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DETERMINANTS OF NEGOTIATED WAGE INCREASES: AN EMPIRICAL ANALYSIS*

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During the past decade a considerable amount of econometric research has been devoted to the explanation of movements in wages. Most empirical studies have used a basic disequilibrium model, first suggested by Phillips [11] in which the change in money wage rates is related to the level of unemployment. By relaxing some of the more rigid theoretical assumptions, the basic Phillips Curve explanation has been expanded to include a number of other variables such as profits, prices, productivity, employment mix, etc. While many of these studies have provided valuable insights into the wage determining process, the statistical approaches used have often failed to adequately deal with the institutional features of the labour market. These statistical problems are briefly discussed in Section I of the paper and our own empirical analysis using data on individual contracts in Canada is presented in Section II. The main implications of our study for the aggregate Phillips Curve are given in Section III.

I

A major weakness of existing econometric wage research is the failure to take account adequately of the discontinuity of wage adjustments. Given the prevalence of collective bargaining and the development of longer term contracts, the change in average wages in any period will reflect the terms of contracts negotiated not only in that period, but also those negotiated in a number of past periods. While under appropriate assumptions [10, p.33] long term contracts will probably not introduce any systematic bias, the unexplained variance (particularly for quarterly disaggregated data) will be greatly increased since current wage changes will be related to the explanatory variables with long and variable lag distributions.[1]

Current econometric wage research has attempted to deal with the complications arising from these institutional features in two different ways. The first approach virtually ignores the problem and proceeds as if wages are determined by annual negotiations which are spread out evenly during the year. Under these conditions it should be possible to explain quarterly changes in wages. The generally poor results obtained with such equations suggest that these assumptions are unrealistic, particularly for disaggregated data.[2] The usual approach to overcome the "noise" in the quarterly series is to employ overlapping annual wage changes on the assumption that the same percentage of workers negotiate their annual wage increase in each quarter. However, this statistical device has the serious disadvantage of transforming the error terms in the underlying behavioural relationships into moving averages so that serial correlation is built in.[3] Thus, the least squares estimates will be inefficient and their variances will be biased downwards.[4]

The second, and perhaps more appealing, method for dealing with these institutional features is to consider the length of the agreement as the appropriate interval of time. A first attempt at this approach was made by Eckstein and Wilson [3] who specifically recognized the collective bargaining process and the existence of multi-year contracts. Based on Levinson's analysis of the clustering of wage settlements over time [7], they chose as their period of observation the wage round assuming that the pattern for each round was established by a few early key bargains. Thus, their series of observations includes one point for each designated wage round with the dependent variable taking the form of the total wage change (in annual percentage terms) over the complete round.

A number of points can be raised against this procedure. First of all, the use of economy-wide wage rounds is open to question. Based on a study of the period June 1955 - September 1958, Kuh concluded: "An examination of monthly wage settlements ..... simply did not reveal any clearly defined pattern of rounds to enable the separation of one period from another with little ambiguity" [6, p. 346]. A recent study by Reuber [12] also failed to detect the existence of identifiable wage rounds in Canadian manufacturing industry. The use of similar wage round periods for all industries is also questionable. In some of the shorter periods it is unlikely that all sectors bargained, while in longer periods the same sector may have bargained several times.[5]

In summary, the predominant institutional forces affecting wage determination have been a major stumbling block to the specification and testing of wage theory. On the one hand, the forcing of a Phillips curve type of explanation into a quarterly model by the use of overlapping changes gives results which are highly suspicious in light of the serial correlation built into the basic model and the unrealistic assumptions imposed. On the other hand, attempts to explicitly recognize the collective bargaining process and the interaction of key industries have relied on the existence of identifiable economy-wide wage rounds.

