A risk-sharing view of real wages and contract length

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Abstract. This paper models a union and firm choosing between long labour contracts, in which wages are predetermined, and short contracts, in which wages are flexible. It is shown that the union strictly prefers short contracts because it dislikes the greater employment volatility in long contracts. In contrast, the convexity of the firm's profit function leads the firm to prefer the greater uncertainty of long contracts. The model predicts that workers are prepared to enter long contracts only if they are compensated with a higher real wage. This prediction is tested using a large sample of Canadian collective agreements, with generally supportive results.

Une perspective de partage du risque sur les salaires réels et la longueur des contrats. Ce mémoire présente un modèle d'un syndicat et d'une entreprise choisissant entre de longs contrats dans lesquels les salaires sont prédéterminés et des contrats courts dans lesquels les salaires sont flexibles. On montre que le syndicat préfère strictement des contrats courts parce qu'il déteste la volatilité plus grande de l'emploi quand on a de longs contrats. D'autre part, la convexité de la fonction de profit de la firme l'entraîne à préférer la plus grande incertitude des longs contrats. Le modèle prédit que les travailleurs sont seulement prêts à s'engager dans de longs contrats si on leur donne un salaire réel plus élevé. Cette prédiction est mise au test en utilisant un grand échantillon de conventions collectives et les résultats sont généralement favorables.

I. INTRODUCTION

Macroeconomic models that focus on the role of nominal wage contracts in the labour market, such as Fischer (1977) and Taylor (1980), emphasize that the effectiveness of macroeconomic policy depends on the length of time that wages

I thank Olivier Blanchard, Mick Devereux, Seamus Hogan, Larry Katz, and anonymous referees for helpful comments on earlier versions, David Card and Tim Fisher for providing data, and SSHRCC for financial support. All errors are mine.

Canadian Journal of Economics Revue canadienne d'Economique, XXVIII, No. 4b
November novembre 1995. Printed in Canada Imprimé au Canada

0008-4085 / 95 / 1161–79 $1.50

are fixed – that is, on the length of wage contracts. As contract length increases, relative to the length of time required before policy makers can act, the role for stabilization policy increases. A related issue is that the ability of prices in the labour market to adjust to external shocks is diminished as contracts increase in length. It is therefore useful, from both a policy viewpoint and the standpoint of understanding labour market flexibility, to examine the determination of contract length.

An influential paper that examines contract length is Gray (1978), in which the labour market is modelled with demand and supply curves, both subject to real and nominal shocks. Gray assumes that the firm and workers have well-aligned interests; their goal is to choose contract length and the degree of wage indexation that together minimize the deviations of employment from the ex post market-clearing level over the life of the contract. In a continuous-time setting, arbitrarily short contracts are ruled out by the existence of a fixed contracting cost.

As in her earlier paper on indexation (1976), Gray states that the existence of both nominal and real uncertainty implies that complete indexation to the price level is not optimal; real wages are therefore not constant over the life of the contract. Furthermore, since she assumes the conditional variance of nominal and real shocks to be greater over longer periods, optimal contract duration is inversely related to the degree of nominal and real uncertainty. Christofides and Wilton (1983) show some empirical support for this model – in particular, the negative correlation between contract length and nominal uncertainty – using a large sample of collective agreements in Canada.

Motivated by the observation that the average duration of major collective agreements in the United States did not fall in the mid-1970s – a period commonly associated with heightened real uncertainty – Danziger (1988) challenges Gray's view of optimal contract duration. He is naturally led to ask if there may be some countervailing force that leads firms and workers to sign longer contracts when real uncertainty increases.

Danziger constructs a model of efficient risk sharing between a risk-neutral firm and a single risk-averse worker with inelastic labour supply. Since the marginal product of labour is random, if the competitive labour market were a spot market, the real wage would also be random. The firm and worker must choose between a contract in which the wage is determined ex post, and thus always equals its spot-market value, and one in which the wage is determined ex ante, before the uncertainty is revealed. Crucial to Danziger's model is the assumption that the wage has no allocative role. Since employment is constant, the firm's profit function is linear in the random variable, and thus the risk-neutral firm is indifferent between the two contracts. The worker cares only about volatility in the real wage and so naturally prefers the ex ante contract. Danziger's model therefore predicts that an increase in real uncertainty leads to shorter contracts.

The absence of any contracting costs in Danziger's model implies that real wages are unrelated to contract length; in an expected-value sense, wages are the same in ex ante or ex post contracts. By including a fixed contracting cost as in Gray

(1978), however, Danziger's model would predict longer contracts to have higher real wages; the benefit of lower per-period contracting costs in long contracts would be split between firms and workers.

Danziger's assumption of constant employment removes a potentially important aspect of contract-length determination. Employment volatility, in addition to wage volatility, may be important to the group of workers. To the extent that wage rigidity inherent in long contracts implies more volatile employment, then the simple assumption of risk-aversion over employment might provide one reason why workers prefer shorter contracts. Furthermore, if changes in the real wage affect employment, then the natural convexity of the firm's profit function implies that even a risk-neutral firm may strictly prefer longer contracts, in which there is effectively more uncertainty. That firms and workers may have opposing preferences over contract length – stemming from their different attitudes towards risk – suggests a role for some sort of bargain based on the efficient sharing of risk.

