0.07	1.00
3. Industry Wage (Expiration Month)	0.045	0.056	−0.04	0.59
4. Provincial Wage (Expiration Year)	0.044	0.060	−0.07	0.51
5. Unanticipated Change in Real Wages Over Contract[b]	−0.004	0.060	−0.12	0.45
6. Unanticipated Change in Consumer Prices Over Contract[c]	0.006	0.069	0.13	−0.44

[a]Sample size is 1293. All variables are measured as changes in logarithms between expiration dates of consecutive contracts.
[b]Percentage difference between real wage at end of contract and expected real wage forecast at signing date of contract.
[c]Percentage difference between Consumer Price Index at end of contract and expected price index forecast at signing date of contract.

These simple correlations reveal three features of the contract-level data. First, changes in employment are only weakly negatively correlated with changes in end-of-contract real wage rates. Second, the correlations between employment and outside wages are of similar magnitude to the correlations between employment and contract wages. Third, changes in employment are more strongly negatively correlated with changes in the unexpected component of real wages. Thus, the OLS estimate of the elasticity of employment with respect to contract wages is much smaller in absolute value than the corresponding instrumental variables estimate formed using unexpected changes in real wages as an instrumental variable. The OLS estimate is −0.19, with a standard error of 0.08, while the instrumental variables estimate is −0.70, with a standard error of 0.18. As will be seen below, this pattern continues to hold when other covariates are added to the employment determination equation.

III. The Effect of Previous Wage Rates on Subsequent Wage Determination

As a preliminary step in the analysis of employment demand, this section presents a brief summary of estimated wage equations for the sample of collective bargaining contracts described above. The purpose of this analysis is to identify any "spillover" effect from real wage rates at the end of one contract to wage rates in the next contract. A finding of significant spillovers implies that unexpected changes in real wages have persistent effects on the cost of contractual labor. A finding of insignificant spillovers, on the other hand, implies that these unexpected changes are relatively short-lived. The degree of persistence in unexpected wage changes is important for assessing the magnitude of the effect that these changes will exert on employment determination.

The analysis is based on two alternative measures of negotiated wages: the real wage at the start of the contract and the expected average real wage over the term of the entire contract. In the presence of adjustment costs the wage at the start of the next contract is particularly relevant for employment setting behavior in the last few months of an existing agreement. The expected average real wage over the next contract gives a longer-term measure of the costs of contractual employment.

A convenient statistical framework for analyzing the determinants of wages is a simple components-of-variance model of the form

$$(8)\quad w_{ij} = \theta_i + bx_{ij} + \lambda w(T)_{ij-1} + \xi_{ij},$$

where w_{ij} represents the measure of wages (either the real wage at the start of the contract or the expected average real wage over the life of the contract) for the jth contract of the ith firm, θ_i represents a permanent firm-specific component of wage variation, x_{ij} represents a vector of determinants of wages (measured at the negotiation date), $w(T)_{ij-1}$ represents the real wage at the end of the previous contract, and ξ_{ij} represents a contract-specific component of variance. The parameters b and λ can be estimated by taking contract-to-contract first-differences:

$$(9)\quad \Delta w_{ij} \equiv w_{ij} - w_{ij-1} = b\Delta x_{ij} + \lambda \Delta w(T)_{ij-1} + \Delta\xi_{ij}.$$

Ordinary least-squares estimates of this first-differenced wage equation may be inappropriate, however, if there is any correlation between the real wage at the end of the $(j-1)$st contract and the error component $\xi_{ij} - \xi_{ij-1}$ in the first-differenced wage equation.[21] This problem is readily overcome by using instrumental variables for the lagged change in ending real wage rates. Suitable instruments include the first-difference in the unexpected component of ending real wages and any exogenous components of Δx_{ij-1}. First-differencing also introduces a moving average error component into consecutive wage observations from the same bargaining pair. The estimated standard errors and test statistics throughout this paper therefore allow for a first-order moving average error component among the observations from each bargaining pair, as well as for arbitrary conditional heteroskedasticity.