II

In the light of the central role of collective bargaining in the determination of wage changes, we have attempted to surmount some of the difficulties discussed above by using data on individual contracts. It is our view that a statistical estimation of wage changes must first focus on the explanation of these infrequent, highly discontinuous

negotiated changes in basic wage rates since they cannot be adequately represented in an aggregate equation. Only after such an analysis can one proceed to formulate an aggregate theory of wages encompassing additional factors such as changes in employment mix, overtime hours, escalator clauses, etc. As implied above, this paper is directed to the first stage of this type of analysis. A large sample (133 independent observations) was obtained by combining time series and cross-section data on the wage settlements negotiated during the 1951-65 period in the following Canadian manufacturing industries:

1. Sawmilling
2. Pulp and paper
3. Iron and steel
4. Agricultural implements
5. Aircraft
6. Motor vehicles
7. Non-ferrous metals
8. Electrical apparatus
9. Meat products
10. Fish products
11. Tobacco
12. Textiles
13. Clothing.

In each case, a few leading firms in terms of numbers of employees were selected as representative of the industry. If more than one of these firms negotiated in the same year, the contracts were treated as one observation by averaging. For example, in the case of motor vehicles, the individual wage bargains for the three leading companies were combined to form a single independent time series since their bargaining tended to coincide in time, as well as to produce similar wage settlements.[6]

Using our data on the initial <u>basic</u> hourly wage rate and the increases negotiated for each year in the contract, we constructed for each contract in our sample, the average annual wage increase as a percentage of the initial rate.[7] This measure, which was used as the dependent

variable in the regressions reported below, is an improvement over that used in previous studies since it does not reflect cyclical variations in overtime hours or employment mix.

Following Eckstein and Wilson [3], we used as our basic explanatory variables the unemployment rate (U) and profits (π). Since our data refer solely to wage increases resulting from collective bargaining, we view the unemployment rate as a factor affecting union bargaining power rather than simply as a measure of excess supply, as would be appropriate in the competitive labour market envisioned by the simple Phillips curve theory. As no data was available for industry unemployment rates, we were forced to assume sufficient inter-industry labour mobility to justify the use of the national rate.[8] For each contract in our sample, we took as the relevant measure of unemployment a four quarter average of the unemployment rate ending in the quarter in which the contract was signed. As in a number of previous studies [2, 6, 10, 13], better results were obtained using the reciprocal of the unemployment rate. Similarly, we view profits as an important factor affecting management's willingness to grant wage increases as well as an influence on union demands. In order to provide an appropriate comparison of profits across industries we employed profits as a per cent of assets.[9] Using the available annual data on industry profit rates, we calculated the observation for each contract as a weighted average of the current and preceding year's profits with the weights based on the quarter in which the contract was signed, assuming a one quarter lag (e.g. if the signing took place in the second quarter, the current year's profits were given a weight of .25).

We also experimented with the following additional variables. First, the change in the unemployment rate is also emphasized in the original formulation of Phillips [11] and Lipsey [8], and more recently by Kuh [6].

This variable may represent extrapolative expectations or it may reflect constraints on short run labour market adjustments such as imperfect information and the existence of bottlenecks in particular segments of the market. Second, to test the effect of increases in the cost of living,[10] we entered the percentage rate of change in the Consumer Price Index over the four quarters preceding the signing of each contract ($\Delta P/_P$). Even though a small percentage of our sample contracts contained escalator clauses which capture price effects independent of base rate negotiations, we still expected a positive price effect in view of its likely impact on the remaining observations.

In addition, we included an interaction between unemployment and the rate of change of prices. This interaction effect has been found to be significant by de Menil [9] who argues that changes in the cost of living will have a greater wage effect in periods of high unemployment when the excess demand pressure on wages is weak. Under these circumstances, labour may concentrate on maintaining real wages above some minimum acceptable level. We tested de Menil's hypothesis by adding a new multiplicative price-unemployment variable (with unemployment in reciprocal form).