This paper argues that there are good reasons to expect a divergence of firm and union interests concerning contract length. In particular, in a simple monopoly-union setting, unions generally prefer short contracts, while firms can often be expected to prefer long contracts. The divergence of interests between the firm and union suggests an obvious relationship between contract length and real contract wages, even in the absence of any formal costs associated with the contracting process. Firms' desire for long contracts can be satisfied by offering higher wages to workers. Conversely, unions' desire for short contracts can be satisfied by offering to accept lower wages in shorter contracts. A prediction of the model developed here, therefore, is that risk sharing between firms and workers leads to real contract wages' being higher in longer contracts.

This prediction is tested using a large sample of major collective agreements from the Canadian manufacturing sector. The results suggest that as contracts increase in length by one year, the real contract wage, relative to other manufacturing wages, increases by about 10 per cent.

The arguments in this paper can be viewed as both complementary and challenging to Danziger's theoretical setup. The emphasis here on risk sharing offers one explanation – unrelated to the existence of contracting costs – for real wages' being higher in longer contracts, and in this sense the paper complements Danziger's. On the other hand, it is the variability of employment – which is assumed away in Danziger – that is responsible for the existence of the divergence between firm and union interests and is thus central to viewing the relationship between real wages and contract length as the outcome of efficient risk sharing.

The paper is organized as follows. In section II the general arguments concerning the union's and firm's different preferences over contract length are presented. In section III a very simple model is shown – by means of an example – to illustrate the basic point. In section IV the data set on collective agreements is discussed and a simple test of the hypothesis that real wages are higher in longer contracts is provided. Final remarks are offered in section V.

II. THE GENERAL ARGUMENT

The basic argument is that in a monopoly-union setting in which a union and firm must decide either to conclude a 'long' contract – in which wages are set ahead of any uncertainty – or conclude a 'short' contract – in which wages are set after the uncertainty is revealed – the firm and union generally can be expected to have opposing interests. In particular, the union will generally prefer to have short contracts, while firms will often prefer longer contracts. In what follows, we use 'ex ante' and 'ex post' to refer to long and short contracts, respectively.

The emphasis here on ex post versus ex ante contracts allows a discussion of contract 'length' to take place within a model of only one period. This approach is used by Danziger (1988) and Anderson and Devereux (1991); its value is that it captures in an easy way what is perhaps the most important difference between real-world short and long contracts – the ability of the contract wage is respond to random events. One problem with the approach is that it explicitly ignores issues like fixed costs associated with the contracting process.

To see the basic argument in a one-period model, suppose that the real wage, w, is chosen by the union, while employment, L, is determined by the firm. Let e represent the random variable, with a distribution function F. We interpret an increase in e as a shock that is beneficial to the firm, such as an increase in labour productivity or an increase in the demand for the firm's product. In an ex ante contract, the wage is set before e is revealed and is not contingent on e. The firm's profit-maximizing employment choice is given by $L(w, e)$, where $L_w < 0$ and $L_e > 0$. In an ex post contract, the union sets the wage after observing the shock, and so the wage choice is $w(e)$. The firm's employment choice is then $L(w(e), e)$.

1. Union preferences

Consider the union's choice over the two types of contract. Suppose that the union's preferences over w and L can be represented by the utility function $U(w, L)$, which is increasing in both arguments. We make no specific assumption concerning the union's degree of risk aversion. In an ex post contract, the union's expected utility is given by

$$\int_e \left(\operatorname*{Max}_{w(e)} U(w(e), L(w(e), e)) \right) dF(e),$$

whereas in an ex ante contract the union's expected utility is

$$\operatorname*{Max}_{w} \int_e U(w, L(w, e)) \cdot dF(e).$$

It is straightforward to show that the union's expected pay-off from the ex post contract exceeds that for the ex ante contract; the result follows immediately from the convexity of the maximum operator (Anderson and Devereux 1991). The

economic intuition is simply that in an ex post contract the union can set any wage it likes after observing e, including any wage it might have chosen in an ex ante contract; the extra flexibility available to the union in an ex post contract cannot make it worse off. In the extreme case where $w'(e) = 0$, the union is indifferent between the two contracts.

2. Firm preferences

Now consider a risk-neutral firm that has a revenue function given by $R(e,L)$. In an ex ante contract, the firm's profit is given by

$$\Pi(w, e) = R(e, L(w, e)) - w \cdot L(w, e),$$

whereas in an ex post contract, the firm's profit is

$$\Pi(w(e), e) = R(e, L(w(e), e)) - w(e) \cdot L(w(e), e).$$

The firm's preferences over contracts depends on the comparison of the expected utility available in each contract. In order to focus on the differences across contracts due only to the different timing of the wage setting, rather than any possible differences in the level of the contract wages, we restrict attention to contracts in which the expected wages are equal. The firm then strictly prefers ex ante contracts to ex post contracts if and only if

$$\int_e \Pi(w, e) \cdot dF(e) > \int_e \Pi(w(e), e) \cdot dF(e), \tag{A}$$

where

$$w = \int_e w(e) \cdot dF(e).$$

For a risk-neutral firm facing the same expected wage in both contracts and the same distribution over e, the only reason to prefer one contract over the other is the convexity of the firm's profit function. One advantage of imposing expected-wage parity across the two contracts, therefore, is that a comparison of expected utility across contracts reduces to a simple comparison of the convexity of the two profit functions. If $\Pi(w, e)$ is 'more convex' in e than $\Pi(w(e), e)$, then the firm will prefer ex ante contracts. Since $\partial\Pi/\partial w < 0$, one result is immediately clear in condition (A): if $w(e)$ is sufficiently concave in e, then $\Pi(w(e), e)$ will be more convex than $\Pi(w, e)$, and so the firm will prefer ex post contracts.