Estimation results for the first-differenced wage equation (9) are reported in Table 3. Columns 1–4 of the table report estimates using the real wage at the start of the contract as the measure of wage outcomes, while columns 5–8 report estimates using the first-difference of the expected average real wage rate over the life of the contract as the dependent variable.[22] The components of x_{ij} include the regional unemployment rate and the real wage rate in aggregate manufacturing (measured in the effective month of the contract), a province-specific real wage rate for unskilled workers (measured in the effective year of the contract), and a set of unrestricted year effects for the effective date of the contract. The year effects capture a number of omitted factors, including a period of wage-price controls between 1975 and 1978. Their addition provides a significant improvement in the fit of the wage equations, although they hardly affect the estimated coefficient of previous wages. I have also estimated wage equations that include industry-specific output and price variables. These are only weakly related to negotiated wages, however, and their inclusion has virtually no effect on the reported coefficients in Table 3.

Colunms 1 and 5 of Table 3 report OLS estimates of equation (9) for the two alter-

[21]This problem is similar to one of estimating the effect of a lagged dependent variable in a panel data model: see Douglas Holtz-Aitken, Whitney Newey, and Harvey S. Rosen (1988).

[22]The expected average real wage in each month of the contract is estimated by formulas analogous to equations (6) and (7), using estimates of the expected price level in that month and estimates of the elasticity of indexation as described above. The expected average real wage is an unweighted average of expected monthly rates sampled at six-month intervals throughout the contract period, starting in the first month of the contract.

TABLE 3—ESTIMATED WAGE DETERMINATION EQUATIONS

	Real Wage at Start of Contract				Expected Average Real Wage During Contract			
	OLS	IV[a]			OLS	IV[a]		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Regional Unemployment Rate	−0.50	−0.45	−0.46	−0.46	−0.38	−0.44	−0.45	−0.47
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)
3. Real Wage in Manufacturing	0.04	0.11	0.11	0.10	0.40	0.30	0.31	0.26
	(0.10)	(0.11)	(0.11)	(0.12)	(0.11)	(0.12)	(0.12)	(0.12)
5. Real Wage in Region	0.02	0.04	0.04	0.03	0.04	0.02	0.02	0.01
	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
5. Real Wage at End of Previous Contract	0.48	0.36	0.35	–	0.25	0.41	0.35	–
	(0.03)	(0.05)	(0.07)		(0.03)	(0.06)	(0.07)	
6. Expected Real Wage at End of Previous Contract	–	–	–	0.46	–	–	–	0.36
				(0.08)				(0.09)
7. Unexpected Real Wage at End of Previous Contract	–	–	–	0.41	–	–	–	0.43
				(0.06)				(0.07)
8. Change in Prices During Previous Contract	–	–	−0.01	–	–	–	−0.05	–
			(0.03)				(0.03)	
9. Standard Error	0.039	0.039	0.039	0.038	0.038	0.039	0.038	0.038
10. Overidentification Test[b]	–	0.261	0.273	0.489	–	0.037	0.016	0.006

Note: Standard errors in parentheses. Sample size is 1293. All regressions include a (first-differenced) linear trend. The mean and standard deviation of the dependent variable in columns (1)–(4) are 0.050 and 0.066. The mean and standard deviation of the dependent variable in columns (5)–(8) are 0.043 and 0.061. Standard errors are corrected for first-order moving average error component and heteroskedasticity.

[a]In columns (2), (3), (6), and (7), instrumental variables for real wage at the end of the previous contract include 18-year effects, the real wage in manufacturing at the start of the previous contract and the unanticipated change in real wages over the previous contract. In columns (4) and (8) instrumental variables for expected real wage at the end of the previous contract include 18-year effects, the real wage in manufacturing at the start of the previous contract, and the change in consumer prices during the previous contract.