The regression results obtained using these variables are shown in equation I.1 in Table I. All the coefficients are highly significant although the R^2 is somewhat low, even in terms of typical cross-section results. It is interesting to note the important role played by the price-unemployment interaction. In fact, when this interaction variable is not included, the coefficient on the rate of change or prices is not significant.

Next, we attempted to take into account explicitly the economic effect on wages of a strike, labour's chief threat or weapon in the bargaining process. The basic reasons for management's displeasure with

Table I

Regression Equations for the Rate of Change of Wages*

	R^2	Standard Error of Estimate	Constant	Unemployment Rate (U^{-1})	Profits (π)	Change in Unemployment (ΔU)	Rate of Change of Prices ($\Delta P/P$)	$U^{-1}\,\Delta P/P$	Strike Dummy (S)	Growth Rate (g)	Relative Wage Rate (B/W)	Productivity (PROD)	(PROD)(B/W)	(PROD)(U^{-1})
I.1	.25	1.95	-1.996 (-1.97)	18.70 (4.99)	.1989 (3.74)	-.4135 (-2.80)	2.078 (4.34)	-6.372 (-4.34)						
I.2	.28	1.95	-1.272 (-.89)	17.05 (4.28)	.1864 (3.30)	-.3808 (-2.55)	1.979 (4.11)	-6.131 (-4.17)	.8573 (1.63)	.0621 (1.51)	-.0041 (-.42)			
I.3	.35	1.87	-7.292 (-2.13)	1.832 (.21)	.1964 (3.52)	-.3245 (-2.25)	1.750 (3.73)	-5.241 (-3.62)	1.016 (2.00)	.0618 (1.56)	.0952 (3.07)	.0776 (2.25)	-.0011 (-3.28)	.1202 (1.80)
I.4 (Industry Dummy Variables)	.43	1.82	10.89 (4.41)	14.02 (3.85)	.3300 (4.43)	-.3483 (-2.42)	1.607 (3.38)	-4.654 (-3.14)	.9309 (1.58)	.0364 (.8850)	-1293 (-2.99)			
I.5 (Short Contracts)	.81	1.49	-56.44 (-2.28)	-4.726 (-.32)	.3930 (4.04)	-.4599 -2.06	3.513 (4.29)	-12.05 (-3.53)	3.135 (2.67)	.1780 (1.63)	.5796 (2.41)	.4437 (2.24)	-.0050 (-2.67)	.2985 (2.78)
I.6 (Long Contracts)	.26	1.72	-4.894 (-1.46)	3.099 (.31)	.1031 (1.61)	-.3070 (1.80)	1.300 (2.42)	-3.34 (-2.07)	.8029 (1.54)	.0530 (1.30)	.0730 (2.42)	.0661 (1.99)	-.0008 (-2.37)	.0289 (.37)

Coefficients on Dummy Variables in Equation I.4

1.	Sawmilling	.700 (.86)	5. Aircraft	0	8. Electricial Apparatus	-.241 (-.32)	11. Tobacco	.140 (.13)
2.	Pulp and Paper	.545 (.55)	6. Motor Vehicles	-.146 (-.09)	9. Meat Products	-.592 (-.62)	12. Textiles	-4.68 (-2.55)
3.	Iron and Steel	1.04 (.96)	7. Non-ferrous Metals	2.22 (2.15)	10. Fish Products	.420 (.50)	13. Clothing	-6.92 (-3.29)
4.	Agricultural Implements	1.13 (1.23)						

* The t- ratios are shown in brackets under the coefficients.

a strike are obvious - loss in revenues and customer good will, potentially greater wage costs, etc. Labour on the other hand also suffers temporary losses but has the potential to recoup them through a larger wage settlement. As in any other confrontation, the judicious use of one's principal threat enhances its value as well as permitting one to bargain and bluff more effectively. A frequent calling of strikes would tend to condition management's response and diminish the value of the strike threat. In light of the relatively infrequent use of strikes in our sample (13.5%), we expect that a strike would have a definite positive impact on wages. Without attmepting to develop a theory concerning the optimum strike length (from labour's point of view), we have simple employed a dichotomous strike dummy (S), taking the value of unity whenever a strike occurred, to test the effects of this variable.[11] We also introduced the growth rate of employment in the particular industry (g) as an explanatory variable. A rapidly developing industry, particularly in a young expanding economy such as postwar Canada, may need to attract labour from other sectors by offering higher wages. To test this hypothesis, the growth in the industry's employment (as measured by the sectoral employment index) was employed in the form of the average percentage change over the two years ending in the year of the contract signing.