From the definitions of $\Pi(w, e)$ and $\Pi(w(e), e)$ above, it is straightforward to show that the firm will prefer ex ante contracts if and only if

$$L_e \cdot w_e > L_w \cdot w_e(R_{Le} - w_e) - L \cdot w_{ee}, \tag{B}$$

where subscripts denote partial derivatives. Recall that $L_w < 0$ and we have defined e so that $L_e > 0$ and $R_{Le} > 0$.

Suppose we restrict our attention to the reasonable subset of possibilities in which the union's wage choice in an ex post contract reflects a desire to increase *both* wages and employment in response to a positive shock. This implies that $w_e > 0$ and $(R_{Le} - w_e) > 0$. In these cases the left-hand side of condition (B) is clearly larger than the right-hand side unless $w(e)$ is sufficiently concave in e.

To sum up the general argument, a very general result in this monopoly-union setting is that the union prefers ex post contracts to ex ante contracts. One implication of this preference is that the union would presumably be prepared to accept a lower average wage in return for securing the ex post contract. The results are not as general for the firm, but in the plausible set of cases in which the union desires both higher wages and higher employment when confronted with a positive shock, the firm strictly prefers ex ante contracts unless $w(e)$ is strongly concave.

III. A SIMPLE MODEL

In this section we present a simple model to illustrate the basic argument of the previous section. A specific form for the union's utility function is chosen which clearly distinguishes the union's desire for employment stability from its desire for wage stability. A simple specification for the firm's product demand and technology is also chosen. The result is a model that generates closed-form solutions for wages, employment, and expected pay-offs, which are easy to interpret in terms of fundamentals: union preferences, the wage-setting rule, and the elasticity of labour demand.

1. The basic setting

We follow Danziger (1988) in constructing a one-period model that highlights the difference between ex post and ex ante contracts. But there are three important differences from Danziger's model. First, Danziger assumes that workers are risk averse over the real wage, whereas here the union is risk averse over both the real wage and employment. Second, Danziger assumes constant employment, whereas here the firm's employment choice is sensitive to the real wage. Finally, Danziger assumes a competitive labour market; so workers have no influence on the wage. When we examine the duration of contracts in unionized labour markets, however, it seems more natural to recognize that the union may have some power in wage-determination. For this reason the wage in both ex ante and ex post contracts is assumed to be a weighted average of the monopoly and monopsony wage.

The firm and the union face the same basic problem as outlined in the previous section. The only uncertainty is assumed to be a shock that affects the firm's product demand. For simplicity, the aggregate price level is assumed to be constant, so that issues of wage indexation are unimportant; the model focuses only on real uncertainty.[1] In the empirical section that follows, the issue of wage indexation is explicitly addressed.

1 An earlier version of the paper included nominal uncertainty and optimal indexation of the nominal wage to the price level, but this inclusion did not change the basic results. If changes in

2. The firm

The firm is risk neutral and faces an inverse product demand,

$$P = a - bQ + e.$$

where P is the price received by the firm, Q is the firm's output, and e is a white-noise disturbance with zero mean and variance, σ^2. Labour input, L, is the only factor of production, and technology displays constant returns, so that $Q = L$.[2] Facing the real wage, w, the firm's employment choice and profits are

$$L(w, e) = (a - w + e)/2b \tag{1}$$

and

$$\Pi(w, e) = (a - w + e)^2/4b. \tag{2}$$

3. The union

In order clearly to distinguish the union's desire for wage stability from its desire for employment stability, the union's preferences over w and L are assumed to be represented by a separable utility function,

$$U(w, L) = u(w) + v(L), \tag{3}$$

where u and v are increasing and strictly concave. Defining $\bar{w}$ as the workers' alternative wage and $\bar{L}$ as the mean level of employment chosen by the firm at $\bar{w}$, the union's utility function can be normalized so that $U(\bar{w}, \bar{L}) = 0$. Then a second-order Taylor expansion of equation (3) around $(\bar{w}, \bar{L})$ yields

$$U(w, L) \cong u'(w - \bar{w}) + (.5)u''(w - \bar{w})^2 + v'(L - \bar{L}) + (.5)v''(L - \bar{L})^2, \tag{4}$$

where u', u'', v', and v'' are evaluated at $(\bar{w}, \bar{L})$ and thus are constants.

The monopoly wages, w_p^u and w_a^u, are the wages that the union would choose, in ex post and ex ante contracts, respectively, if it had the power to set the wage. They are given by

$$w_p^u = \bar{w} + \nabla + \theta e \tag{5a}$$

$$w_a^u = \bar{w} + \nabla, \tag{5b}$$

the price level are uncorrelated to real variables, then complete indexation is optimal and so the nominal uncertainty is irrelevant. If changes in the price level are correlated to real variables, then incomplete indexation is optimal, and so we are effectively left with 'more' real uncertainty. These results are similar to those in Blanchard (1979).