[b]Probability value of test for orthogonality of residuals and instruments. The statistic is distributed as chi-squared with 19 degrees of freedom in columns (2), (3), (6), and (7), and with 18 degrees of freedom in columns (4) and (8).

native dependent variables, while columns 2 and 6 report instrumental variables (IV) estimates. These specifications suggest that negotiated wages are significantly positively related to the level of wages at the end of the preceding contract. The OLS estimates of the spillover coefficient λ (in row 6) differ somewhat between the two alternative measures of the dependent variable, although the IV estimates are closer together. The last row of the table reports overidentification test statistics for the instrumental variables estimators. There is no evidence against the exclusion restrictions implicit in the IV procedure for the specification in column 2. The test statistic for the specification in column 6, on the other hand, presents mild evidence against these restrictions.

In columns 3 and 7 the change in prices over the preceding contract is introduced directly into the wage determination equation. This addition permits a test of the hypothesis that aggregate price movements affect future wage determination only to the extent that they affect the level of real wages at the end of the preceding contract. The estimated coefficients in row 8 of the table provide no evidence against this hypothesis. Finally, the specifications in columns 4 and 8 relax the assumption that the expected and unexpected components of the end-of-contract wage $w(T)_{ij-1}$ have the same effect on subsequent wages.[23] Perhaps sur-

[23]These equations are estimated using the change in prices over the previous contract, the manufacturing

prisingly, there is no evidence against the restricted specification: the t-statistics for the hypothesis of equal coefficients for the expected and unexpected components are 1.32 in column 4 and 1.22 in column 8.

These results suggest that unexpected changes in wages have persistent effects on the costs of contractual labor. An unanticipated 10 percent decrease in real wages leads to an approximately 3 percent lower real wage throughout the following contract. Thus even in the presence of substantial adjustment costs, employment should be expected to respond to unanticipated changes in real wages, provided that the unilateral employment determination model is correct.

IV. The Determinants of Contractual Employment

This section turns to estimates of the employment demand function (5). As in the previous section, the framework for the analysis is a components-of-variance model for the logarithm of end-of-contract employment in the jth contract of the ith firm (n_{ij}):

$$(10)\quad n_{ij} = \psi_i + \alpha z_{ij} + \beta w(T)_{ij} + \varepsilon_{ij}.$$

In this equation, ψ_i represents a permanent firm-specific effect, z_{ij} represents a vector of determinants of employment, measured at the end of the contract, $w_{ij}(T)$ represents the real wage rate at the end of the contract, and ε_{ij} is a contract-specific disturbance. Assuming that industry output and prices are used as proxies for firm-specific output and price data, the wage elasticity β in equation (10) is related to the underlying parameters of the employment demand schedule (3) and the relative output equation (4) by $\beta = -(\beta_1 + \sigma\gamma_1)$. Note that β is assumed to be constant across industries. Although this is unlikely to be true, the relatively small number of contracts in each industry makes it difficult to estimate parameters other than the average demand elasticity across industries. Heteroskedasticity introduced by variation in β is taken into account in the calculation of the standard errors.

Again, a convenient method for eliminating the pair-specific effects is to take first-differences between consecutive contracts, yielding

$$(11)\quad \Delta n_{ij} = \alpha \Delta z_{ij} + \beta \Delta w(T)_{ij} + \Delta \varepsilon_{ij}.$$

In many previous studies, employment outcomes have been found to follow a partial adjustment equation of the form $n_{ij} = (1-\mu)n^*_{ij} + \mu n_{ij-1}$, where n^*_{ij} represents the optimal level of employment in the absence of adjustment costs, as given by an equation such as (5). Partial adjustment is readily accommodated within the framework of equation (11) by the addition of a lagged dependent variable. In the present context, however, consecutive employment outcomes are 20–36 months apart. Thus, the extent of partial adjustment is likely to be much smaller than that observed in quarterly or annual data. This issue is addressed more thoroughly below.