Having dealt specifically with factors originating within the particular industry or economy wide variables, it is now necessary to consider interindustry effects.[12] Eckstein and Wilson emphasize the effects of spillovers, as it is likely that any individual settlement is influenced by recent wage increases obtained by other workers. However, the incorporation of this effect into a statistical relationship is a

difficult problem. The simple grouping or pooling of industry explanatory variables to form "key group" variables (as done by Eckstein and Wilson) would be inappropriate for individual contracts running over different time periods. Furthermore, it also suggests a pooling or averaging of wage changes into one dependent variable if one contends that "spillovers are so pervasive that the key group of industries can be treated as a unit." [4, p. 692]. On the other hand, the simple introduction of a past "key settlement" which might be expected to influence a current wage bargain presents problems in identifying the key contract (s), and obscures the role of other variables by increasing multicollinearity.

In an attempt to capture these interindustry effects while avoiding some of the above problems, a variable B/W defined as the current base rate at the time of the bargain divided by a four quarter average of average hourly earnings in manufacturing was entered into the relationship.[13] Its effect should be negative since wage earners with low basic rates relative to the average will press for higher settlements. This "catch-up effect" will affect industries with generally low wages as well as those whose bargaining follows a number of key settlements which push up the average wage.

The regression results obtained adding these variables are shown in equation I.2 in Table I. The unemployment, profits and price coefficients remain highly significant and undergo little change in magnitude. Using a one-tailed test, the strike dummy and the growth rate fall just below the 5% level of significance, while the relative wage rate is insignificant. Thus, the latter three variables appear to play a minor role in the present specification.

In an attempt to improve the fit, several techniques were tried to allow for different patterns of behaviour in different industries. The first approach employed interaction effects entailing the selection of an appropriate cross-sectional variable. We initially employed concentration ratios under the assumption that in highly concentrated industries (e.g. autos, steel) unions are typically strong and firms are able to pass on wage increases in the form of higher prices.[14] However, statistical tests failed to uncover such a relationship, probably because of the poor quality of the data (we are able to obtain only rough estimates for our particular industry break-down for one year, 1948).

Greater success was achieved with a variable which characterized industries by their productivity relative to total manufacturing (PROD). Our productivity concept is simply annual real gross domestic product divided by employment using the same weighting pattern for the timing of each contract as was employed for profits. To the extent that our productivity variable is related to union strength and the competitive environment of the product market it may be a suitable alternative to the concentration ratio. For example productivity may serve as a proxy for capital intensity which may affect ease of entry into an industry and therefore the degree of competition. When this variable was interacted with the other variables, two terms were found to be significant, - PROD (B/W), PROD (U^{-1}). As shown in equation I.3, the inclusion of these two interaction variables improves the fit and produces a highly significant relative wage effect.

To facilitate interpretation of the coefficients in the presence of interaction effects, the net coefficients for the interacted variables calculated at the means are shown in Table II.[15] Although each of the

variables, with the exception of productivity, enters with the expected sign, it should be noted that a relationship in this form cannot be expected to remain valid over a range extending considerably beyond that of the sample. This caveat, of course, applies to any regression equation, but it is of particular importance when interaction terms are present which can lead to a change in the sign of a partial derivative. The fact that the productivity effect is close to zero in the vicinity of the mean raises questions as to the role of this variable. A closer examination of the distribution of values of B/W revealed that this variable was highly skewed towards the lower range. Consequently, the net productivity coefficient takes on a negligible value for values of B/W above the mean and plays an important role only in the case of observations in the lower range of B/W where it has the expected sign. For example, taking the value of B/W at the tenth percentile we obtain a positive coefficient of .0430. Thus, productivity differences appear to be of importance mainly for lower paid workers when our other basic variables are taken into account.