2 Anderson and Devereux (1991) develop a similar model in which capital is also an input to production. In their model the union's wage-setting behaviour in an ex ante contract influences the firm's investment behaviour; this fact presents the union with a trade-off between the benefits of precommitment and those of wage flexibility.

where $\theta = v''/(4b^2u'' + v'') \in (0, 1)$ and $\nabla = (2bv' - 4b^2u')/(4b^2u'' + v'')$.[3] θ plays a central role in the union's wage choice in an ex post contract. If the union is more risk averse over employment than over wages, then v''/u'' is large and θ is close to one. In this case the union wishes to absorb into the wage most of any change in labour demand, leaving employment to vary only slightly. In contrast, a union that is mostly risk averse over the wage has a small θ and will thus leave the wage relatively unresponsive to changes in e. Loosely speaking, θ represents the slope of the union's wage-setting locus or labour-supply curve.

4. Wage determination

A firm with the power to set the wage would choose $w = \bar{w}$, below which all workers would leave. The wage-setting rule is simply a weighted average of the monopoly wage (w^u) and the monopsony wage ($\bar{w}$),

$$w = \lambda w^u + (1 - \lambda)\bar{w}, \qquad \lambda \in [0, 1]. \tag{6}$$

This wage-setting rule is efficient, conditional on employment's being set by the firm. From equation (2) it is clear that profits are decreasing in w; from the definition of w^u it is clear that for any wage below w^u the union prefers an increase in the wage. Thus, equation (6) can be seen as an efficient wage bargain in which λ is viewed as the union's 'bargaining power.'

5. Contracts

Using equations (1), (5a), and (6) to construct the wage and employment solutions in an ex post contract, the union's expected utility and the firm's expected profits are then given by

$$E\Pi_p = (\Gamma^2 + (1 - \lambda\theta)^2\sigma^2)4b \tag{7a}$$

$$EU_p = \Psi + u''\theta^2\lambda^2\sigma^2/2 + v''(1 - \lambda\theta)^2\sigma^2/8b^2, \tag{7b}$$

where $\Psi = \nabla\lambda(u' - v'/2b + u''\nabla\lambda/2 + v''\nabla\lambda/8b^2)$.

Using equations (1), (5b), and (6) to construct the wage and employment solutions in an ex ante contract, the expected pay-offs are

$$E\Pi_a = (\Gamma^2 + \sigma^2)//4b \tag{8a}$$

$$EU_a = \Psi + v''\sigma^2/8b^2. \tag{8b}$$

3 Since u and v are strictly concave, ∇ is positive if $u' > v'/2b$. I assume that this condition is satisfied. The economic interpretation is that at $(\bar{w}, \bar{L})$, the union can increase its utility by increasing the wage; that is, the direct benefit of an increase in the wage outweighs the loss from lower employment. The monopoly wage in an ex ante contract is therefore always greater than the alternative wage. Note that in order to guarantee a wage in excess of the alternative wage in ex post contracts (when e may be negative), some limits must be put on the range of e; I therefore assume that e is never less than $-\nabla/\theta$.

Now define Δ_F and Δ_U as the change in expected pay-off, for the firm and the union, respectively, from choosing an ex ante contract rather than an ex post contract. Then,

$$\Delta_F \equiv E\Pi_a - E\Pi_p = \sigma^2\lambda\theta(2-\lambda\theta)/4b > 0 \tag{9a}$$

and

$$\Delta_U \equiv EU_a - EU_p = v''\sigma^2\lambda\theta(2-\lambda)/8b^2 < 0. \tag{9b}$$

For a given value of λ, and thus a given real wage, the firm strictly prefers ex ante contracts, while the union strictly prefers ex post contracts.

There are several points to note about Δ_F and Δ_U. First, for a given value of θ, an increase in v'' magnifies the union's preference for ex post contracts. This is because employment in ex ante contracts is necessarily more volatile than employment in ex post contracts and an increase in v'' is simply a greater dislike of this employment volatility.[4] It is precisely this greater employment volatility, combined with the convexity of the firm's profit function, that explains the firm's preference for ex ante contracts. In an ex ante contract the wage cannot respond to the shock and thus there is 'more convexity' available to increase expected profits.[5]

Second, if $\lambda\theta$ equals zero, then both the firm and the union are indifferent between the two contracts. Recall that λ is the union's weight in wage-setting and θ reflects the union's relative risk-aversion of employment to wages. Consider the special case in which the union has some influence on wage-setting but does not care about employment volatility ($\lambda > 0$, $\theta = 0$). In this case, as shown in equation (5), the union's wage choice in both contracts is independent of the value of e – the union's wage-setting locus is horizontal. Under these conditions both the firm and the union are indifferent between the two contracts because they generate identical wage/employment outcomes. In the other special case the union cares about both wage and employment volatility but has no influence in wage-setting ($\lambda = 0$, $\theta > 0$). In this case the wage in either contract will equal the constant alternative wage, and so, independent of union preferences, the two contract types generate the same wage/employment outcomes.

Third, the magnitude of Δ for both firm and union is increasing in the degree of uncertainty, σ^2. Thus, when the variance of the underlying shock increases, there is a widening in the divergence of the firm's and the union's interests. As expected, when there is no uncertainty, both the firm and the union are indifferent between the two contracts. Note, however, that, in contrast to the models of Gray and Danziger, this model does not predict a relationship between contract length and the degree of

4 The relative variance of employment in ex ante to ex post contracts is equal to $1/(1-\lambda\theta)^2$, which exceeds one.

5 Recalling the importance in section II of the concavity of $w(e)$, the unambiguous result for the firm in equation (9b) follows from the linearity of $w(e)$ in equation (5a).

uncertainty. What it does predict is that an increase in uncertainty simply increases the existing wedge between the firm's and the union's views regarding optimal contract length.