Estimation results for the first-differenced employment equation are presented in Tables 4 and 5. Following the discussion in Section I, Part B, the determinants of employment include the three-digit industry input price index (deflated by the consumer price index), industry-level real output, and the end-of-contract real wage rate. Specifications that add outside wage rates and a lagged dependent variable are presented in Table 5. The odd-numbered columns of Table 4 present estimated equations that include a linear time trend, while the even-numbered columns report estimates that include a set of unrestricted dummy variables for the different expiration years in the sample. I have not made any attempt to measure the user cost of capital. On the assumption that capital costs are constant across manufacturing industries, variation in

wage at the effective date of the previous contract, and year effects for the effective date of the previous contract as instrumental variables for the expected and unexpected components of real wages at the end of the previous contract.

TABLE 4—ESTIMATED EMPLOYMENT DETERMINATION EQUATIONS

	OLS		IV[a]		IV[b]			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Year Effects	No	Yes	No	Yes	No	Yes	No	Yes
2. Real Industry Input Price	0.22	0.16	0.20	0.16	0.19	0.16	0.19	0.15
	(0.06)	(0.08)	(0.06)	(0.08)	(0.06)	(0.08)	(0.06)	(0.08)
3. Real Industry Output	0.20	0.29	0.22	0.28	0.23	0.28	0.23	0.28
	(0.07)	(0.09)	(0.07)	(0.09)	(0.07)	(0.09)	(0.07)	(0.09)
4. Real Industry Output (Previous Year)	0.17	0.10	0.15	0.11	0.14	0.11	0.14	0.10
	(0.06)	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)
5. Real Wage at End of Contract	−0.15	−0.02	−0.28	−0.45	−0.39	−0.51	−0.42	−0.40
	(0.08)	(0.10)	(0.17)	(0.35)	(0.12)	(0.29)	(0.17)	(0.42)
6. Unexpected Inflation During Contract	–	–	–	–	–	–	−0.03	0.10
							(0.13)	(0.20)
7. Standard Error	0.196	0.194	0.196	0.195	0.196	0.196	0.196	0.195
8. Test for Exclusion of Year Effects (p-Value)	–	0.003	–	0.006	–	0.004	–	0.004
9. Overidentification Test[c]	–	–	–	–	0.76	0.97	0.74	0.96

Note: Standard errors in parentheses. Sample size is 1293. All regressions include a (first-differenced) linear trend. The mean and standard deviation of the dependent variable are −0.017 and 0.201. Standard errors are corrected for first-order moving average error component and heteroskedasticity.

[a]Instrumental variable for real wage at end of contract is the unanticipated change in real wages during the contract.

[b]Instrumental variables for real wage at end of the contract include 18 year effects, the real wage in manufacturing at the start of the contract, and the unanticipated change in real wages during the contract.

[c]Probability value of test for orthogonality of residuals and instruments. The test statistic is distributed as chi-squared with 19 degrees of freedom in all cases.

the user cost of capital is absorbed by the trends and/or time effects in the empirical specification. The unrestricted year effects also capture any aggregate-level shocks (such as aggregate demand shocks or productivity shocks) that are shared by all contracts in a given year.

In an effort to capture partial adjustment effects, and also to control for the fact that industry output is measured annually, the employment equations in Tables 4 and 5 include industry output in both the expiration year of the agreement and the previous year. I have experimented with specifications that also include wage rates and input prices in the year prior to the expiration date, but the effects of these variables are always poorly determined and small in magnitude.

The first two columns of Table 4 present OLS estimates of the employment equation with and without dummy variables for the expiration date of the contract. Employment is positively related to intermediate input prices and current and last year's level of output. The elasticity of employment with respect to output (i.e., the sum of the coefficients of current and last years' output) is substantially less than unity, implying increasing returns to scale in the framework of equation (5). The addition of the year effects results in a relatively small improvement in the fit of the employment equations: the probablity value of an exclusion tests for the year effects is reported in row 8 of the table. When the year effects are included, however, the estimated wage elasticity of employment demand falls to essentially zero.