Our second approach to the inclusion of industry effects was to employ a set of twelve industry dummy variables.[16] The results, as shown in equation I.4, reveal a substantial improvement in overall fit. As in the case of equation I.3, the relative base rate variable now enters significantly. The highly significant coefficients obtained for the last two dummy variables indicates that the main effect of the inclusion of the dummies is to split off the clothing and textile industries from the rest of the sample. This parallels the results obtained in equation I.3 since these two industries fall at the lower end of the relative wage scale. The significant positive coefficient in the case of non-ferrous metals suggests that wage increases have been higher in this industry than is

Table II

Coefficients for Interacted Variables in Equation I. 3

Variables	Mean	Coefficient
U^{-1}	.2116	8.755
$\Delta P/P$	1.406	.6410
B/W	95.87	-.0356
PROD	118.9	-.0024

Table III

Negotiated Wage Changes for Various Values of Unemployment Rates and Price Changes from Equation I. 4

Price Changes	Unemployment Rates				
	3%	4%	5%	6%	7%
1/2%	5.03	4.05	3.47	3.08	2.83
1%	5.06	4.28	3.81	3.53	3.30
1½%	5.07	4.50	4.15	3.94	3.77
2%	5.11	4.72	4.48	4.36	4.24
2½%	5.14	4.94	4.82	4.74	4.71

explainable by our other variables.

In general, our attempts to explain cross-sectional differences have been only moderately successful. Better interaction variables are required to capture the varying degrees of union militancy and management resistance which exist in various sectors, as well as the existence of inter-industry spillovers. The lack again of adequate data (sectoral) is a serious handicap in this respect.

One further experiment was carried out in an attempt to determine the extent to which our results are distorted by a failure to take account of differences in the lengths of the contracts included in our sample. In periods when labour's bargaining position is strong, one would expect labour to favour a long contract. On the other hand in periods when their position is weak, one would expect labour to favour a short contract. Thus, for example, in periods of low unemployment, high rates of inflation etc. one would expect wage settlements to be inversely related to the length of the contract. Conversely, when labour's position is weak one would expect a positive relationship between wage settlements and contract length.

To test this hypothesis, we split our sample into one year contracts (of which there were 41 out of 133) and contracts longer than one year. The results of running separate regressions on these subsamples are shown in rows 5 and 6 of Table I. There is a striking difference in the goodness of fit as we obtained an R^2 of .81 for the short contracts compared with .26 for the long contracts. This instability in the case of long contracts, which affects the goodness of fit for the whole sample, may reflect the greater influence of expectations of the future course of economic variables in the case of long contracts.

The magnitudes of the coefficients obtained are consistent with the hypothesis stated above. For example in the case of profits and the rate of change of prices, the coefficients are higher in the short contract equation. As illustrated in Figure I, this implies that in periods of low profits and low rates of inflation, when labour's bargaining power is weak, holding out for a short contract will result in a lower wage rate than accepting a long contract. Conversely, when labour's bargaining position is strong, the wage increase will be higher for a short contract. The same argument can be applied in the case of unemployment although this variable enters significantly only in the interaction terms.

III

In order to summarize the main implications of our study concerning the relationship between negotiated wage changes and the two important aggregative variables, unemployment and price changes, the predicted wage settlement for various values of these variables (appropriate for our sample period) are presented in Table III. The calculations were based on the coefficients of equation I.4 using a value of zero for U and the mean values for the other variables.[17] The importance of the de Menil interaction effect is clearly indicated. For example, at 3% unemployment, the rate of change of prices has a negligible effect on wage changes while the impact of this variable is considerable at higher rates of unemployment.