Finally, note the importance of the union's having some wage-setting power. For example, consider the special case where workers are risk averse only over real wages, so that $v'' = \theta = 0$, which corresponds closely to the assumptions in Danziger's model. But unlike the case of Danziger's workers, who strictly prefer ex ante contracts, equation (9) shows that in this case the union is indifferent between ex post and ex ante contracts. This result follows from the assumption that the union can influence the wage. The wage is a linear combination of the alternative wage and the union's monopoly wage, which is also constant when $v'' = 0$. Thus, when the union cares only about wage volatility in this model, the union is able to secure a constant wage even in ex post contracts. In contrast, Danziger assumes that a competitive labour market forces the equality of the real wage and the stochastic marginal product of labour. Danziger's workers necessarily face wage volatility in ex post contracts, and this volatility can be eliminated only by signing an ex ante contract.

III. REAL WAGES AND CONTRACT LENGTH IN CANADA

Unlike existing empirical work on the determinants of contract length, such as Christofides and Wilton (1983) and Bils (1989), this paper does not address the relationship between contract length and the degree of real or nominal uncertainty. A negative correlation between uncertainty and contract length, as found by Christofides and Wilton (1983) and interpreted as support for the Gray model, might be interpreted differently here. For example, a rise in uncertainty might increase the firm's preference for long contracts less than it increases the union's preference for short contracts, and the firm and union therefore agree on a short contract, with some accommodating reduction in the wage. On the other hand, a positive correlation between uncertainty and contract length, as found by Bils (1989) and taken as evidence against the Gray model, could be interpreted along similar lines.

The empirical approach in this paper begins by taking seriously the separation of firm and union interests examined in the previous two sections. This focuses the attention on the relationship between contract length and real wages rather than between contract length and the degree of uncertainty. Taking short-term and long-term contracts as the real-world analog of ex post and ex ante contracts, respectively, the hypothesis to be examined is that, ceteris paribus, real wages are higher in longer contracts.

The empirical approach is therefore to estimate

$$\ln (w_{it}/\bar{w}_t) = \nu_i + \beta D_{it} + \gamma X_{it} + \epsilon_{it}, \tag{10}$$

where w_{it} is a measure of the real wage in the contract for firm/union pair i beginning in period t, $\bar{w}_t$ is a measure of the average real manufacturing wage, D_{it}

TABLE 1
Frequency distribution of contract length

Length (d)	Frequency	Percentage
d < 12 months	7	0.3
d = 12 months	266	11.8
12 < d < 24 months	115	5.1
d = 24 months	931	41.2
24 < d < 36 months	190	8.4
d = 36 months	700	31.0
36 < d < 48 months	42	1.9
d = 48 months	6	0.3
48 < d < 60 months	0	0.0
d = 60 months	1	0.0

TABLE 2
Average contract length by industry (months)

Industry	mean	s.d.	freq.	Industry	mean	s.d.	freq.
Food	24.2	8.3	321	Printing	22.2	8.8	83
Tobacco	23.2	4.9	38	Pri. Metal	29.3	8.5	246
Rubber	34.3	4.5	61	Fab. Metal	29.9	7.5	55
Leather	28.8	5.9	28	Machinery	26.2	8.0	92
Textiles	28.2	7.4	103	Trans. Eq.	29.8	7.6	260
Clothing	28.3	7.6	134	Elect. Eq.	26.2	8.3	240
Wood	24.5	6.3	47	Non-Metal	26.2	6.8	100
Furniture	21.1	5.3	21	Petroleum	20.7	9.3	6
Paper	27.2	6.9	308	Chemicals	22.6	8.9	82
				Misc.	24.8	7.1	33

is the duration of the contract, X_{it} is a vector of other variables influencing the real contract wage, and ν_i is a pair-specific fixed effect.

1. Contract data

The data used in this paper contain characteristics of 2,258 union contracts signed in the Canadian manufacturing sector between 1963 and 1985, each covering at least 500 workers. The sample contains agreement between 299 firm/union pairs, spanning nineteen two-digit industries, and represents roughly 470,000 workers.

The mean contract duration in the sample is 26.9 months, with a standard deviation of 8.1 months; duration ranges from a low of eight months to a maximum of sixty months. A frequency distribution of contracts by length is shown in table 1. Notice that there are three modes in the distribution at twelve, twenty-four, and thirty-six months. Eighty-four per cent of the contracts in the sample have one of these three durations. Of this 84 per cent the vast majority of the contracts are either twenty-four or thirty-six months long. Contracts shorter than twelve months or longer than forty-eight months are very uncommon, making up less than 2.5 per cent of the sample.