The estimated wage elasticity is substantially larger (in absolute value) when the end-of-contract wage rate is instrumented by the unanticipated change in real wages over the term of the contract. The results of this exercise are reported in columns 3 and 4 of Table 4. Without year effects, the esti-

TABLE 5—ESTIMATED EMPLOYMENT DETERMINATION EQUATIONS

	OLS		IV[a]			IV[b]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Year Effects	Yes	Yes	Yes	Yes	Yes	No	Yes
2. Real Industry Input Price	0.16	0.16	0.14	0.16	0.14	0.13	0.10
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.09)
3. Real Industry Output	0.29	0.29	0.27	0.28	0.27	0.20	0.25
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.07)	(0.09)
4. Real Industry Output (Previous Year)	0.10	0.10	0.11	0.11	0.11	0.15	0.13
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
5. Real Wage at End of Contract	−0.03	−0.02	−0.56	−0.51	−0.56	−0.52	−0.58
	(0.10)	(0.10)	(0.32)	(0.31)	(0.33)	(0.22)	(0.32)
6. Real Wage in Industry	0.06	-	0.23	-	0.23	0.26	0.38
	(0.22)		(0.26)		(0.26)	(0.22)	(0.25)
7. Real Wage in Region	-	−0.03	-	0.04	0.06	-	-
		(0.15)		(0.16)	(0.21)		
8. Lagged Dependent Variable (Instrumented)	-	-	-	-	-	−0.13	−0.08
						(0.14)	(0.15)
9. Standard Error	0.194	0.194	0.196	0.196	0.196	0.193	0.194
10. Overidentification Test[c]	-	-	0.972	0.967	0.972	0.451	0.666

Note: See note to Table 4. Standard errors in parentheses.

[a]Instrumental variables for the real wage at the end of the contract include 18-year effects, the real wage in manufacturing at the start of the contract, and the unanticipated change in real wages during the contract.

[b]Estimated on subsample of 1107 observations. Mean and standard deviation of the dependent variable are −0.015 and 0.0200, respectively. Instruments include the instrument set above plus the lagged value of industry output.

[c]Probability value of test for orthogonality of residuals and instruments. The test statistic is distributed as chi-squared with 19 degrees of freedom in columns (3)–(5), and 16 degrees of freedom in columns (6)–(7).

mated elasticity rises from −0.15 to −0.28, although the estimated standard error rises proportionately. With year effects, the change in the point estimate is even more remarkable: from −0.02 to −0.45. Due to the imprecision of the IV estimators, however, tests of the difference between the OLS and IV estimates are insignificant in either case.

The specifications in columns 5 and 6 attempt to reduce this imprecision by expanding the list of instrumental variables for the end-of-contract real wage rate to include the level of real wages in manufacturing at the start of the contract and year effects for the signing date of the contract. The additional instrumental variables lead to a slight increase in the magnitude of the estimated wage elasticities and provide some increase in the precision of the estimates. Overidentification test statistics for the internal consistency of the instruments are reported in row 9 of the table. In all cases these are below conventional significance levels. I have also estimated employment equations that use only the additional instruments (i.e., excluding the unexpected change in real wages) to identify the effect of wages on employment. As the overidentification statistics suggest, these estimates are very similar to those in Table 4.

Even with the additional instrumental variables the estimated elasticity of employment demand in column 6 is only significantly different from zero at the 10 percent level. Nevertheless, a test of the difference between the estimated demand elasticities in columns 1 and 5 is significant at the 1 percent level, and a test of the difference between the estimated elasticities in columns 2 and 6 is significant at the 10 percent level. These results suggest that OLS estimates of the elasticity of employment demand are positively biased.

