Background Paper on Inflation and Unemployment

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BACKGROUND PAPER ON INFLATION AND UNEMPLOYMENT

Prepared for the

COMMISSION OF INQUIRY ON UNEMPLOYMENT INSURANCE

By

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1 INTRODUCTION

The purpose of this paper is to provide background on the trade-off between inflation and unemployment to assist the Commission of Inquiry on Unemployment Insurance in the preparation of its report. The main issues from the point of view of the Commission are the existence of a trade-off between inflation and unemployment and the effects of Unemployment Insurance on the trade-off. To shed light on these issues, the paper reviews the literature on the relationship between the rate of change of wages and the rate of unemployment.

The expectations-augmented Phillips curve paradigm for wage determination is reviewed in the second section of the paper. A full exposition of its theoretical rationale and implications is provided. According to this theory, the rate of increase of wages is a function of the the gap between the actual and non-accelerating inflation rate of unemployment, and of the expected rate of price inflation. Other variables such as catch-up for real wage losses and profitablity have also been included in wage equations. An important implication of the extended Phillips curve model, which is emphasized in the paper, is that there is no long run trade-off between higher inflation and permanently lower unemployment, but only a short-run trade-off between higher inflation and temporarily lower unemployment.

The Canadian empirical literature on the relationship between wages on the one hand and unemployment and inflationary expectations (based on the cost of living) on the other is reviewed in the third section of the paper. This review, which focuses on the studies done in the last ten years, includes estimates made using micro-data on wage settlements as well as macro wage equations. The wage sectors of the main Canadian macroeconomic models are also canvassed. Tabular summaries of the key results of the studies are provided.

Estimates of the impact of variables other than labour market tightness and inflation expectations such as productivity, catch-up, and profitability, which are included in wage equations, are also presented.

Three important findings of the literature search on wage behaviour and unemployment, which are of particular interest to the Commission and which are summarized in tabular form in the third section of the paper, are empirical estimates of:

- the Non-Accelerating Inflation Rate of Unemployment (NAIRU) or natural rate of unemployment that is believed to be consistent with the maintenance of a constant rate of inflation;

- the short term trade-off between inflation and unemployment based on the coefficient and lag structure of the unemployment rate in the wage equation; and

- the impact of the 1971 and 1979 changes in Unemployment Insurance on the natural (non-accelerating inflation) rate of unemployment.

The estimates of the impact of changes in the Unemployment Insurance on the natural rate of unemployment should be of particular value in the Commission's deliberations of implications of any further changes in the program that are under consideration.

2 THE PHILLIPS CURVE IN THEORY

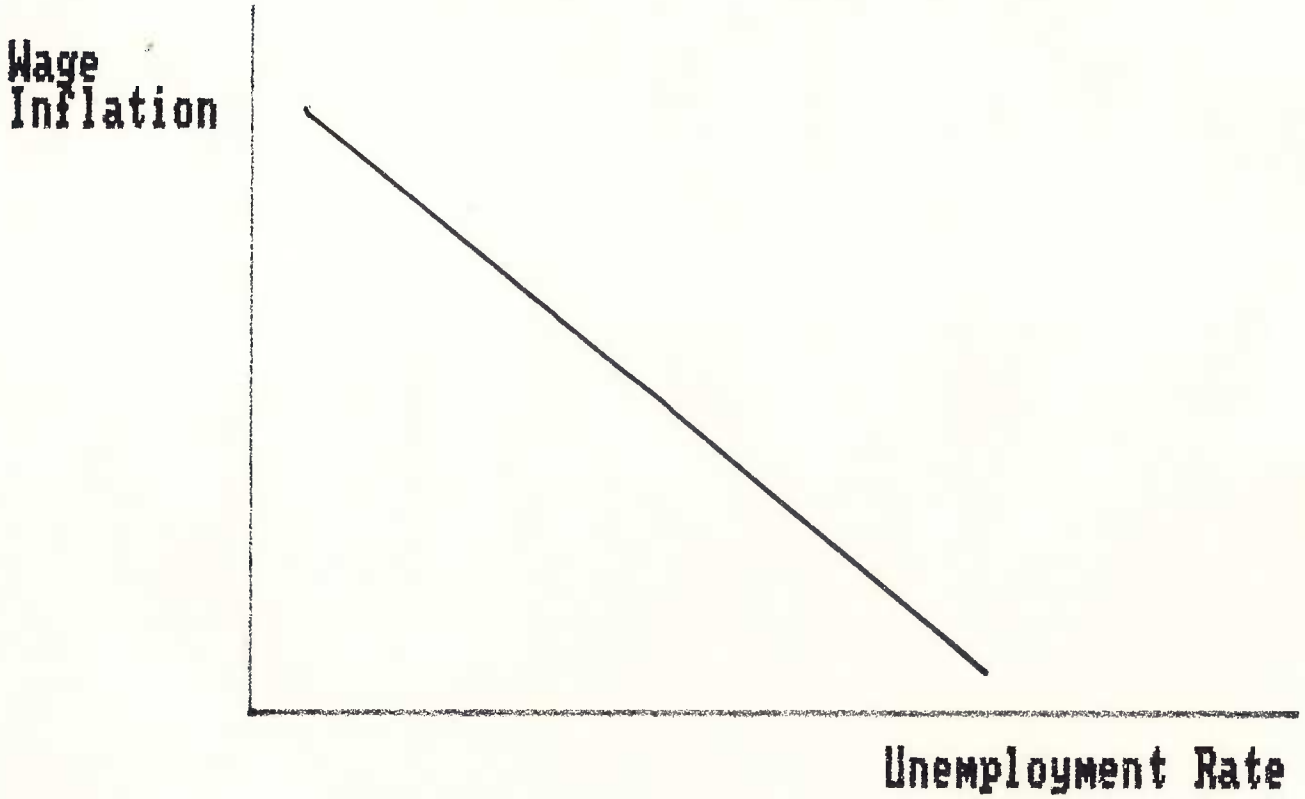
The Phillips curve was named after A.W. Phillips who in 1958 published an paper (Phillips 1958) in which he demonstrated statistically that over the almost century long period from 1861 to 1957 there existed a stable negative relationship between the rate of change of wages and the unemployment rate. The theory underlying Phillips empirical relationship was a simple extension of the law of supply and demand. The price of labour as measured by the wage rate was posited to respond to fluctuations in the demand for labour as represented by the unemployment rate.

A more rigorous theoretical grounding in disequilibrium dynamics was imparted to Phillips empirical relationship by Richard Lipsey (1960). Lipsey specified that wages adjust to the gap between supply and demand in the labour market with the rate of wage change (the speed of the adjustment) being proportional to excess demand. The unemployment rate was regarded by Lipsey as a proxy for excess demand in the labour market. Based on his more refined theoretical model and using more appropriate econometric estimation techniques than those employed by Phillips, Lipsey confirmed the existence of the Phillips curve, but suggested that the relationship was less stable than Phillips results indicated. Lipsey also introduced the rate of price inflation into the wage equation to capture changes in the cost of living and found it to improve the fit of the equation.

An important implication of the simple Phillips curve was that there was a trade-off between inflation and unemployment. By adopting more expansionary fiscal and monetary policy the government could engineer a lower level of unemployment at a cost of a higher, but stable level, of inflation. A Canadian study of this genre that stressed the trade-off is that of Bodkin, Bond, Reuber and Robinson (1967).

Chart 1 provides a schematic depiction of a Phillips curve which embodies a trade-off between inflation and unemployment. The lower the rate of unemployment and the greater the level of demand in labour markets, the higher would be the rate of wage inflation. In the chart the trade-off is portrayed as linear, but it is more commonly shown as convex to the origin.

Chart 1



Milton Friedman (1968) and Edmund Phelps (1967) contested the existence of a long-run stable trade-off between inflation and unemployment such as is shown in Chart 1. Instead they argued that there is a natural rate of unemployment that is determined by real economic phenomena such as primarily the structure of labour markets and that is the equilibrium level of the unemployment rate to which the actual unemployment rate tends to gravitate. If unemployment were pushed temporarily pushed below this level by demand shocks, inflation would accelerate until the natural rate was restored. A stable relationship between inflation and unemployment was said to depend on the implausible assumption that workers suffered from "money illusion." If workers were able to secure higher wages because of demand pressure in labour markets, they could be expected to seek to retain these real gains if inflation turned out higher than expected by seeking additional nominal wage gains sufficient to compensate them for inflation.

According to Friedman and Phelps, the Phillips curve relationship relating wage increases to the unemployment rate should incorporate expectations of price inflation as an additional explanatory variable and the coefficient on price expectations should be equal to unity. With such a relationship there is no long-run trade of between inflation and unemployment but only a short-run trade-off in the interval before the natural rate of unemployment is restored.

The workings of the Friedman-Phelps expectations augmented Phillips curve can be better understood with the aid of the simplified relationships graphically portrayed in Chart 2. Wage inflation is posited to be a function of unemployment and price expectations.

$$W = a + b*U + PE$$

Price expectations are a function of actual price changes.