Table 2 shows the average contract length across the nineteen manufacturing

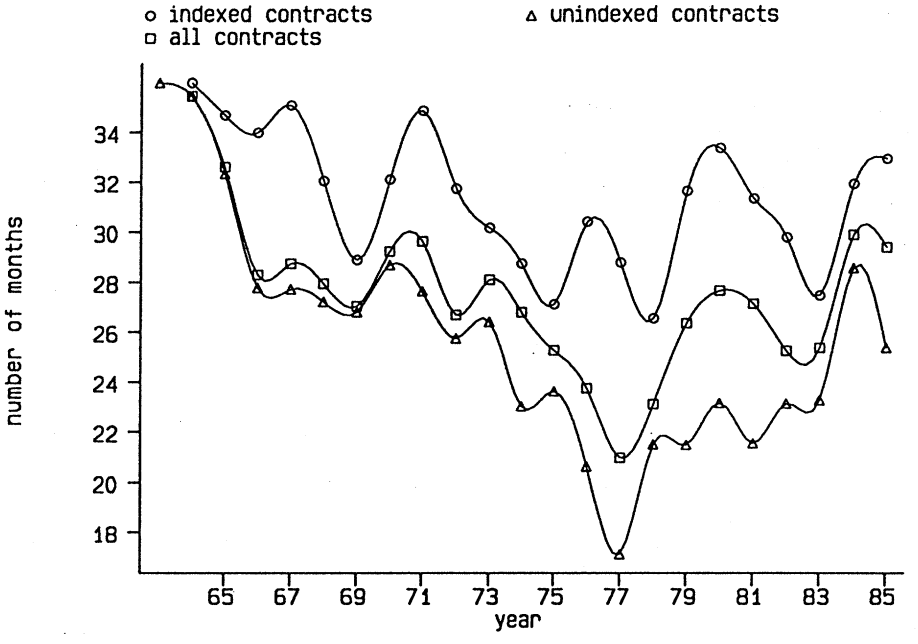

FIGURE 1 Mean contract length

industries in the sample. There is only a limited amount of variation in contract length across industries, though there is considerable variation within industries. Rubber and Tobacco stand out as industries with unusually long and short contracts, respectively. For the most part, however, the standard deviations in table 2 indicate that we are unable to reject the hypothesis that average contract duration in any one industry is the same as in any other industry.

Figure 1 shows average annual contract length over the sample period for indexed and unindexed contracts. Notice that the average length of indexed contracts exceeds the average for unindexed contracts in every year in the sample. This finding suggests that indexation is indeed an important consideration when the determinants of contract length are examined, and for this reason an attempt is made to control for this factor in the empirical work.

2. Measures of the real wage

A sensible measure of the real contract wage is perhaps the single biggest obstacle in estimating equation (10). The model above focused on real uncertainty and thus assumed away changes in the price level and issues concerning wage indexation. In reality, movements in the price level are highly uncertain, indexation is often incomplete, if not totally absent, and the nominal wage, even in unindexed contracts, is not constant during the contract period. Furthermore, a measure of the real wage appropriate for testing the model's prediction is some measure of the *expected*

TABLE 3
Example of the importance of front-loading of wages

		One-period contracts		Two-period contracts	
Period	Price level	Nominal wage	Real wage	Nominal wage	Real wage
1	100	100	1	104.7	1.04
2	110	110	1	104.7	0.95
3	121	121	1	126.7	1.04
4	133	133	1	126.7	0.95

real contract wage, conditional on information available at the time the contract is negotiated.

Three different measures of the real wage are used to estimate equation (10). The first, $w1$, is the real wage at the beginning of the contract. The main advantage of this measure is that it is known with certainty at the time the contract is signed. As suggested by Card (1987), if it is assumed that the firm and union set the nominal wage at the start of the contract to achieve a desired real wage, and establish deferred increases and escalation provisions to maintain that target level, then the real wage at the start of the contract is a reasonable measure of the contract real wage.

Recent work by Bils (1990) has shown the extent to which wages in U.S. union contracts are front-loaded, displaying large positive changes in the first year and small (often negative) changes in later years. In these cases $w1$ would not be a good measure of the real wage over the life of the contract. To understand the importance of front-loading for the relationship between real wages and contract length, one can imagine an extreme example in which there is no indexation and perfectly anticipated inflation of 10 per cent per period. Contracts last for either one period or two periods and in each case have nominal wages that are constant over the life of the contract. In both contracts the nominal wage is set to maintain an average real wage over the contract equal to 1. Table 3 shows the real wages in both contracts.[6]

It is clear in this example that by using $w1$ to estimate equation (10), a positive relationship would be found that has nothing to do with risk sharing. Moreover, if we instead compared the real wage at the end of two-period contracts with real wages in one-period contracts, the opposite relationship would be found. Thus, while existing explanations for the existence of front-loading are far from satisfactory,[7] the well-documented existence of front-loading suggests that we must use caution when interpreting estimated wage equations that use $w1$ as the dependent variable.

In the sample of Canadian union contracts the front-loading of wages is pervasive. Of the 2,258 contracts in the sample, 1,724 display a lower real wage at the

6 I thank Larry Katz for suggesting this example.
7 See Bils (1990) for a menu of unsatisfactory explanations.

end of the contract than at the beginning. Average real wage growth over entire contracts is 4.3 per cent, while the average real wage growth taking place at the start of contracts is 8.7 per cent.