The final two columns of Table 4 present employment equations that include the unexpected change in consumer prices during the term of the contract as an additional explanatory variable. These specifications provide a simple check on whether unexpected price increases affect employment through the contractual wage, or whether there is a direct correlation between unexpected inflation and employment demand.[24] Neither specification provides any evidence of a direct role for unexpected price changes. Nevertheless, the standard errors of the wage and price terms in column 8 are sufficiently large that one cannot rule out a direct effect of inflationary surprises on employment demand.[25] Taken together with the other estimates in the table, however, I interpret the results in columns 7 and 8 as supporting the conclusion that price surprises affect employment determination solely through their effect on realized wages.

The effect of outside wage rates on contractual employment is addressed in Table 5. The theoretical analysis in Section I identifies two alternative routes for this effect. On one hand, increases in average wages in the industry may have a positive effect on employment, reflecting the competitive advantage implied by higher costs elsewhere in the industry. On the other hand, increases in wage rates representing the alternative value of workers' time may have a negative effect if employment is influenced by efficient contracting considerations. In an effort to distinguish between these hypotheses, I have included the industry average wage in columns 1 and 3 of the table, and a province-specific wage for unskilled laborers in columns 2 and 4 of the table. Both wage measures are included in column 5.

The OLS estimates in columns 1 and 2 of Table 5 show no evidence of a role for either outside wage measure. When the contract wage is instrumented, however, the point estimate of the effect of the industry-specific wage rises substantially, while the estimated effect of the regional wage measure remains close to zero. A similar pattern emerges in column 5 when both outside wage measures are included. Given the imprecision of the estimated elasticities it is difficult to draw strong conclusions from these results. Nevertheless, the estimates lend much stronger support to the view that outside wages belong in the employment equation as a proxy for the level of competitors' costs than to the view that outside wages belong in the employment equation as a proxy for the shadow value of employees' time.[26] If the former view is taken literally, the point estimates in column 3 suggest that the output-constant elasticity of employment demand with respect to wages is -0.33, while the elasticity of output supply with respect to an increase in wages is -0.70.[27] This estimate of the output-constant demand elasticity is in the midpoint of the range of estimates usually reported in the static employment demand literature (see Daniel S. Hamermesh, 1986, pp. 451–54).

The question of whether the estimated employment equations are robust to the inclusion of lagged employment is explored in the last two columns of Table 5. Since the employment models are estimated in first-differences, and the covariance of consecutive changes in employment is biased downward by any measurement error, the lagged value of industry output is added to the list of instrumental variables, and lagged employment and real wages are treated as jointly endogenous. The results show no evi-

[24]It is worth pointing out, however, that aggregate demand shocks (or any other variables that affect all contracts at a point in time) are absorbed by the year effects included in columns 4 and 6.

[25]At the suggestion of a referee, I estimated an employment equation that includes unexpected price increases (and year effects) and excludes wages. In this specification the estimated elasticity of employment with respect to unanticipated price increases is 0.23, with a standard error of 0.14.

[26]My 1986 paper and Stephen J. Nickell and Sushil Wadhwani (1987) report employment specifications that show a positive effect of outside wages, while Brown and Ashenfelter (1986) report positive effects in more than one-half of their specifications.

[27]Recall from equation (5) that the elasticity of employment with respect to wages is $-(\beta_1+\sigma\gamma_1)$, while the elasticity of employment with respect to industry average wages is $\sigma\gamma_1$. An estimate of σ from column (3) of Table 5 is 0.39 (the sum of the coefficients of current and last year's output). Using the other estimated coefficients from this equation leads to the estimates of β_1 and γ_1 reported in the text.

dence of a role for lagged employment. As mentioned earlier, this probably reflects the 20–36 month interval between consecutive observations in the data set. Over two or three years the effects of partial adjustment are likely to be much smaller than over an interval of a quarter or year.[28]