$$PE = P$$

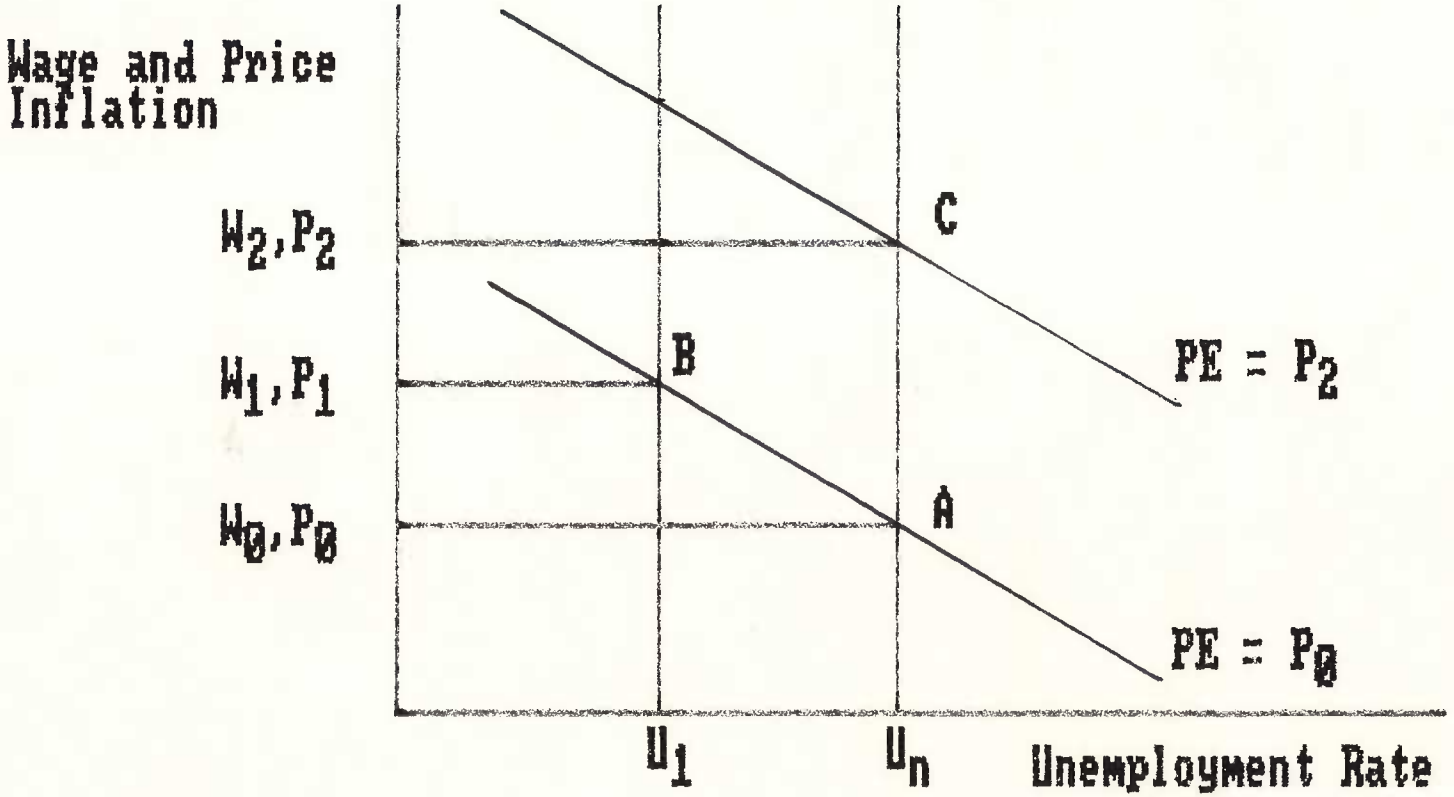
The rate of price increase is a function of the rate of increase of wages.

$$P = W$$

In such a model, the natural rate of unemployment is

$$U_n = -a/b$$

Chart 2


Wage and Price Inflation
W_2, P_2
W_1, P_1
W_0, P_0
C
B
A
PE = P_2
PE = P_0
U_1
U_n
Unemployment Rate

Starting from a position of equilibrium (point A on chart 2) at a natural rate U_n, with price inflation running at P_0 and fully anticipated by all and wage inflation running at W_0, suppose a the level of the unemployment rate is pushed down to U_1 by expansionary monetary policy. At this lower level of unemployment workers would ask for and be granted higher rates of nominal wage increase of W_1 consistent with point B on the chart, expecting that at P_0 inflation this would be translated into a real wage increase. However, discovering that this nominal wage increase were eroded by inflation, they would seek a higher nominal wage increase expecting inflation would remain constant at the new higher level of P_1. When inflation turned out to again be greater than anticipated, wage increase would be further stepped up. The whole process would continue until the unemployment reducing effects of the expansionary monetary policy were dissipated by higher inflation and the unemployment rate were restored to its natural level. This new equilibrium represented by say point C on Chart 2 would be characterized by unemployment at its natural rate U_n and rates of increase of wages and prices of W_2 and P_2 respectively. This would entail no permanent trade-off of lower unemployment for higher inflation, but instead temporarily lower unemployment would have been purchased at a cost of permanently higher inflation.

The term the natural rate of unemployment was translated into the more neutral Non-accelerating Inflation Rate of Unemployment (NAIRU) by Martin Neil Baily and James Tobin (1977), but the underlying concept remained the same.

One possible rigorous microeconomic theoretical underpinning for the macroeconomic phenomena is the extended Phillips curve is the theory of search unemployment pioneered by Phelps (1970). At a risk of oversimplification, according to this theory, unemployment is voluntary and results from job search. This theory would explain the reduction in unemployment that occurs when a demand shock lowers unemployment below the natural rate as resulting from the willingness of workers to supply more labour at higher nominal wage rates. The increased nominal wages caused by the tightening of labour markets would induce workers to supply more labour. However, once prices caught up with wages and real wages were reduced back to their initial level, workers would cut back on the amount of labour they supply and the unemployment rate would also be restored to its initial level.

Search theory has been applied successfully to analyze many aspects of the microeconomic functioning of labour markets. Its application to the macroeconomic issues of inflation and unemployment has been much less satisfactory. The greatest weakness of search theory from a macroeconomic point of view is its inability to explain cyclical unemployment which is largely involuntary. A particular issue is the failure of the search theory to predict the countercyclical pattern of quit rates and the corresponding pattern of lay-offs. The extended Phillips curve can thus be said to lack a rigorous microeconomic foundation. Nevertheless, it still is one of the most important macroeconomic theoretical relationships.

Another theoretical issue with bearing on the extended Phillips curve concerns the role and measurement of expectations. Price expectations are, of course, along with labour market conditions the most important determinant of wage increases. Price expectations have traditionally been specified in accordance with the adaptive expectations model as a weighted average of lagged actual price increases. An alternative view is the "rational expectations" approach whereby price expectations are formed on the basis of a rational analysis of future effects of current and anticipated economic policy and other factors. A characteristic of rational price expectations is that the expectations must be an unbiased predictor of future inflation. If this were the case and if wages and prices were sufficiently flexible, the key implication of rational expectations for stabilization policy is that it would be impossible for the government to trade off higher inflation for lower unemployment even in the very short run. As soon as it was recognized that the government was seeking to lower unemployment through expansionary policies, wages and prices would be bid up and any employment generating impact of the policies would be dissipated. This is the extreme rational expectations view. While this view has gained many adherents among theorists, it has not been very widely or successfully applied in empirical studies of wage behaviour. This reflects two things; first, the great difficulty of translating rational expectations into operational concepts for use in applied analysis; and, second, the generally satisfactory performance of adaptive price expectations in empirical explanations of wage behaviour.

A final relevant theoretical issue concerns the appropriate price variable to use in the wage equation. There are two alternatives: consumer prices, and output prices. On the one hand, consumer prices are important in the determination of the supply price of labour, representing the prices paid by workers. Consumer prices are thus the appropriate deflators to use in calculating the real income of the workers. On the other

hand, output prices are important in the determination of the demand price for labour. Wages divided by the price of output constitutes the labour cost of the firm. Obviously, an equation for the rate of change of wages that is based on the Phillips-Lipsey model of dynamic adjustment to the gap between labour demand and supply must take into account factors that affect demand as well as supply. The relative importance of demand and supply factors is necessarily a question which must be left for empirical analysis.

3 A REVIEW OF THE CANADIAN EMPIRICAL LITERATURE ON THE PHILLIPS CURVE

3.1 THE HISTORICAL RECORD ON WAGE INFLATION AND UNEMPLOYMENT

Before considering the many Canadian empirical studies of the Phillips curve, it is useful to review briefly post-war trends in wages and unemployment. Chart 3 shows the relationship between the rate of increase in wages and the rate of unemployment in Canada during the post-war period.[1]

The relationship between wage changes and the unemployment rate from 1947 to 1967 looks very much like a simple downward sloping Phillips curve. The relationship then broke down and after 1968 started to drift rightward. A regression line through the observations from 1968 to 1974 would be upward sloping as both wage inflation and unemployment rose together. More complicated causal relationships are necessary to preserve the Phillips curve as a viable description of wage behaviour after 1968.

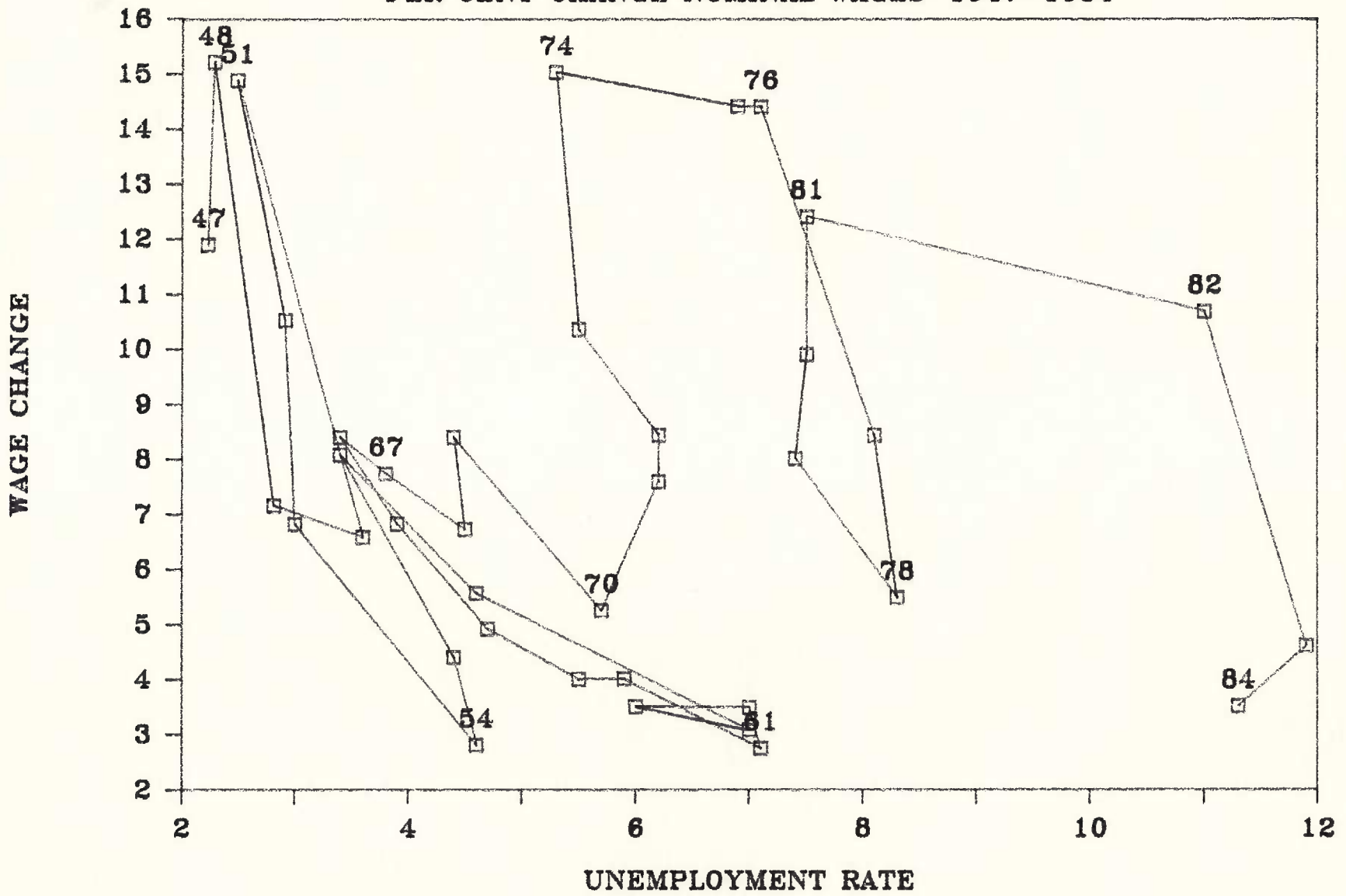
The Friedman-Phelps model of the expectations augmented Phillips curve provides the generally accepted explanation for the outward shift in the Philips curve. According to this model, it was the continuous increase in inflation expectations over the 1968 to 1974 period that caused the outward shift in the Phillips curve. Another factor contributing to the outward shift was the increase in the natural rate of unemployment over this period due to demographic factors and changes in the Unemployment Insurance program.