The second measure of the real contract wage, $w2$, is the simple average of the real wages at the start and end of the contract. This measure is motivated largely by the problem of front-loading; in the example in table 3, $w2$ would be exactly equal in the one-period and two-period contracts. Unlike the value of $w1$, however, the value of $w2$ cannot be known with certainty at the time the contract is negotiated. There are two reasons. First, the price level at the end of the contract is not known with certainty. Second, the uncertainty over the price level implies that the nominal wage at the end of indexed contracts is not known at the time of contract negotiation. In the sample of 2,258 contracts, 756 are indexed and, among those indexed contracts, the average degree of indexation is 0.46 with a standard deviation of 0.36.[8]

The third measure of the real wage, $w3$, is the *expected* average real wage during the contract. Using w and p to denote the nominal wage and price level, respectively, $w3$ is given by

$$w3 = (0.5)\left[\frac{w_{\text{start}}}{p_{\text{start}}} + \frac{w^{nc}_{\text{end}} + w_{\text{start}}(\in \cdot \Pi^e)}{p^e_{\text{end}}}\right], \tag{11}$$

where w^{nc} is the non-contingent nominal wage, $(w_{\text{start}})(\in \cdot \Pi^e)$ is the expected value of changes in the nominal wage due to a COLA clause, and p^e is the expected price level. Π^e is the expected inflation over the length of the contract, and $\in$ is the degree of indexation.[9]

The main drawback with using $w3$ as a measure of the expected real wage over the contract is that it requires the construction of estimates of the future price level.[10] Its main advantage over $w1$, aside from dealing with the front-loading problem, is that it might reasonably be viewed as a measure of the real wage that workers expect to receive during the contract, based on information available at the time the contract is negotiated.

The dependent variable used to estimate equation (10) is (the log of) the real contract wage relative to other real wages in manufacturing. We therefore divide each measure ($w1$, $w2$, and $w3$) by the annual average real manufacturing wage for

8 This is the ex post elasticity of indexation, defined as the percentage change in the nominal wage generated by the COLA clause divided by the percentage change in the price level over the life of the contract. It is interesting to note that 100 contracts designated as containing an indexation clause actually generated no increases in the nominal wage and so had measured degrees of indexation equal to zero. Among the 656 'active' indexed contracts the mean degree of indexation was 0.53 with a standard deviation of 0.33.

9 See Card (1983) for a detailed description of COLA clauses in major Canadian contract settlements.

10 A naïve AR(4) forecasting model, using quarterly logged CPI observations, is used to generate the price-level predictions. The CPI data are from *Consumer Price and Price Indexes*, Statistics Canada #62-010.

the province in which the contract applies. For contracts that cover workers in more than one province, the average real manufacturing wage for Canada is used.[11]

3. Estimation and results

One important estimation issue is dealing appropriately with ν_i. To the extent that this pair-specific effect is correlated with contract length, OLS will produce a biased estimate of β. This bias can be corrected by transforming all variables into their deviations form and using the within-groups estimator. Alternatively, an approach that is quite common in the empirical work on union contracts (e.g., Card 1990), is to eliminate the fixed effect by taking contract-to-contract differences of all variables. Both approaches of dealing with the fixed effects are used here.

A second important issue in estimating equation (10) is the potential simultaneity bias arising from the fact that the path of wages and contract length are determined jointly at the beginning of the contract. Both OLS and two-stage least squares (2SLS) estimates are shown below.

One important characteristic of the data on contract length, which is not revealed in figure 1 or table 2, is that most industries have a similar time-series pattern for contract length. In the mid-1970s, for example, when overall average contract length declines, this decline is apparent in almost every industry.[12] This property of the data makes the overall annual average contract length, $\bar{D}_t$, a potential instrument for D_{it} in the 2SLS estimation of equation (10). Note also that $\bar{D}_t$ is likely to be uncorrelated with ϵ_{it} because the dependent variable in equation (10) is the *relative* wage $w_{it}/\bar{w}_t$, rather than the absolute real contract wage. Suppose that contract length is indeed strongly positively related to the real contract wage. Given that contract lengths in all industries tend to move together, this supposition implies that overall average contract length and w_{it} are also likely to be correlated. But even if all industries, for example, experience a shock that leads them to shorten their contracts and lower their real contract wages, it is not clear that this fact should systematically affect the *relative* wage structure. An important identifying assumption made in the 2SLS estimation, therefore, is that changes in the average contract duration across all industries do not systematically affect relative wages.

The basic set of explanatory variables used in the estimation of equation (10), aside from contract length, includes: linear and quadratic time trends; the average provincial unemployment rate; the deviation of industry-level employment from trend; the average size of the bargaining unit (measured as thousands of employees); a dummy variable indicating whether the current contract was preceded by a strike; a dummy variable indicating whether the contract contains an indexation

11 Data on average hourly earnings in manufacturing industries by province is from *Employment, Earnings and Hours* for 1970–85, Statistics Canada #72-002. For 1969 and earlier, the source is *Man Hours and Hourly Earnings*, Statistics Canada #72-003.

12 Of the nineteen industries in the sample, annual average contract length in seventeen of those industries is positively correlated with the overall annual average.

clause; a dummy variable for the wage and price controls in effect between October 1975 and December 1978; and dummy variables for industry and year.[13]

Table 4 shows both OLS and 2SLS results. The three estimation approaches used are indicated along the left-hand margin of the table: Levels, using various industry and year controls; Fixed Effects I, in which variables are expressed as deviations from firm-specific means; and Fixed Effects II, in which variables are expressed as contract-to-contract differences. OLS estimates are reported in the top section of the table; 2SLS estimates are contained in the last three rows. The numbers reported are the estimated coefficient on contract length with its associated *p*-value. Note that the interpretation of the estimated coefficient is the percentage increase in the firm's *relative* wage associated with an increase in contract length of one year.

Begin by considering the first three rows. Notice that, for a given equation, the results are quite insensitive to the dependent variable used. Once industry controls are included as explanatory variables, the effect of an additional year in contract length on the firm's relative wage is approximately 4 per cent. The magnitude of the estimates fall when the pair-specific effects are eliminated. In rows 4 and 5 the equation is estimated with all variables in deviations form (the within-groups estimator). The estimates are still rather insensitive to the choice of dependent variable, although when year controls are used, the estimates lose some precision, likely owing to the previously mentioned time-series pattern for contract length which is similar across most industries. In rows 6 and 7 all variables are expressed in contract-to-contract differences. There are virtually no differences between Fixed Effects I and Fixed Effects II; estimated coefficients and *p*-values are very similar.