We stress that inferences concerning aggregate wage changes are subject to the following three limitations: (a) the predicted levels reflect the industry composition of our sample, (b) the effects of changes in these two explanatory variables on aggregate wage changes will depend on the pattern of occurrence of wage settlements, and (c) the use of

Figure 1

Effect of Contract Length on Wage Increases

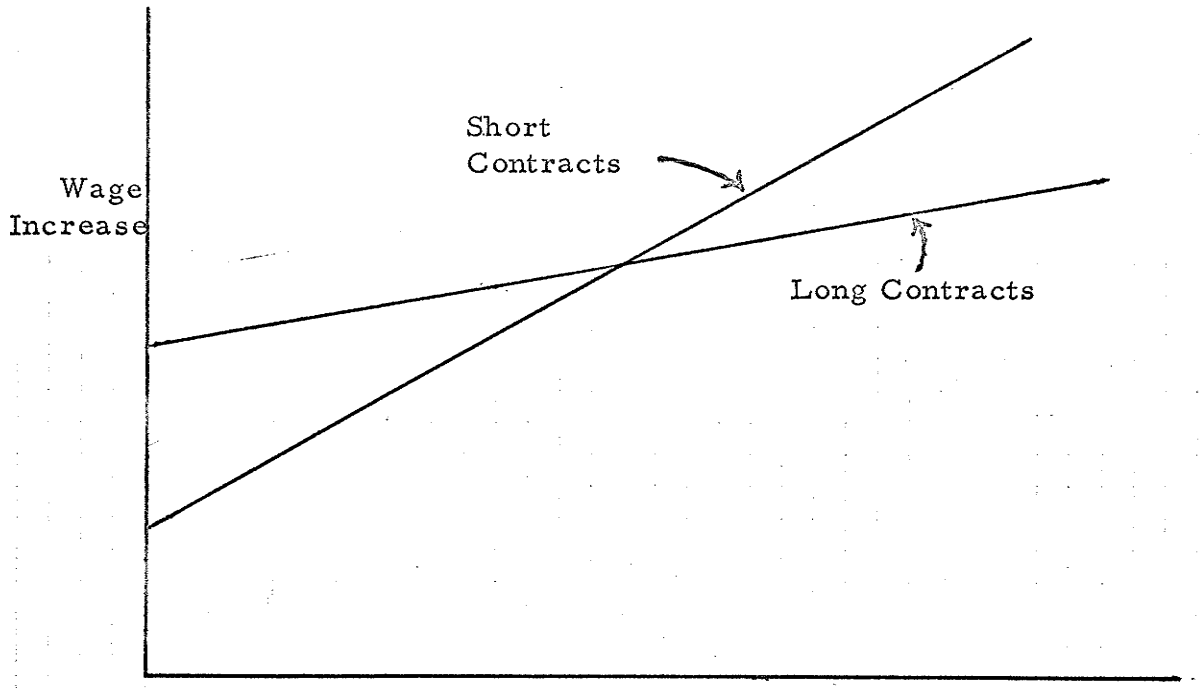
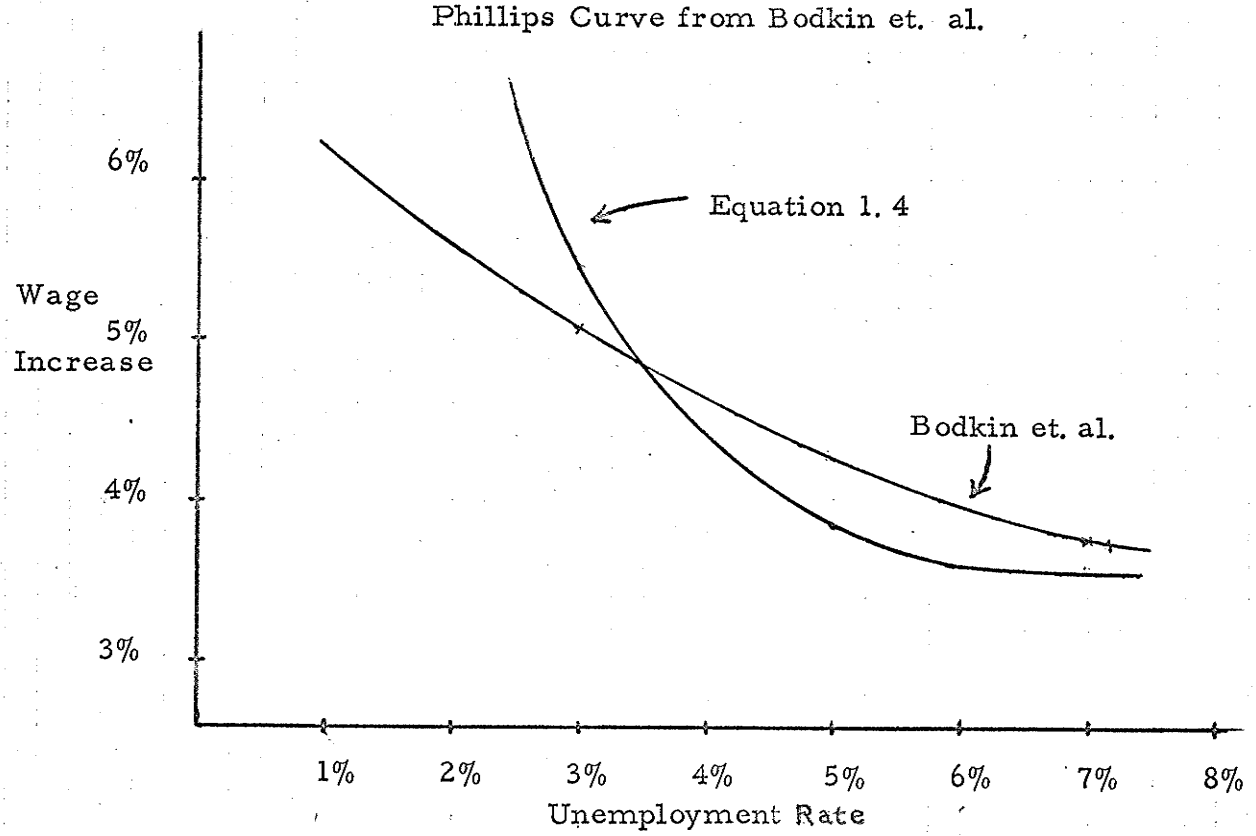