From 1974 to 1978 the unemployment rate increased following the 1974-75 recession and wage inflation slowed as predicted by the extended Phillips curve model. However, it is also relevant to note that wage and price controls were in effect from 1975 to 1978. The unemployment rate edged down from 1978 to 1981 and wage inflation increased markedly. The recession in 1981 and 1982 raised the rate of unemployment substantially and the rate of inflation dropped sharply through 1984. Again these developments were as predicted by the extended Phillips curve model.

Chart 3

INFLATION/UNEMPLOYMENT RELATIONSHIP

PER CENT CHANGE NOMINAL WAGES–1947–1984



3.2 WAGE EQUATIONS ESTIMATED IN THE 1960S AND EARLY 1970S

The most well-known Canadian study of the Phillips curve during this period was that of Bodkin, Bond, Reuber and Robinson for the Economic Council of Canada (1967). Using wage and price change equations estimated over the 1953 to 1965 period, this study derived a long-run trade-off curve between inflation and unemployment. The derivation of such a curve was possible because the coefficient on price expectations in the wage equation, which varied between 0.40 and 0.52, was less than unity. This curve implied that a rate of unemployment just below 5 per cent was consistent with price stability and that a lower rate of unemployment such as 3 per cent would give rise to inflation in the 2 1/4 to 6 1/2 per cent range.[2]

The stability of the Bodkin et al. wage equations and their implicit long-run trade-off between inflation and unemployment was called into question by Kaliski (1972). On the basis of a thorough examination of their equations including extending their sample periods, reestimating them, and performing statistical stability tests, Kaliski (1972, p. 109) concluded that the equations were no longer satisfactory and that the trade-off in 1972 was must less favourable than the equations fitted for 1953-65 would predict. He also observed that price changes had over time come to be more fully reflected in wages than was the case in earlier period studied by Bodkin et al. The studies of wage behaviour by Turnovsky (1972) and Vanderkamp (1972) were cited by Kaliski (1972, p.91-92) as confirming that the coefficient of price change had risen in the wage equation. More fundamentally, these studies suggested that the expectations hypothesis embodied in the extended Phillips curve was applicable in Canada.

The stability of the most of the empirically estimated Phillips curves for Canada, including that of Bodkin et al., was called into question by Rowley and Wilton (1973) on technical econometric grounds. The most common specification for the wage change variable used in Canadian wage equations was the year-over-year change. This specification has the unfortunate property of introducing fourth order serial correlation which causes the error of the estimated equations and the statistical significance of the explanatory variables to be both overstated. When Rowley and Wilton (1973, pp. 385-386) estimated the Bodkin et al. equations using a more appropriate statistical estimation technique called generalized least squares, which is designed to correct for higher order serial correlation, they found that most of the coefficients that had

been significant became insignificant.

3.3 WAGE EQUATIONS ESTIMATED IN THE LATE 1970S

The difficulties encountered in estimating Phillips curves in the early 1970s did not discourage further efforts. A new crop of studies of wage behaviour was published in the late 1970s. Many of these studies were sponsored by the Anti-Inflation Board. Surveying these studies is made easier by the availability of survey of empirical estimates of the short-term trade-off between inflation and unemployment which were available in 1978 that was done by the Long Range and Structural Analysis Division of the Department of Finance (1978). The main contribution of this study was to derive on a consistent basis estimates of the relationship between wage changes and unemployment. This required a number of non-trivial adjustments and some translation of relationships based on labour market variables such as vacancies and the help-wanted index into those based on unemployment. The seven empirical studies covered by the survey were: (1) Freedman (1978); (2) John F. Helliwell et al. (1971); (3) L.N. Christofides, R. Swidinsky and D. Wilton (1978); (4) W.C. Riddell (1979); (5) Frank Reid (1978); (6) Jean-Michel Cousineau and Robert Lacroix (1977); and (7) Thomas A. Wilson and Gregory Jump (1978).

The main characteristics of these studies as summarized by the Department of Finance are shown in Table 1. While the estimation periods vary, three of the studies (Christofides, Swidinsky and Wilton (1978), Reid (1978), and Cousineau and Lacroix (1977)) cover approximately the same period (1966-67 to 1975). Two other studies (Freedman (1978), and Wilson and Jump (1978) utilize samples ending in 1975. Thus except for Helliwell et al. (1971) and Riddell (1978) the studies can be said to describe wage behaviour up to the beginning of 1975 when the wage and price controls were imposed.

Table 1

Alternative Inflation-Unemployment Relationships, Canada

	Freedman	Helliwell et. al.	Christofides-Swidinsky-Wilton	Riddell	Reid	Cousineau-Lacroix	Wilson-Jump
Estimation period	61 II - 75 IV	55 I - 68 IV	66-75	53-73	67 I - 75 III	67 I - 75 III	55 II - 75 III
Wage measure	E	E	CM	CM	CA	CA	E
Labour market tightness measure	U*	U	HW	U	V	HW	U
Expectations mechanism	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Variables							
Catch-up term	No	Yes	Yes	Yes	No	No	No
Change in unemployment	No	No	No	Yes	No	No	No
Inflation uncertainty	No	No	No	Yes	No	No	No
U.S. wages	No	No	No	No	No	No	Yes
Social insurance taxes	No	No	No	No	No	No	Yes

Symbols

E Earnings
CM Contracts (micro)
CA Contracts (aggregate)
U* Unemployment rate adjusted for effects of the 1971 UI revisions
U Unemployment rate
HW Help-wanted
V Vacancies divided by labour force

Source: Department of Finance (1978), p.45.

The dependent variable in all of estimated equations is the percentage change in wages. Freedman (1978), Helliwell et al. (1971), and the Wilson and Jump (1978) studies use some measure of earnings as the wage variable. Reid (1978), and Cousineau and Lacroix (1977) use aggregate data on wage increases in collective agreements. Christofides, Swidinsky and Wilton (1978) and Riddell (1978) utilize micro data on wage settlements.

The use of wage settlements data in wage equations gives a different perspective on the Phillips curve. The existence of multi-year overlapping contracts is an institutional reality that, as Wilton has repeatedly argued, is difficult for aggregate wage equations to take into consideration. Deferred increases in contracts can be most appropriately explained in terms of the economic conditions, in effect or anticipated, at the time the contract is concluded. This can lead to very complicated variable weight distributed lag relationships that are difficult to model and hence tend to be ignored.[3] The drawback of wage settlement data is that it only covers about 40 per cent of the wages of the non-agricultural paid labour force. It is thus not necessarily representative of economy-wide wage behaviour.

The main independent variables in the equations are inflation expectations and labour market tightness. Most of the equations have a unitary coefficient on inflation expectations. This is consistent with the Phelps-Friedman model of the expectations augmented Phillips curve. In some cases such as Wilson and Jump (1978) the coefficient was imposed. In others it was estimated. Notable exceptions to the unitary elasticity of wages with respect to inflationary expectations are the results of Christofides, Swidinsky, and Wilton (1978) and Cousineau and Lacroix (1977) both derived using micro contract data. Christofides, Swidinsky, and Wilton (1978) include a catch-up variable in their equation that reflects both unanticipated inflation and uncompensated inflation in the previous contract. Taking this variable as well as price expectations into account yields a price coefficient in the .73 to .82 per cent range. Cousineau and Lacroix (1977) introduced price expectations as the lagged value of the square of the actual inflation rate. Their justification for this peculiar specification was that inflation was accelerating over the period. Equations based on such a specification have dynamic properties that are unacceptable and not consistent with the theory of the extended Phillips curve.

The effects on the percentage change in wages of changes in the rate of unemployment as calculated by the Department of Finance using the wage equations from the seven studies are

presented in Table 2. It should be stressed that these estimates are not simply those obtained by the coefficient on the unemployment rate variable in the equations. Many of the equations do not even have the unemployment rate as a variable, but instead use the vacancy rate or help-wanted index. In these cases, the Department of Finance had to supply estimates of the relationship of changes in these variables to changes in the unemployment rate.

Table 2

Estimated Impact of Changes in the Unemployment Rate on the Annual Percentage Change in Wages, Canada

Change in Unemployment rate (per cent)	Change in Percentage Change in Wages (percentage points)							
	Freedman	Helliwell et. al.	Christofides-Swidinsky-Wilton	Riddell	Reid	Cousineau-Lacroix	Wilson-Jump	Average
Increase								
8.5 to 9.5	-.38	-.10	-.21	-.10	-.13	-.34	-.22	-.21
8.5 to 10.5	-.67	-.17	-.35	-.18	-.24	-.60	-.39	-.37
8.5 to 11.5	-.89	-.22	-.49	-.25	-.33	-.80	-.53	-.47
Reduction								
8.5 to 7.5	+.53	+.16	+.28	+.13	+.17	+.47	+.27	+.29
8.5 to 6.5	+1.33	+.42	+.68	+.29	+.39	+1.14	+.62	+.70
8.5 to 5.5	+2.66	+.91	+1.30	+.52	+.69	+2.15	+1.10	+1.33

Source: Department of Finance (1978), p.46.

The general conclusion drawn by the Department of Finance from its analysis of these wage equations is that the short-term Phillips curve is very flat. An increase in the unemployment rate from 8.5 per cent to 11.5 per cent is estimated to reduce wage inflation by somewhere in the .22 to .89 percentage point range or by an average of .47 per cent.

3.4 WAGE EQUATIONS ESTIMATED IN THE EARLY 1980S

The key features of the wage equations estimated in some of the studies done in the early 1980s are summarized in Tables 3 and 4. Since these studies are the most recent and hence should shed the most light on the current trade-off between inflation and unemployment, they are each considered separately.