The estimates in Tables 4 and 5 suggest two main conclusions. First, employment outcomes are negatively related to contractual wage rates. Although the simple correlation between end-of-contract wage rates and employment is small and statistically insignificant, this is apparently a consequence of simultaneity bias. When unanticipated real wage changes and/or other exogenous variables are used as instrumental variables for the end-of-contract wage, the estimated wage elasticity is consistently negative and stable in magnitude across alternative specifications. Second, there is no evidence that employment is related to outside wages in a manner consistent with simple efficient contracting models. Even though employment is uncorrelated with region-specific wage measures, it is weakly positively correlated with industry average wages. This positive correlation is consistent with the hypothesis that higher average industry wages lead to improvements in the firm's competitive position and increases in employment.

V. Conclusions

This paper presents new evidence on the role of nominal wage contracts in the union sector. An important feature of these contracts, emphasized by the simple macro models of Fischer (1977) and Taylor (1980), is the predetermined nature of nominal wages. Real wage rates at the end of a contract therefore contain unanticipated components that reflect unexpected changes in consumer prices and the degree of indexation in the contract. The empirical analysis, based on a large sample of indexed and nonindexed contracts, indicates that these unexpected real wage changes are associated with systematic employment responses in the opposite direction. This suggests that nominal contracts play a role in the link between aggregate demand shocks and real economic activity, at least in the part of the economy covered by explicit nominal contracts.

Three other findings emerge from the empirical analysis. First, the contract-level correlation between employment and wages apparently reflects both demand and wage-setting behavior. Similar simultaneity problems may arise in other studies of firm-specific employment and wage data. Second, unanticipated changes in prices are found to generate changes in real wages that spill over from existing labor contracts to subsequent agreements. Inflation surprises therefore have persistent effects on real wages in the union sector, in addition to their short-run effects on employment. Finally, the empirical results suggest that employment outcomes in union contracts are determined on a conventional downward-sloping demand schedule, taking the prevailing contract wage as given. There is no indication that employment is related to outside wages in a manner consistent with a simple model of efficient contracting.

DATA APPENDIX

I. Contract Sample

The contract sample is derived from the December 1985 version of Labour Canada's Wage Tape. This tape contains information on collective bargaining agreements covering more than 500 employees in Canada. Starting from the 2868 manufacturing contracts on the tape, I merged together contract chronologies between the same firm and union covering different establishments, and eliminated contracts from bargaining pairs with fewer than four contracts. These procedures yield a sample of 2258 contracts negotiated by 299 firm and union pairs. Further information on the merging process and the characteristics of the resulting sample are presented in the Data Appendix to my 1988 paper and in Tables 1 and 2 of that paper.

The employment data for this sample were then checked in two stages. First, the number of workers covered in each contract was compared to the number covered in the preceding and subsequent agreements. Second, in cases where the number of workers changed dramatically between contracts, the contract summaries in the appropriate issue of the *Collective Bar-*

[28] In principle, the coefficient of the lagged dependent variable will differ, depending on the duration of the previous contract. In view of the imprecision of the estimated partial adjustment coefficients in Table 5, however, I have not attempted to address this issue.

gaining Review were consulted. In 238 contracts, the employment counts recorded on the wage tape were found to be in disagreement with the counts reported in the *Collective Bargaining Review*. In these cases, counts from the published contract summaries were used. In cases for which the set of establishments covered by the contract changed over time, contracts with inconsistent coverage were deleted from the sample. Of the 2258 contracts in the subsample of merged contracts, valid coverage data are available for 1813 contracts (80.3 percent). Checking of the employment data was performed by Thomas Lemieux. I am extremely grateful for his assistance with these data.

In this paper, employment at the end of a contract is measured by the number of workers covered by the subsequent agreement. Furthermore, the estimation procedures require information on employment and wage outcomes in the previous agreement and on various industry and aggregate data that are only available between 1966 and 1983. The sample of contracts used in this paper therefore consists of the subset of contracts in the initial 2258 contract merged subsample that satisfy the following criteria:

(a) Information on at least one previous contract is available in the sample.