Figure 2

Comparison of Equation I. 4 with
Phillips Curve from Bodkin et. al.



values for explanatory variables which fall outside the sample period, e.g. the current high rate of inflation, is inappropriate. However, it is interesting to note that our results are roughly comparable to those obtained by Bodkin et. al. [2] using average hourly earnings in manufacturing. Figure II compares equation I.4 with a typical equation from their study, assuming a rate of inflation of 1½%.[18] Altering the rate of inflation of course changes the slope as well as the position of our Phillips curve given the interaction effect, whereas their curve simply shifts vertically.

In summary, existing research has failed to consider adequately the institutional forces at play in the labour market. This market is characterized predominantly by bilateral monopoly, not free and continuous wage determination. Any attempt to explain wage levels effectively must first identify and then quantify the various wage bargains which comprise the aggregate wage level in question. This study has attempted to explain the determinants of wage settlements in a sample of Canadian manufacturing industries. Since we view the setting of basic wages as a bargaining process between two sides, our theory is somewhat eclectic encompassing a number of variables which may influence either side's demands. The key variables were found to be profit levels, unemployment, price changes, relative productivity and relative wage rates in a non-linear formulation. A dummy variable for the occurrence of a strike and the growth rate of employment were only marginally significant. The statistical determination of wage negotiations should facilitate the explanation of average earnings using such additional factors as changes in employment mix, overtime hours, escalator clauses, wage drift, etc. However, to jump to a final aggregate wage equation without adequately representing the wage bargaining process with its discontinuities is likely to be statistically unsuccessful.