Table 3
SUMMARY OF RECENT STUDIES ON THE PHILLIPS CURVE

Study	Data	Sample	Labour Market Tightness Variable	Impact of 1% Incr. in Unempl.	Coeff. on Price Expect.	NAIRU	Impact of UI changes	Impact of AIB	Other Variables
Fortin and Newton (1982)	total compens. per per.-hour	56 to 78	UGAP ratio of normalized to actual unempl. rate	-0.33% -1.39% if lagged wages taken into account	constrained to 1 allowing for wage-wage emulation	6.5 to 7% in 1977-78 now closer to 6%	na	-7.5% cumulative	lagged wages producer prices direct taxes hours worked UI replacement ratio
Christofides and Wilton (1985)	micro wage agreements ex COLA	66Q4 to 78Q3	vacancy rate calculated with nat. and reg. help-wanted	-.4% if 1% incr. in unemploy. equals a 0.2% decr. in vacancies	0.73 allowing for catch-up	does not exist	na	-3.4% per year	catch-up
Aubrey (1982)	quarterly avg. wages ind. comp.	61Q1 to 80Q4	actual and natural unemploy. rate gap	-1%	imposed equal to 1 on 12 quarter moving avg.	6 to 6.5% in 1980	na	-2.7% after 3 years	productivity
Guindon and Grignon (1981b)	quarterly avg.weekly earnings in non-ag commercial	61Q1 to 80Q4	ratio of actual to structural unemploy. rate	-.13% -.33% if lagged wages taken into account	1 including lagged wages and consumer and producer prices	6.6% in 1979	+0.7% 1971 -0.3% 1979	-2.0%	productivity direct tax changes change in hours demographic changes UI changes public sector wages minimum wage

Table 4
SUMMARY OF RECENT STUDIES ON THE PHILLIPS CURVE

Study	Data	Sample	Market Tightness Variable	Impact of 1% Incr. in Unempl.	Coeff. on Price Expect.	NAIRU	Impact of UI changes	Impact of AIB	Other Variables
Riddell and Smith (1982)	monthly aggregate wage agreements ex COLA	67M1 to 81M12	unemploy. rate	-1%	about 1 new expect. variable	6.2% in 1979	+1.4% 1971 -0.4% 1979	-2.0% per year	catch-up
Coe and Gagliardi (1985)	semiannual national accounts wage bill per employee	61H1 to 83H1	unemploy. rate linear, log and inverse	-0.47%	1.07	6.9 to 7.4% 1980-83 depending on import price growth	na	na	none
Wilton (1985)	quarterly aggregate wage contracts ex COLA in comm. sector	78Q1 to 83Q4	inverse of unemploy. rate and job vac.	-1.5%	1.1	7 to 7.3% if coeff. on price exp. set to 1	na	na	6/5 dummy

3.4.1 Fortin and Newton (1982)

Fortin and Newton estimated equations for the annual rate of compensation in the private commercial sector over the 1956 to 1978 period. Their preferred equation is:

$$
\begin{aligned}
W = &- 0.92 + 0.51*W(-1)5759 + 0.76*W(-1)7078 + 0.49*PP(-1)5769 \\
&\quad (0.76)\ (0.09) \qquad\qquad (0.09) \qquad\qquad (0.10) \\
&+ 0.24*PP(-1)7078 + 0.11*WM-W(-1) + 3.33*UGAP + 0.44*TD \\
&\quad (0.10) \qquad\qquad (0.04) \qquad\qquad (0.84) \qquad (0.14) \\
&- 0.44*TD(-1) - 2.99*C7678 \\
&\quad (0.14) \qquad (0.57) \qquad\qquad SEE= 0.59
\end{aligned}
$$

where W is the annual rate of change of compensation in the private sector;
PP is the percentage change in producer prices;
WM-W is the relative change in the minimum wage;
UGAP is the ratio of the standardized unemployment rate to the aggregate unemployment rate;
TD is the percentage change in the direct tax rate;
C7678 is an AIB dummy variable; and
the figures in parenthesis below the coefficients are standard errors.

The labour market tightness variable used by Fortin and Newton is the ratio of a the unemployment rate standardized for changes in the demographic composition of the labour force and such policy changes as affected Unemployment Insurance and the minimum wage. According to the estimated coefficient in their equation, the short-run impact of a one percentage point increase in the unemployment rate would be to reduce the rate of increase of wages by .33 per cent. Taking into account the lagged rate of increase of wages also included in the equation the reduction would be increased to 1.39 per cent. The coefficient on price expectations was constrained to be equal to unity taking into consideration the impact of lagged wages.

The NAIRU based on their calculation of the standardized unemployment rate was said to be in the 6.5 to 7 per cent range in 1977-78 and to be closer to 6 per cent at the time of writing around 1982.

The Anti-Inflation Program is estimated to have a cumulative impact of about 7.5 per cent.

3.4.2 Christofides and Wilton (1985)

Christofides and Wilton estimated a wage equation using data from 3,065 wage contracts concluded over the period from the fourth quarter of 1966 to the third quarter of 1978. Their most basic equation is:

$$W = \underset{(11.81)}{3.048} + \underset{(12.95)}{0.4654}*P + \underset{(22.07)}{0.497}*CPU + \underset{(7.64)}{2.014}*VRHW - \underset{(17.44)}{3.372}*D1$$

$$SEE=4.198 \quad \bar{R}^2=0.401$$

where W is the annual compound percentage change in the base wage rate of the current contract;
P is the expected change in the CPI over the current contract based on a regression of the CPI on past values;
CPU is catch-up defined to be the difference between actual inflation and that built into the last contract
VRHW is a vacancy rate constructed using the help-wanted index; and
the figures in parentheses below the coefficients are t-statistics.

If it is assumed that a 1 percentage point increase in unemployment translates into a .2 percentage point reduction in the vacancy rate, then the Christofides and Wilton equation given suggest that a one percentage point increase in the unemployment rate would reduce the rate of increase of wages by 0.4 percentage points.

The total coefficient on price changes in the equation taking into account catch-up is about 0.73 (calculated as .465 + .497 - .465*.497). This is less than one and means that there does not exist any rate of unemployment that is consistent with stable inflation (NAIRU).

The equation indicates that the Anti-Inflation Program lowered wage settlements by 3.4 percentage points per year.

3.4.3 Aubrey (1982)

As part of a complete wage-price block including an exchange rate equation, Jean-Pierre Aubrey estimated a quarterly wage equation using data for average weekly wages for the industrial composite over the period from the first quarter of 1961 to the fourth quarter of 1980. The equation is:

$$W = A1(L)*PROD - .00295*AIB + A2(L)*P - .00271*RU$$

$$\bar{R}^2 = 0.552 \qquad SEE = .0059$$

where W is the quarter to quarter percentage change in wages;
A1(L) is a twelve quarter moving average lag operator;
PROD is the change in productivity;
AIB is a dummy variable for the AIB;
A2(L) is a seven quarter Almon lag operator of the second degree with the sum of the weights constrained to be unity;
P is the deflator for value added in the private sector; and
RU is the gap between the actual and natural rate of unemployment.

This equation implies that productivity gains are fully passed through into real wages after twelve quarters. Price increases are also fully reflected in wages. The relevant price increases are those in the deflator for value added in the private sector, a producer rather than consumer price deflator. The coefficient on the gap between the actual and natural unemployment rate suggests that a one percentage point increase in the unemployment rate would lower the rate of increase of wages by 1.1 percentage points. This is at the high end of the range of estimates for the time period covered by the equation. The natural rate used in calculating the gap variable was equal to about 6 to 6 1/2 per cent in 1980. A simulation of the impact of the AIB using the whole wage-price block suggested that after three years wage and price controls reduced the rate of wage inflation by 2.7 per cent. This estimate in not strictly comparable with those derived just using the wage equation because it allows wage-price feedback.

3.4.4 Guindon and Grignon (1981b)

Denis Guindon and Louis Grignon estimated equations for the percentage change in average weekly earnings of employees in the non-agricultural commercial private sector over the period

running from the first quarter of 1961 to the fourth quarter of 1980. Their preferred equation, which incorporated several constraints on the coefficients that could not be rejected by the data, is:

$$W = 0.4*A + \underset{(2.9)}{0.96*V} + 0.602*W(-1) + B1(L)*PC + B2(L)*PV$$

$$+ \underset{(3.8)}{0.17*TW} + \underset{(2.5)}{0.06*WPUB} + \underset{(1.9)}{0.03*WMIN} + \underset{(2.0)}{0.02*R} - \underset{(-1.6)}{.05*C}$$

$$+ \underset{(2.4)}{0.26*EH2554} + .40*H$$

where W is the percentage change in average weekly earnings in the non-agricultural private sector;
A is the percentage change in trend productivity;
V is the ratio of an actual to a calculated structural unemployment rate;
B1(L) and B2(L) are lag operators;
PC is the percentage change in consumer prices;
PV is the percentage change in selling prices in the domestic non-agricultural private sector;
TW is the percentage change in the direct tax rate;
WPUB is the percentage change in public sector wages relative to private;
WMIN is the percentage change in the minimum wage relative to private sector wages;
R is the percentage change in the net wage replacement rate associated with Unemployment Insurance;
C is a dummy variable for the AIB;
EH2554 is the percentage change in the proportion of men aged 25 to 54 in the total employed labour force; and
H is the percentage change in hours in the domestic non-agricultural private sector.

It should be noted that the percentage changes of wages and all other variables are expressed in year-over-year form. The choice of this particular specification leaves the estimation results open to a technical econometric criticism that should be borne in mind in interpreting them. Rowley and Wilton (1973) argued that the use of such overlapping year-over-year specifications with ordinary least squares estimation procedures may lead to a considerable understatement of the error term and overstatement of the degree of significance of the explanatory variables. They recommended that generalized least squares be

used in these cases.

In spite of its apparent complexity and abundance of explanatory variables, this equation can be reduced to an extended Phillips curve. The constraint that the sum of the coefficients of lagged wages, producer prices, and consumer prices must equal unity ensures that the equation is accelerationist. The equation allows for separate roles for consumer and producer prices with 56 per cent of the total effect of prices coming through consumer prices and and 44 per cent through producer prices (sum of lag weights of .224 on consumer price changes and .174 on producer price changes).

The coefficient on the the ratio of the structural to the actual unemployment rate indicates that 1 percentage point increase in the unemployment rate from 6.6 per cent to 7.6 per cent in 1979 around a structural unemployment rate of 7 per cent would reduce the growth rate of wages by 0.13 per cent in the short run and by 0.33 per cent in the longer run taking into account the impact of the lagged dependent wage variable. This is a relatively small impact compared to some of the other comparable wage equations.