Of the three dependent variables offered, *w*3 is probably the preferred choice, since it is the only one that can be viewed as a measured of the real wage that workers expect to receive based on information available at the time the contract is signed. Focusing on the *w*3 column, then, note that the estimation in levels or the fixed effects without year controls suggests a statistically significant relationship between relative wages and contract length, while the fixed effects estimation with year controls suggests no relationship at conventional levels of significance. More important than statistical significance, however, one might reasonably question the economic significance of any of the estimates, especially in the light of recent work documenting the existence of interindustry wage differentials well in excess of 15 per cent (e.g., Krueger and Summers 1987, 1988; Dickens and Katz 1978). To see this, note that an estimated coefficient of 0.008 in Table 4 indicates that a firm/union pair that signs a contract for an extra one-year duration might expect an increase in their relative wage of about eight-tenths of 1 per cent. Thus, while one might regard the results in table 4 as (weak) support for the theoretical model in this paper, these results do not suggest that issues of contract length will contribute much to the debate on interindustry wage differentials.

13 The data for strikes are available only for 2,173 of the contracts on the Wage Tape. I thank Tim Fisher for providing these data. The industry employment data are from *Canadian Statistical Review* and unemployment rates are annual averages from *Historical Labour Force Statistics.*

TABLE 4
Estimates of β in equation (10)

Dependent variable: log of relative wage			
Equation	$w1/\bar{w}$ Real wage at start of contract	$w2/\bar{w}$ Average real wage over contract	$w3/\bar{w}$ Expected average real wage over contract
1. Levels with industry controls	0.038 ($p = 0.000$)	0.037 ($p = 0.000$)	0.040 ($p = 0.000$)
2. Levels with year controls	0.016 ($p = 0.038$)	0.016 ($p = 0.039$)	0.010 ($p = 0.214$)
3. Levels with year and industry controls	0.033 ($p = 0.000$)	0.034 ($p = 0.000$)	0.034 ($p = 0.000$)
4. Fixed Effects I: no controls	0.008 ($p = 0.002$)	0.006 ($p = 0.024$)	0.007 ($p = 0.010$)
5. Fixed Effects I: year controls	0.006 ($p = 0.017$)	0.005 ($p = 0.031$)	0.003 ($p = 0.219$)
6. Fixed Effects II: no controls	0.009 ($p = 0.000$)	0.008 ($p = 0.000$)	0.008 ($p = 0.000$)
7. Fixed Effects II: year controls	0.005 ($p = 0.013$)	0.005 ($p = 0.004$)	0.002 ($p = 0.277$)
8. Levels with industry controls (2SLS)	0.191 ($p = 0.000$)	0.154 ($p = 0.000$)	0.230 ($p = 0.000$)
9. Fixed Effects I: (2SLS)	0.030 ($p = 0.038$)	0.021 ($p = 0.136$)	0.070 ($p = 0.000$)
10. Fixed Effects II: (2SLS)	0.090 ($p = 0.000$)	0.041 ($p = 0.000$)	0.121 ($p = 0.000$)

NOTES
The number shown in each cell is the estimated coefficient on contract length (years) in a version of equation (10).
The p-value is the probability that rejection of the null ($\beta = 0$) results in a type-I error.
The number of observations is 2,173 for all equations except the Fixed Effects II. In this case $N = 1874$.
The 2SLS estimates use the overall annual average contract length as an instrument for D_{it}.

Now consider the 2SLS estimates shown in the last three rows of table 4. Since $\bar{D}_t$ has no cross-sectional variation, year controls cannot be used in the regressions.[14] In all cases the estimated coefficient on contract length increases significantly when 2SLS rather than OLS is used, in most cases by a factor of five or more. In most cases the estimates are also more precise. Focusing again on the $w3$ column, the 2SLS estimates suggest that an increase in contract duration of one

14 One could compute the annual average contract length by industry, which would obviously have cross-sectional variation. But it is unlikely that such an instrument would be uncorrelated with ϵ_{it}.

year is associated with a rise in the relative wage of between 7 and 12 per cent. In contrast to the OLS results, this is economically quite significant.

V. SUMMARY

This paper examines the choice faced by a firm and union between negotiating an ex post 'short' contract and an ex ante 'long' contract. In contrast to the existing literature, this paper emphasizes the firm's and the union's opposing interests concerning length. A union that cares about both wages and employment generally prefers short contracts in which employment is less volatile. Firms, though assumed to be risk-neutral over profits, typically have convex profit functions and so will often prefer the heightened uncertainty associated with long contracts. Given the opposing interests of the two parties regarding wages and contract length, an obvious trade-off between these two variables would appear to exist. The clear implication is that efficient risk-sharing should lead to longer contracts' being associated with higher real contract wages.

This simple prediction is tested using a sample of major Canadian collective agreements which span nineteen two-digits manufacturing industries between 1963 and 1985. It is found that longer contracts are indeed associated with higher real contract wages; in particular, the results suggest that as contracts increase in duration by one year, real contract wages, relative to other manufacturing wages, increase by between 7 and 12 per cent.

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