FOOTNOTES

[1]Based on tabular evidence provided by the Economic Council of Canada, the average length of contracts negotiated in Canada has increased from 16 months in 1953 to 27 months in 1965 (5, p. 131).

[2]See for example (6).

[3]For a more complete discussion of this statistical problem, see Perry (10, pp. 30-31).

[4]It should be noted that in a recent study on Canadian price-stability (2) an attempt was made to correct for serial correlation by using a simple first order autoregressive transformation. However, such a transformation is inappropriate since it fails to remove the serial correlation in a moving average residual.

[5]Other difficulties with this procedure include: (1) the existence of wage drift, (2) the lack of adaptability to conventional macro-models which have fixed time intervals, and (3) the uncertainty in forecasting in that some contracts are terminated or re-negotiated before their expiry date.

[6]All Wage settlement data were obtained from the Canadian Department of Labour. The data used for our particular sample is available on request. All other variables used in this study are taken from published Dominion Bureau of Statistics documents, unless otherwise specified.

[7]It should be noted that this variable is strictly in terms of changes in the basic wage rate. Theoretically, wage supplements and fringe benefits should also have been included in the negotiated settlements as many contracts involve trade-offs between actual monetary wage increases and fringe benefits such as pension plans, increased vacations, new cafeterias, etc. Inadequate data preclude the use of this more relevant variable. Also our sample had 9 contract settlements involving zero wage increases, with gains presumably being made in other non-monetary matters. However, we retained these 9 observations as it would be completely arbitrary to discard these observations without adjusting all other observations for fringes.

[8]Given some degree of mobility, the concept of an industry unemployment rate becomes ambiguous since the unemployed labour force cannot be allocated to finely disaggregated industries.

[9]The data on profits (taxable corporate income before taxes) and total assets by industry were obtained from: Department of National Revenue Taxation Division, Taxation Statistics, Part Two.

[10]Prices were first introduced into Phillips curve analysis by Lipsey (8) and have been used in a number of recent studies (10, 13).

[11]We also experimented, without success, with a pair of dummy variables dividing strikes into two classes according to their duration. For a recent theoretical discussion of the occurrence and duration of strikes, see Ashenfelter and Johnson (1).

[12]In the case of Canada, it might also be desirable to examine the influence of United States settlements on Canadian negotiations. Since these American influences affect only a few of our sectors, e. g. steel and autos, we have neglected to consider this factor, although we refer the interested reader to (2) where this problem is discussed in a Phillips curve context.

[13]Although it would have been more desirable to use an average base rate as the denominator, lack of an adequate set of weights precluded the generation of such a variable.

[14]Eckstein and Wilson (3) experimented with a dummy variable based on an index of concentration in their cross-section regressions with some success. It entered significantly in two of the five wage rounds.

[16]The order corresponds to the list of industries given above. Industry number five was omitted since a constant term is included. We also experimented with a set of year dummies but these were abandoned because of strong multicollinearity with the price and unemployment variables.

[17]A non-zero value for U reduces the wage change by . 35 percentage points for each percentage point change in U.

[15]The coefficients shown in table II were obtained in the following way. Given a relationship of the form, $y = a + b_1 x_1 + b_2 x_2 + c x_1 x_2$, we obtained the net coefficients as, $d_1 = b_1 + c \bar{x}_2$ and $d_2 = b_2 + c \bar{x}_1$ where $\bar{x}_1$ and $\bar{x}_2$ are the sample means.

[18]The equation used is that given in (2); Table 6. 1, page 163. A rate of inflation of 1 1/2% is used while the values of the other variables are taken from Table 6. 2, page 164.

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