Guindon and Grignon derive an estimate of the NAIRU from their estimate of the structural rate of unemployment by solving their equation for the rate of unemployment that is consistent with price stability given the 1979 values of the other variables in the equation. Their point estimate of the NAIRU in 1979 is 6.6 per cent. They also provide estimates of confidence intervals for the NAIRU. The 95 per cent confidence interval is between 5 per cent and 8.1 per cent, the 90 per cent confidence interval is between 5.4 and 7.7 per cent, the 75 per cent interval between 5.9 and 7.3 per cent, and the 50 per cent confidence interval between 6.2 and 7 per cent.

Using their wage equation in conjunction with a price equation, Guindon and Grignon estimate that the cumulative impact of wage and price controls on the wage level was 2 percentage points.

There are other results worth noting in the equation. First, taking into account the lagged dependent variable, wages increase one-for-one with productivity and with hours worked. Second, increases in the direct tax rate are passed on into wages. Third, increases in public sector wages and the minimum wage relative to private sector wages raise wages. Fourth, increases in the share of prime age adult males in the employed labour force pushes up wages because of their higher average wage. Fifth, increases in the replacement rate under Unemployment Insurance temporarily steps up wage increases.

Guindon and Grignon also provide estimates of the impact of changes in Unemployment Insurance in another paper in which the structural unempoyment rate is calculated (Guindon and Grignon (1981a)). These estimates are for a 0.7 percentage point increase in the structural unemployment rate following the 1971 changes and a 0.3 per cent decrease following the 1979 changes.

3.4.5 Riddell and Smith (1982)

Riddell and Smith (1982) estimated relationships explaining wage changes using data on monthly aggregate wage agreements for contracts without COLA clauses for the period spanning January 1967 to December 1981. Their basic equation for total wage changes in both the public and private sectors is:

$$W = \underset{(2.21)}{6.73} - \underset{(1.03)}{2.04}*AIB + \underset{(0.107)}{0.136}*PE + \underset{(0.252)}{0.967}*CATCH1$$

$$-\underset{(0.400)}{0.933}*U + \underset{(9.57)}{11.3}*UIC$$

$$SEE = 1.43$$

where W is the percentage change in base wage rates;
AIB is a dummy variable for the AIB;
PE is expected consumer price inflation;
CATCH1 is the difference between the actual rate of inflation over the previous contract and the expected rate at the time the previous contract was signed;
U is the unemployment rate;
B is a dummy variable for the AIB;
PE is expected consumer price inflation;
CATCH1 is the difference between the actual rate of inflation over the previous contract and the expected rate at the time the previous contract was signed;
U is the unemployment rate;
UIC is a variable reflecting the proportion of the labour force covered by UI, the ratio of average benefits to the average weekly wage, and the tax status of UI benefits; the figure in parentheses below the coefficients are standard errors.

A novel feature of the Riddell and Smith specification is the use of a synthetic price expectations variable calculated using

Box-Jenkins techniques on a moving sample incorporating the last 384 months of data. This price expectations variable is also used to define the catch-up variable in the regression. The results of the estimation show that both price expectations and catch-up are important factors with catch-up being the more important of the two. The combined effect of price inflation in the equation taking into effect both forward looking expectations and catch-up is not significantly different form unity (.973=.136+.967-.136*.967). The estimated equation is thus consistent with a vertical long-run Phillips curve.

The coefficient on the unemployment rate in the equation indicates that a one percentage point increase in the unemployment rate would lower the rate of increase of wages by almost one percentage point. This estimated impact is higher than earlier estimates obtained using wage settlements data. It reflects the experience of recent years when greater variability in the rate of unemployment has had a correspondingly greater impact on wages.

Solving their equation for the unemployment rate consistent with price stability, Riddell and Smith estimated that the NAIRU in 1979 was 6.2 per cent. Utilizing their Unemployment Insurance variable, they also estimated that the 1971 revisions to UI raised the unemployment rate by 1.4 percentage points and the 1979 changes lowered the rate by 0.4 percentage points.

The equation also suggests that the wage and price controls administered by the AIB reduced wage increases by about 2 percentage points per year. This is lower than earlier estimates. Riddell and Smith attribute this to their use of post controls data which exhibit a greater degree of sensitivity to labour market conditions.

3.4.6 Coe and Gagliardi (1985)

Coe and Gagliardi (1985) examined the determinants of wages in ten OECD countries including Canada. Extended Phillips curve equations were estimated. The degree of linearity of the short-run Phillips curve was explored. The dependent wage variable used in most equations including that for Canada was the national accounts average wage calculated by dividing national accounts wages and salaries by the number employed. The frequency of the data utilized was semi-annual. While the sample period for the equations varied from one country to another usually covering the period from the mid-1960s to the early 1980s, for Canada it extended from the first half of 1961 to the second half of 1983. The equation estimated for Canada is:

$$W = \underset{}{3.57} - \underset{(4.8)}{0.47}*U + \underset{(9.6)}{1.07}*P$$
$$\quad\ (7.0)$$

where W is the semi-annual percentage change in the average wage;
U is the unemployment rate;
P is a three semester moving average of the semi-annual percentage change in the consumption deflator; and
the figures below the coefficients are t-statistics.

The coefficient on the price expectations variable at 1.07 is not significantly different from unity. Various forward looking indicators of inflation expectations were also tried. These included expectations calculated using a reduced form inflation equation, an autoregressive equation, and the actual future inflation. The coefficient on price expectations was also around unity in all cases. The results thus suggest that there is no long-run trade-off between inflation and unemployment in the estimated equation.

The coefficient on the unemployment rate in the equation indicates that in the short-run a one percentage point increase in the rate of unemployment would depress the rate of increase of wages by 0.47 percentage points. This coefficient was lower in the equations incorporating forward looking price expectations measures.

If the coefficient on price expectations is set equal to unity, the wage equation itself can be solved for the level of inflation that is consistent with steady inflation. This yields an estimate for the NAIRU of 7.6 per cent. A more sophisticated approach is utilized in the paper to calculate the NAIRU. This approach utilizes a the wage equation in conjunction with a cost mark-up price equation incorporating the cost of imported goods as well as unit labour costs. It yields an estimate of 6.9 per cent for the 1980-83 period if the actual growth rate of import prices and an estimate of 7.4 per cent if the average growth of import prices over the estimation period is utilized.

Another interesting result for Canada reported by Coe and Gagliardi was that the explanatory power of the wage equation was significantly less if the unemployment rate variable were introduced in a non-linear fashion in log or inverse form. Also profit variables were tried in the wage equation but they were positive and significant only in equations with no activity variables.

Gagliardi and Coe also estimated the equation including a dummy variable for wage and price controls. This variable took the value of 1 from the first half of 1976 to the first half of 1977 and a value of -1 from the second half of 1977 to the second half of 1978. Given that this variable had an inappropriate negative value in this second period when the controls probably had their largest effects (the phased method of decontrol ensured that most bargaining groups were covered by controls during the whole of 1978 and the guideline was lowered to 6 per cent well below the anticipated rate of inflation), it is not surprising that the coefficient on this variable was significant with the wrong sign indicating that the controls actually raised the rate of wage increase. This is the opposite result from that obtained by all others that have empirically examined the effect of the AIB on wage increases.

3.4.7 Wilton (1985)

As a byproduct of a paper on public sector wage compensation prepared for the Royal Commission on the Economic Union and Development Prospects for Canada, David Wilton (1985) estimated price expectations augmented Phillips curves for both the private and public sector covering the post AIB 1978 to 1983 period. His dependent variable was the average quarterly wage settlement, excluding contracts with COLA clauses. The estimated equations for the commercial and non-commercial sectors are:

$$WCOM = \underset{(7.79)}{-11.50} + \underset{(8.93)}{82.40}*(1/U) + \underset{(9.01)}{1.13}*PE$$

$$SEE = .922$$

$$WNON = \underset{(5.00)}{-11.27} + \underset{(4.40)}{68.22}*(1/U) + \underset{(6.24)}{1.21}*PE$$

$$SEE = .764$$

where WCOM is average quarterly wage settlements, excluding contracts with COLA clauses, in the commercial sector;
WNON is average quarterly wage settlements, excluding contracts with COLA clauses, in the non-commercial sector;
U is the unemployment rate;
PE is a simple two year moving average of past inflation; and the figures below the coefficients in parentheses are t-statistics.

Characterizing his estimation results, Wilton (1985,p.31) says:

> "Having estimated literally hundreds of wage equations over the past fifteen years, I cannot recall such overwhelmingly strong statistical evidence in favour of the price expectations-augmented Phillips curve...Every labour market coefficient is correctly signed and significant at the .01 level. All inflation expectation coefficients are significantly

greater than zero (at the .01 level) but never significantly different from unity (at the .01 level). Clearly the Canadian Phillips curve is alive and well, in both the private and public sectors."

The coefficient on the inverse of the unemployment rate indicates a very high degree of sensitivity of wage settlements to labour market conditions. It suggests that a one percentage point increase in the rate of unemployment from 7 to 8 per cent would lower the average wage settlement by about 1.5 percentage points in the commercial sector and by 1.2 percentage points in the non-commercial sector.

It is interesting to note that Wilton also tried the help-wanted index as an indicator of labour market conditions in his wage equations. The help-wanted index worked somewhat better in the commercial sector and somewhat worse in the non-commercial sector. This is in sharp contrast with the experience with earlier wage equations where it was often necessary to use the help-wanted index to get correct signs in wage equations estimated using contract data. There are two possible explanation for the improved performance of the unemployment rate in wage equations over the 1978 to 1983 period. The first is that the changes in the demographic composition of the labour force and in Unemployment Insurance that overwhelmed the cyclical variability of the unemployment rate in the 1970s were no longer sufficiently potent to do so over the 1978 to 1983 period. The second is that there was a much greater degree of cyclical variability of the unemployment rate after 1978.

Also of interest is that Wilton introduced a dummy variable representing the federal governments 6&5 program into his best wage settlement equations for both the commercial and non-commercial sector. His finding was that this 6&5 dummy variable was both insignificant and had the wrong sign. Consequently, he (Wilton 1985,p.34) concluded that lower wage settlements in the latter half of 1982 and 1983 "were primarily attributable to declining labour market conditions."

3.5 WAGE EQUATIONS IN CURRENT CANADIAN MACROECONOMIC MODELS

A useful source of empirical estimates of the trade-off between inflation and unemployment is the wage sectors of current Canadian macroeconomic models. These are described in a recent study done by the author for the Economic Forecasting Division of the Department of Finance on the "State of the Art in Canadian Macroeconomic Modelling."(Grady 1985). This section draws on this study.[4])

3.5.1 CANDIDE 2.0

CANDIDE 2.0 is the econometric model of the Economic Council of Canada. It is a large annual model (approximately 2,400 equations) built around an input-output framework.