(b) Information on at least one subsequent contract is available in the sample.

(c) The expiration dates of the current and previous contract are after January 1966 and before December 1983.

(d) Valid employment data are available for both the current and preceding contract (i.e., valid counts of workers covered are available for both the current and subsequent contracts).

II. Aggregate and Industry-Level Data

The following aggregate and industry-level data were merged to the contract sample.

(a) Consumer price index, all items, 1981 = 100. January 1961 to November 1985: Cansim D484000, from the 1985 Cansim University Base Tape. December 1985 to June 1986: from the *Bank of Canada Review*, November 1986.

(b) Average hourly earnings in manufacturing. January 1961 to March 1983: Cansim D1518, from the 1983 Cansim University Base Tape. April 1983 to December 1983: Cansim L5607, from the *Bank of Canada Review*, various issues. Data from April 1983 and later are multiplied by 1.04035 to correct for the revision in the establishment survey.

(c) Average hourly earnings of nonproduction production laborers, by province. Annual data on hourly earnings for selected occupations are available for major cities. I matched data for the following cities to their respective provinces: Halifax, St. John, Montreal, Toronto, Winnipeg, Regina, Edmonton, Vancouver. The wage rates used are listed as rates for "male general laborers" between 1966 and 1977, for "general laborers in service occupations" between 1978 and 1981, and for "nonproduction laborers" between 1982 and 1985. Data for 1966–72 are from *Wage Rates, Salaries, and Hours of Labour*, 1966–1972 editions. Data for 1973–1986 are from *Canada Year Book*, various editions. For contracts that cover two or more provinces, I used a weighted average of Montreal, Toronto, and Vancouver rates with weights of 0.35, 0.55, and 0.10, respectively.

(d) Unemployment rates, seasonally adjusted. For contracts in Quebec, Ontario, and British Columbia, I used the province-specific unemployment rates for all workers. For contracts in other provinces, I used the national average unemployment rate. The series used were as follows: Quebec–Cansim D768478; Ontario–Cansim D768648; British Columbia–Cansim D769233; all others–Cansim D767611. Data for January 1966 through November 1983 were obtained from the 1983 Cansim University Base. Data for December 1983 were taken from the *Bank of Canada Review*, November 1986.

(e) Industry selling prices, input prices, and output. Three-digit industry level annual data for 1961–71 were taken from Statistics Canada, *Real Domestic Product by Industry 1961–71*. These data are classified by 1960 standard industrial codes (SICs). Data on a 1971 SIC basis for 1971–83 were taken from the 1978 and 1984 issues of Statistics Canada, *Gross Domestic Product by Industry*. The 1960 and 1971 SIC codes were then matched, and the price and output indexes spliced using the 1971 observations from the two sources. Of 65 three-digit industries represented in the contract sample, there were a total of 31 for which three-digit-level data were not available on a consistent basis. For these industries, two-digit-level data were used. The publications report the value of gross output and implicit price indexes for gross output and intermediate inputs. These data were used to construct the value of real gross output (the measure of "output" used in this paper). Implicit price indexes for gross output and intermediate inputs were deflated by the annual average consumer price index to obtain real selling prices and input prices used in the paper.

(f) Industry average hourly earnings. Monthly two-digit industry-level average hourly earnings data for the period January 1961 to March 1983 were taken from the 1983 Cansim University Base. Earnings data are unavailable for two industries: knitting mills and miscellaneous manufacturing. For the former, I used earnings in clothing industries. For the latter, I used average earnings in all manufacturing. Wage rates for April through December 1983 were constructed by index-linking wage rates from the new establishment survey to the rates in the old survey using their values in March 1983. Earnings data from the new survey for March-December 1983 were taken from the 1985 Cansim University Base.

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