In CANDIDE 2.0 wages are modelled at the industry specific level. The sample utilized ends in the mid-1970s. The base specification for the individual industry equations is an extended Phillips curve including an indicator of inflation expectations and an indicator of labour market tightness, the unemployment rate for prime age males. The latter is not included in all the equations, however, probably because it did not pass the estimation test. Some of the equations also incorporate U.S. wage rates and industry specific productivity as explanatory variables.

The use of the unemployment rate for prime age males as the labour market tightness variables can be taken to imply that the natural rate of unemployment is that consistent with the average rate of unemployment for prime age males.

Industry specific productivity is included in some of the equations, but more generally it is picked up by the constant term. There is no catch-up term in any of the wage equations.

The CANDIDE price expectations variable incorporating lagged consumer prices and the rate of change in the money supply is utilized in the wage equations.

The long-term aggregate wage equation in CANDIDE has been characterized as: [5]

$$J1P(W) = 1.366 + .950 * J1P(.CPIE) + 10.75 * (1/DMURATE25.54)$$
$$+ b * J1P(PROD) + c * J1P(WUS)$$

where J1P(W) is the percentage change in aggregate wages,
J1P(.CPIE) is the percentage change in expected inflation,
DMURATE25.54 is the unemployment rate for prime age males,
J1P(PROD) is the percentage change in labour productivity,
J1P(WUS) is the percentage change in
the U.S. wage rate,
and coefficients are elasticities.

The coefficient on price expectations in the stylized equation is approximately equal to unity. So there is for all practical purposes any long-run trade-off between inflation and unemployment.

The coefficient on the inverse of the prime age male unemployment rate, which is used as the labour market tightness variable suggests that a one percentage point increase in this particular unemployment rate from 4 to 5 per cent would lower the rate of wage increase by around 0.54 percentage points.

3.5.2 TIM

TIM is the model of Informetrica Ltd.. It also is a large (approximately 3,900 equations) annual model built around an input-output framework.

In TIM the wage per worker is modelled for seventeen industries. The end of the estimation period used in TIM varies from 1977 to 1980 with 1980 being the most common endpoint. The specifications can be characterized as a modified Phillips curve by industry tied to manufacturing, but with a role for industry specific labour market conditions such as hours worked and profits. In the aggregate the rate of inflation influences wages with a lag. After three years, although wages in some sectors such as retail trade, will have increased by less than the full amount of inflation, in the aggregate wages will fully reflect inflation. The key manufacturing rate equation has the inverse of the unemployment rate as an explanatory variable as do the equations for some other industries. Other industries are influenced indirectly by the unemployment rate as a result of the inclusion of the manufacturing wage in the wage equations.

The use of the aggregate unemployment rate in the wage equations can be interpreted as implying that the natural rate

is the average unemployment rate over the sample period. This allows no role for demographic factors or unemployment insurance in altering the natural rate.

Long-term increases in wages above inflation are determined by productivity increases. These are modelled as increases in output per employee and increases in capital per worker.

3.5.3 RDX2

RDX2 is a quarterly model developed in the Research Department of the Bank of Canada. The version of the model considered here is the Redbook version published in 1976 and estimated over the period ending in the fourth quarter of 1972. This model is no longer maintained, but it is of historic interest because of its great influence on subsequent models.

The main wage equation in RDX2 is for quarterly earnings in mining, manufacturing, and other business (WQMMOB). The equation in the original version of RDX2 was one that established an equilibrium real wage dependent on productivity and the unemployment rate. The equation in the latest version of RDX2 was presented as either a factor share or as a Phillips curve with some refinements. By the time RDXF, a subsequent model built in the Research Department of the Bank of Canada in the late 1970s, was constructed, the equation had been transformed into just an extended Phillips curve. This shows the increasing dominance of the extended Phillips curve model.

The equation for WQMMOB in the latest version of RDX2 is:

$$
\begin{aligned}
J1P(WQMMOB) = {} & -4.5950 * QDBAD - 5.1289 * QDGOOD - .79208 * QC1 \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (1) \\
& + .61245 * QC2 + .50506 * QC3 + 18.949 * ELEFF \\
& \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (2) \\
& - 25.067 * J1L(.00093783 * (WQMMOB/PCPI)) \\
& \qquad\qquad\qquad\qquad\quad (3) \\
& + .30374 * J1P(HAWMM) + 8.8029 \\
& \qquad\quad (4) \\
& * ((NMMOBD - NMMOBS)/NMMOBS) + 6.6690 \\
& \qquad\qquad\qquad\qquad\quad (5) \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (6) \\
& * J1L(.00093783(UGPPA/NMMOBD)) - .44541 * J1P(NMMOB)
\end{aligned}
$$

where QDBAD and QDGOOD are dummy variables for so called good and bad years for wage behaviour, QC1, QC2 and QC3 are constrained quarterly dummies, ELEFF is the labour efficiency factor in the production function, PCPI is the CPI, HAWMM is

average weekly hours worked in mining, manufacturing, and other business, NMMOBD is the desired level of employment, NMMOBS is the potential labour force, UGPPA is private business product adjusted for unintended inventory accumulation, and NMMOB is actual employment in mining, manufacturing and other business.

The equation is basically one in which the wage rate adjusts to the gap between the real wage rate as dictated by productivity - term (1) plus term (5) - and the lagged real wage rate - term (2). Term (1) measures pure technological progress and term (5) measures productivity allowing for variations in the capital/output ratio. The third term captures increases in wages due to overtime and other factors not directly related to employment growth. The fourth term reflects labour market slack which affects the level of the equilibrium real wage. The sixth term allows newly hired workers to have a lower than average wage.

Another important private sector wage is quarterly earnings in construction. It is modelled similarly.

3.5.4 CHASE

The CHASE model is a quarterly forecasting model developed by Chase Econometrics. The end year of its estimation period varies from 1978 to 1982. The wage in the industrial composite, the key wage equation in the CHASE model, is characterized in the CHASE write-up as "a function of the marginal product of labour, the difference between the actual and natural rate of unemployment, and a CPI term reflecting the attempt by workers to protect their purchasing power".[6] An inspection of the equation in the current version of the model revealed a quite different specification. It relates the percentage change in the wage bill plus supplementary labour income to the percentage change in current dollar gross private business product and the change in the gap between the actual and natural rate of unemployment. This specification is more akin to a wage share equation than a Phillips curve. The sum of the coefficients on the lagged percentage change in gross private business product in the equation is 1.0614. This is consistent with a moderately increasing wage share. The industrial composite wage is important in the CHASE model because all of the other wage series in the model are explained relative to it. The natural rate of unemployment is a function of the percentage of the population 15 years and over which is between 19 and 24 and of real unemployment insurance benefits per capita. The natural rate series was constructed by CHASE.

3.5.5 DRI

The DRI Canadian model is the quarterly forecasting model of Data Resources Inc. The version examined was estimated on data up to the fourth quarter of 1982. The key wage rate in the DRI model, which is utilized in the price equations, is for average hourly earnings in manufacturing (AHEM). It is a function of inflation (CPI/CPI(-4)) and the gap between the actual and full employment unemployment rate (RU-RUFE). The exact equation is:

AHEM/AHEM(-4) = .0474600 + JW(CPI/CPI(-4)) + JW(RU-RUFE)

The lag on inflation is 9 quarters long and the sum of the weights is approximately equal to 1 consistent with the vertical long-run Phillips curve. The lag on the labour market slack is two quarters and the sum of the weights is equal to .01, meaning that a 1 percent gap would lower the rate of wage inflation by one per cent per year.

The other wage variable is the national accounts average wage. It is also explained by an extended Phillips curve equation. This time, however, the equation also includes productivity as defined by GNE per employed worker as an additional explanatory variable. The inflation term is also different, measured as a three quarter lag on the percentage change in the consumption deflator. The labour market variable is only included with a two quarter lag.

The full employment unemployment rate (RUFE) utilized in the gap in both wage equations is calculated on the basis of research performed by D.P. Dungan and T.A. Wilson for the Economic Council.

3.5.6 FOCUS

FOCUS is the quarterly forecasting and policy simulation model of the Institute for Policy Analysis at the University of Toronto. The end of its estimation period varies from 1975 to 1977.

FOCUS has one key wage equation. It determines the average annual wages and salaries per employee in the private sector

(RCHAAWPS4Q) and is as follows for the pre-AIB period:

$$
\begin{aligned}
RCHAAWPS4Q = {} & .884834 + 2.49944 * (J4A(RN)/J4A(RU))^{(1)} \\
& + 2.49944 * (J4D(J4A(RN)/J4A(RU)))^{(2)} \\
& + .525232 * (J4A(PSALES71)-J4A(CPINSVR))^{(3)} \\
& + .494169 * J4A(RCHPEXP1)^{(4)} \\
& + .299837 * J4A(CPINSVR)^{(5)} \\
& + (1.0 - .494169 - .299837) * J4A(CPINSVR)^{(6)} \\
& + .0529587 * (J4A(CPINSVR - J4A(RCHPEXP1(-1))))^{(7)}
\end{aligned}
$$

where CPINSVR is the CPI, PSALES71 is the price of final sales, RCHPEXP1 is the change in the CPI expected one year in the future, RN is the natural rate of unemployment calculated by Dungan and Wilson using a methodology similar to that employed by the Department of Finance for the cyclically adjusted rate of unemployment, and RU is the unemployment rate .

The first term is the ratio of the natural rate to the actual rate of unemployment, which is an inverse measure of labour market slack. The second term introduces an additional effect on wages from changes in slack. The third term allows for a differential effect between output prices which increase employers ability to pay and the CPI. The fourth term captures expected inflation one year in the future as constructed using a regression of actual future inflation on a set of contemporaneous explanatory variables. The fifth term permits actual inflation to have an impact on wages. The sixth term ensures that the sum of the coefficients on price in the wage equation are equal to unity. This guarantees a vertical long-run Phillips curve. The final term which is the difference between actual and expected inflation is for catchup.

The coefficient on the labour market tightness variable suggests that with a natural rate of 6.5 per cent a one percentage point increase in the rate of unemployment would if maintained eventually lower the rate of increase of wages by 0.3 percentage points.

3.5.7 MTFM

MTFM is the Medium-Term Forecasting Model of the Conference Board. It is a quarterly model used for forecasting. The end of its estimation period varies from 1976 to 1981 with 1981 being most common. The key wage variables in MTFM are for average weekly wages and salaries. Equations are included for average weekly wages and salaries in agriculture, other primary, manufacturing, construction, services, and public administration and defense. Equations are also included for wages and salaries per employee. A representative equation is for manufacturing:

$$\begin{aligned} LOG(WRAWWMAN/AWHMAN) &= .10440 * J4A(\underset{(1)}{PISMAN * QMAN}) \\ &+ (1 - .10440 - .72743) * LOG(\underset{(2)}{PC(-1) * (1 + PCER/100)}) \\ &- .00329 * J4A(\underset{(3)}{RIBP(-2)}) + .72743 * (\underset{(4)}{WRAWWMAN(-1)/AWHMAN(-1)}) \end{aligned}$$

where WRAWWMAN is average weekly wages and salaries in manufacturing,
AWHMAN is average weekly hours in manufacturing,
PISMAN is the industry selling price in manufacturing,
QMAN is the real output price in manufacturing,
PC is the consumer price deflator,
PCER is expected inflation on the
consumer price deflator, and
RIBP is the real interest rate measured as
the rate of long-term industrial bonds minus PCER.

This equation was estimated in first difference form, but is given in levels form to simplify the presentation. The equation is not a Phillips curve specification. Instead it is based on the macroeconomic theory of wage behaviour as suggested by Lucas and Rapping[7]. Under this approach, both a demand and supply function for labour are specified and the wage rate is determined so as to equilibrate demand and supply.

Term (1) in the equation reflects the nominal value of output in manufacturing. Term (2) is the expected price level. Term (3) is the real interest rate. Term (4) is the lagged wage variable and is included to allow for lagged adjustment. In the long-run, under this specification wage growth is a weighted average of nominal output growth and consumer price growth, and the change in the real interest rate. If manufacturing and consumer prices rise at the same rate, the elasticity of wages with respect to prices is unity.

3.5.8 QFS

QFS is the Quarterly Forecasting and Simulation model of the Economic Forecasting Division of the Department of Finance. It was estimated on historic data ending in the fourth quarter of 1981.

The key wage equation in QFS is for the average wage per paid employee (WAYAI). It is:

$$J1P(WAYAI)) = -1.22 - \underset{(1)}{.60} * QAIB + \underset{(2)}{1.62} * LFURGAPP + .25 * \underset{(3)}{J1P(WAHR)} + \underset{(4)}{.83} * J1P(LFPROV16) - .14 * \underset{(5)}{J1P(LPEP)} + \underset{(6)}{PCPIE8X}$$

where QAIB is a dummy variable for the AIB, LFURGAPP is the natural rate of unemployment divided by the actual, WAHR is the average weekly hours worked in manufacturing, LFPROV16 is a 16 quarter moving average of the ratio of real gross national expenditure to total employment, LPEP is paid employment, and PCPIE8X is the expected increase in the consumer price index as measured by an eight quarter moving average of the actual increase in the CPI.

The first term is a dummy variable for the AIB. It is equal to .25 in 1975Q4 and 1976Q1, .5 in 1976Q2 and Q3, .75 in 1976Q4, 1 from 1977Q1 to 1978Q1, .75 in 1978Q2 and .5 in 1978Q3. The sum of these values is 8.5. The coefficient on the AIB dummy is .6. This indicates that the direct effect of the AIB was to lower the wage level by 5.1 per cent by the fourth quarter of 1978.

The second term measures labour market slack as measured by the ratio of the actual unemployment rate to the NAIRU. If the NAIRU were assumed to be 6 per cent, the coefficient suggests that a 1 percentage point increase in the unemployment rate from 6 to 7 per cent would raise the rate of increase of wages by about 0.9 percentage points.

The third term representing average weekly hours in manufacturing is included to pick up the effects of overtime on average wages. It could also be interpreted as an additional demand pressure variable.

The fourth term captures the impact of productivity on wages.

The fifth term for the percentage change in paid employment makes an allowance for the extent to which new workers earn less than average wages due to seniority and skill progression. The sixth term represents expected inflation as measured by the consumer price index. Its coefficient has been constrained to equal 1 as suggested by the theory of the inflation-augmented Phillips curve.

3.5.9 RDXF

RDXF is the quarterly forecasting model of the Research Department of the Bank of Canada. It is the direct descendant of the RDX2 model discussed above. The version of the model considered is that estimated over a period ending between the fourth quarter of 1980 and 1982.

The RDXF wage equations follow an expectations augmented Phillips curve equation. The two key wage series are average weekly wages in the industrial composite (WNIC) and average weekly wages in community services, government and agriculture (WOTH). The industrial composite equation is:

```
                                                    (1)
J1D(LOG(WNIC)) = 1.43530 * J12A(J1D(LOG(ETFP) - .00165
                (2)
                   * (RU - 1.92915 * J6A(NPER.GE.19754.)) - .00969
                                     (3)
                   * (NPER.GE.19761.) * NPER.LE.19774.)
                                   (4)
                   + J8W(J1D(LOG(J1L(PCPI))))
                                   (5)
                   + .37523 * J7A(J1D(LOG(J1L(PGPP/PCPI))))
```

where ETFP is a measure of trend factor productivity derived from a Cobb-Douglas production function, RU is the difference between the actual unemployment rate and the rate at trend output, NPER is the period number, PCPI is the consumer price index, and PGPP is the price deflator for private business product.

The first term allows the changing productivity growth to be explicitly modelled. The second term is the labour market gap variable measured as the gap between actual and the trend unemployment rate. The trend unemployment rate is calculated by a two step procedure. First, the actual unemployment rate is regressed on an output gap, and two structural variables representing unemployment insurance and the proportion of the

young people in the labour force. Second, the gap variable is set equal to 1 giving the unemployment rate at trend output. The coefficient on the labour market gap variable suggests that a one percentage point increase in the unemployment rate would lower the rate of increase in wages by 0.66 percentage points. The third term is an AIB dummy. The fourth term reflects price expectations as measured by an eight quarter lag on actual inflation. The sum of the weights was constrained to unity as is consistent with a vertical long-run Phillips curve. The fifth term allows output prices to have a differential impact on wages from the consumer price index reflecting labour demand considerations.

The other wage variable (WOTH) is tied to the industrial composite wage by an equation incorporating a number of dummy variables to explain the difference.

3.5.10 MACE

MACE is an small annual model developed under the leadership of John Helliwell at the University of British Columbia. It was estimated using data up to 1982.

The MACE wage equation is:

$$
\begin{aligned}
J1P(W) = {} & .62829 * \underset{(1)}{J1P(W(-1))} + .37171 * \underset{(2)}{J1P(Pa)} \\
& + .26602 * \underset{(3)}{(J1P(Pxne/Pmne))} \\
& + .31392 * \underset{(4)}{(J2A(J1P(Q/Qsv)))} \\
& + .37171 * \underset{(5)}{J1P(LPI)} \\
& - .035186 * D77 - .021573 * D78
\end{aligned}
$$

where W is the average annual wage, Pa is the price of absorption, Pxne is the export price index, Pmne is the import price index, Q is the gross output, QSV is supply, and LPI is a labour productivity index.

The second term in the equation reflects the prices perceived by workers. Its long-run coefficient has been constrained to unity, thus making nominal wages rise in step with prices. The third term for the terms of trade represents businesses' ability to pay or profitability. The fourth term is the change in output relative to supply and is a demand measure. The fifth

term is productivity of industry. Since it has been constrained to be one minus the coefficient on the lagged wage, the long-run real wages will keep pace with productivity.

3.5.11 SAM

SAM is a small annual model also developed in the Research Department of the Bank of Canada. The version considered had an estimation period that ended in 1981.

A simplified version of the main SAM wage equation is:

$$J1D(LOG(w)) = a * \overset{(1)}{LOG(ws/w)} + b * \overset{(2)}{(RNAT - RNU)} + DNPX + DNPRX$$

where w is the wage rate, ws is the steady state wage, RNAT is the natural rate of unemployment, RNU is the actual unemployment rate, DNPX is the underlying rate of inflation, and DNPRX is trend real wage growth arising from productivity gains.

The equation expresses the rate of change of wages as a function of the extent of disequilibrium in the level of money wages, the gap between the natural and actual rate of unemployment, and trend terms. DNPX can be viewed as capturing inflationary expectations and fundamental determinants of the equilibrium rate of inflation. In the long run wages are determined by the steady state wage which depends on technology and factor prices. This steady state wage is consistent with full employment of labour and the zero-excess-profit condition. In the shorter-run the wage equation exhibits Phillips-curve-like behaviour. The estimated coefficient on the gap implies that a 1 percentage point unemployment rate gap would lower the rate of increase of wages by 2 per cent. This is by far the largest effect of unemployment on wages in any of the macroeconomic models considered.

3.5.12 Summary of Wage Equations in Macroeconomic Models

The most prevalent specification for wage equations in current Canadian macroeconomic models is the expectations-augmented Phillips curve. Six out of the eleven models considered follow this specification. This includes CANDIDE 2.0, TIM, DRI, FOCUS, QFS, and RDXF. The other models all to varying degrees exhibit

Phillips-curve-like behaviour.

Four of five models - DRI, FOCUS, QFS, and RDXF - have after testing imposed coefficients on price expectations of exactly one. For these models, the long-run Phillips curve is vertical and there is no long-run trade-off between inflation and unemployment. In CANDIDE 2.0 the average of the coefficients is almost 1 so there is a very steep long-run trade-off.

Table 5 summarizes the short-run trade-off between wage inflation and unemployment as estimated roughly using the coefficients form these models. The impact of a one percentage point increase in unemployment ranges from a reduction of 0.33 percentage points in FOCUS to 1 percentage points in the DRI model. The models exhibit a tendency for the estimate of the impact of unemployment on wage inflation to increase the more recent is the end of the estimation period of the wage equation. This is a similar tendency to that observed in the other empirical studies of wage behaviour considered above. It may be related to the much greater variability of unemployment in recent years. This makes it possible to get better estimates of the coefficient of labour market tightness on wage behaviour.

Table 5

SUMMARY OF WAGE EQUATIONS IN MACROECONOMIC MODELS

Model	Short-run impact of 1 percentage point increase in unemployment	Coefficient on price expectations
CANDIDE 2.0	-0.54	average almost 1
DRI	-1.00	1
FOCUS	-0.33	1
QFS	-0.90	1
RDXF	-0.66	1

3.6 ESTIMATES OF THE NATURAL RATE OF UNEMPLOYMENT

The natural rate of unemployment or the Non-Accelerating Inflation Rate of Unemployment (NAIRU) is a critical determinant of the economy's performance with respect to inflation and unemployment. It is the level below which unemployment can go without triggering an upward inflationary spiral. If the rate of unemployment is above the NAIRU, inflation will spiral downward. In the Report of the Royal Commission on the Economic Union and Development Prospects for Canada (1985, vol II, p.284-285) it was written that:

> "The NAIRU is estimated to have risen from the 4 to 5 per cent range in the 1950s and early 1960s, to 6 to 7 per cent in the early 1970s, and to 6.5 to 8 per cent today."

Table 6 summarizes the available estimates of the NAIRU as compiled by Fortin and Newton (1982) and updated to incorporate some new estimates including many of those discussed above in our survey of the literature on wage equations. The increase in structural unemployment due to such factors as shifts in the demographic composition of the labour force and the changes to Unemployment Insurance are evident. Also except for one obvious outlier estimate of 11 per cent by Lucie Samson which can be dismissed on technical grounds,[8] estimates canvassed all fall in the 6 to 7 per cent range. This is lower than the 6.5 to 8 per cent range suggested by the Macdonald Commission. It offers some promise that the rate of unemployment can be reduced to a fairly reasonable level without leading to a resurgence of inflationary pressures.

Table 6

ESTIMATES OF THE INCREASE IN THE STRUCTURAL UNEMPLOYMENT

FROM THE 1950S TO THE 1970S AND OF THE RECENT

LEVEL OF NAIRU

Study	Increase in Structural Unemployment	Period of Increase	Level of NAIRU	Date of NAIRU
Freedman (1976)			7.2	1975:4
O'Reilly (1976)	2.1	1960-75		
Kierzkowski (1977)	2.1	1962-75		
Reid and Meltz (1979)	3.3	1953-75		
Aubrey, DiMillo and Cloutier (1979)	3.2	1953-77	7.0	1977
Fortin and Phaneuf (1979)	2.1	1957-78	6.6	1978
Grubel and Maki (1979)	2.6	1955-75		
Dungan and Wilson (1979)	2.5	1953-77		
Riddell (1979)	2.5	1955-78	7.0	1978
Siedule and Newton (1979)	1.7	1961-78		
Gosselin (1980)	3.3	1962-79	6.5	1979
Aubrey (1982)			6 to 6.5	1980
Guindon and Grignon (1981b)	2.7	1962-79	6.6	1979
Riddell and Smith (1982)	1.5	1966-79	6.2	1979
Samson (1985)	6.4	1957-83	11.0	1983
McCallum (1985)			6.6	1984

Source: Update of estimates in Table 9 of preliminary version of Fortin and Newton (1982).

3.7 THE IMPACT OF UI ON THE RATE OF UNEMPLOYMENT

Unemployment Insurance is widely recognized to have the undesirable side effect of raising the rate of unemployment. It does this by reducing the incentive to work, to keep working if employed, and to look for a job if unemployed. It also makes it easier for employers to lay off workers by reducing the hardship associated with unemployment and lowering the probability that the worker will take another job and be lost to the industry. The current UI program with uniform premiums, regardless of the employment patterns of the industry covered, subsidizes those industries characterized by employment instability. The magnitude of the impact of UI on the unemployment rate depends on the coverage and generosity of the program.

Before 1971, the UI benefit rate ranged between 43 and 53 per cent of previous earnings, the higher figure applying if the claimant had dependents. In July 1971 the benefit rate was raised to 66.6 per cent of actual insurable earnings, provided the earnings were below the ceiling, and to 75 per cent for claimants with dependents who had low earnings or experienced prolonged unemployment. The maximum weekly benefit under the new act was increased to $100 from $53. The new UI legislation also reduced the minimum qualification period from 30 weeks during the preceding two years to 8 weeks for the preceding year. The entitlement period of one week of benefits for every two weeks of work was changed to a maximum entitlement of 28 weeks and 44 weeks in a depressed region for a minimum of 8 weeks of work. Assuming that the benefit replaced about 80 per cent of the net wage, this constituted an implicit subsidy of between 280 per cent and 440 per cent for those in the most unstable segment of the labour market (80 per cent replacement rate times 28 or 44 weeks of benefits divided by 8 weeks qualification period). This compared with a subsidy of only 33 per cent under the old act (66 per cent replacement rate times 1 week per 2 weeks of employment). At the same time the program's coverage was broadened, increasing the number of employees covered by UI by about a third and raising the percentage of the labour force covered to almost 90 per cent. Extended benefits based on regional unemployment rates were also established. This enrichment of the UI program contributed to an increase in total UI benefits from around $700 million in 1970 to almost $2 billion in 1972.

Some estimates of the increase in the unemployment rate attributable to the 1971 revisions to Unemployment Insurance compiled by Fortin and Newton (1982) and updated are shown in table 7. They fall in the 0.7 per cent to 2.0 per cent range. The average estimated increase is 1.2 per cent.

Table 7

ESTIMATES OF THE IMPACT OF THE 1971 UNEMPLOYMENT INSURANCE ACT REVISIONS ON THE UNEMPLOYMENT RATE

Study	Effect (percentage points)
Grubel, Maki and Sax (1975)	0.8
Jump and Rea (1975)	1.0
Green and Cousineau (1976)	0.7
Siedule, Skoulas and Newton (1976)	1.3
Rea (1977)	1.2
Lazar (1978)	1.2
Bodkin and Cournoyer (1978)	1.3
Reid and Meltz (1979)	1.9
Fortin and Phaneuf (1979)	0.7
Wilson and Dungan (1979)	1.4
Vanderkamp and Wilson (1980)	2.0
Guindon and Grignon (1981a)	0.7
Riddell and Smith (1982)	1.4

Source: Update of estimates presented in Table 2 of preliminary version of Fortin and Newton (1982), as updated from Wilson and Dungan (1979, table 11, p. 39).

The unemployment insurance program was modified in 1979 to reduce benefits and tighten eligibility requirements. The benefit rate was reduced to 60 per cent of insured earnings. In addition, qualification requirements for new entrants and re-entrants into the labour force (those with fewer than 14 weeks work in the year preceeding the qualifying period) were raised to 20 weeks of insurable employment from 10 to 14. Qualification requirements for repeat users (those who received benefits in the preceeding year for longer than the prescribed minimum qualifying period) were also raised by up to 6 weeks depending on the regional unemployment rates. A study by Riddell and Smith (1982, p.390) of the effect of these modifications suggest that they caused the NAIRU to decline by nearly half a percentage point after 1979. Fortin and Newton (preliminary version of 1982) estimate that the recent UI revisions coupled the swift deceleration in minimum wages and demographic developments have reduced the NAIRU by 0.5 to 0.7 per cent between 1977 and 1980. Guindon and Grignon (1981a) estimate that the 1977 and 1979 UI revisions lowered the aggregate unemployment rate by 0.3 per cent. These estimates are summarized in table 8. The average of these three estimates suggests that the tightening of UI in the late 1970s lowered the rate of unemployment by 0.5 per cent. This would reverse the average estimated increase of 1.2 per cent associated with the 1971 UI changes by some 40 per cent.

Table 8

ESTIMATES OF THE IMPACT OF THE 1979 UNEMPLOYMENT INSURANCE ACT REVISIONS ON THE UNEMPLOYMENT RATE

Study	Effect (percentage points)
Fortin and Newton (1981a)	0.4 to 0.7
Riddell and Smith (1982)	0.5
Guindon and Grignon (1981a)	0.3
Average	0.5

4 CONCLUSIONS

This paper has examined the issue of the trade-off between inflation and unemployment. The reigning theoretical model is the inflation-augmented Phillips curve of Friedman (1968) and Phelps (1967). According to this model, there is no long-run trade-off between inflation and unemployment, but instead is a natural rate of unemployment determined by real economic phenomena. In its most simple form, the rate of change of nominal wages responds negatively to the gap between the actual and natural rate of unemployment and responds positively with a coefficient of unity to inflation expectations.

The most recent Canadian empirical studies surveyed, with the exception of Wilton and Christofides (1985), but including Wilton (1985) are consistent with the extended Phillips curve model. Though they differ in the degree of the short-run response of wages to unemployment, with the more recently estimated equations which reflect the experience of the latest recession exhibiting the highest degree of responsiveness, the equations all have the coefficients of approximately unity on price expectations that are a necessary condition for there to be no long-run trade-off.

This paper also documented the evidence which suggests that the natural rate of unemployment of NAIRU has shifted upwards over the decade of the 1970s on account of demographic changes in the composition of the labour force and revisions in Unemployment Insurance. The estimates of the NAIRU surveyed were in the 6 to 7 per cent range. This is significantly lower than the 6.5 per cent to 8 per cent range estimated by the Macdonald Commission.

The 1971 revisions to the Unemployment Insurance program, which increase the generosity and coverage of benefits, contributed to the increase in the NAIRU. The available estimates of the magnitude of this effect were in the 0.7 per cent to 2 per cent range and averaged 1.2 per cent. The tightening of Unemployment Insurance in the late 1970s went some way to reversing this effect. The three estimates that are available suggest that this tightening of UI lowered the unemployment rate by 0.5 per cent.

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1. The wage series shown on chart 3 is for the national accounts average annual wage. It is calculated by dividing wages, salaries and supplementary labour income from the national accounts by total employment from the labour force survey. While not strictly a wage rate, this series is representative of broad wage trends in the economy. The advantages of this particular series over others are that it is the only one available on a consistent basis over the whole of the post-war period and that it is also the only wage one representative of economy-wide wage trends.

2. Bodkin et al (1967,Table 6.4, p.172

3. An important exception to this is the excellent modelling of wage and price behaviour in the manufacturing sector by Taylor, Turnovsky and Wilson (1972) and Wilson and Reid (1979).

4. Equations are included in some of the sectoral descriptions. To standardize the terminology while remaining within the normal typewriter character set, the RDX2 J operators have been utilized. JW signifies a distributed lag; JiL an i quarter lag; JiS is an i quarter sum; JiA an i quarter average; JiD an i quarter difference; and JiP an i quarter percentage change. The numbers in parentheses above the terms in the equations are included to facilitate reference.

5. The following equations are taken from P. Someshwar Rao, "The Relative Impact of Wage-Price Controls and Wage Indexation on Economic Growth and Price Stability," Discussion Paper No. 166, Economic Council of Canada, April, 1980, pp. 21-24.

6. CHASE Econometrics, "Canadian Macroeconomic Model," unpublished.

7. R.E. Lucas Jr. and L.A. Rapping, "Real Wages, Employment and Inflation," Journal of Political Economy, 77(5) (September - October, 1969).

8. The methodology followed explains the actual unemployment rate as a function of the dispersion of employment growth among industries, the difference between expected and actual money growth, a time trend and the U.S. rate of unemployment. The equation for the actual rate is then solved for the natural rate assuming that there were no monetary surprises and no random fluctuations in unemployment. This has the implausible implication of making the Canadian natural rate primarily

dependent on the U.S. actual unemployment rate. Now that the U.S. unemployment rate has dropped to near 7 per cent, the Canadian natural rate predicted by the equation could also be expected to drop correspondingly.