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THE PROCESS OF WAGE DETERMINATION: A SURVEY OF SOME RECENT WORK

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The views expressed in this report are those of the author; no responsibility for them should be attributed to the Bank of Canada.

CONTENTS

ABSTRACT

In this report, the author surveys some of the important issues in the process of wage determination, and discusses the work in these areas that has been done in recent years at the Bank of Canada. The discussion is developed from the perspective that there are two alternative approaches to wage determination, distinguished primarily by whether it is the wage level or the rate of wage increase that is affected by conditions of excess supply in the labour market. Single equation estimates of both types of specification are examined.

It can be demonstrated, however, that the distinction between the two approaches becomes less clear when the interaction of the wage equation with prices is made endogenous. In other words, the dynamics of a wage equation cannot be analyzed independently of price determination and price expectations. These dynamics are examined briefly with reference to simulation results from a simple two-equation wage-price model.

Finally, indicators of the degree of slack in the labour market are considered, with particular emphasis given to the measured rate of unemployment. It is known however, that this measured rate is no longer reliable as an indicator of labour-market tightness, since the rate of unemployment that corresponds to full employment has been changing over time. This rate, commonly referred to as the "natural rate" of unemployment, has been estimated using two different methods. Both suggest that in Canada the natural rate is currently about seven percent.

RESUME

Dans ce rapport, l'auteur fait un survol de quelques-unes des principales questions que soulève le processus de détermination des salaires et présente les recherches réalisées ces derniers temps dans ce domaine à la Banque du Canada. Le rapport est articulé autour de la question suivante, qui indique qu'il y a deux manières d'aborder l'étude du processus de détermination des salaires: l'offre excédentaire de main-d'oeuvre sur le marché du travail influence-t-elle le niveau ou le taux de croissance des salaires? L'étude contient un examen d'équations qui rendent compte de chacune de ces deux approches, dans un contexte d'équilibre partiel.

Cependant, il est possible de démontrer que la distinction entre les deux approches devient moins évidente lorsque l'on tient compte de l'interdépendance des salaires et des prix. En d'autres termes, la détermination des prix et les anticipations relatives à ces derniers sont autant d'éléments dont il faut tenir compte dans l'analyse de la dynamique d'une équation des salaires. Cette dynamique est examinée brièvement à partir de résultats d'exercices de simulation effectués à l'aide d'un modèle simple à deux équations construit pour les salaires et les prix.

L'auteur a aussi porté son attention vers le choix d'un indicateur de l'ampleur de l'offre existant au sein du marché du travail, privilégiant à cet effet le taux de chômage observé. Toutefois, ce taux n'est pas reconnu comme un indicateur fiable du degré de tension

existant sur le marché du travail, car le taux de chômage qui correspond au "plein emploi" n'est pas constant à long terme. Généralement appelé le "taux naturel" de chômage, il a été estimé à l'aide de deux méthodes distinctes. Ces deux méthodes indiquent qu'au Canada le taux naturel serait maintenant d'environ 7 pour cent.

ACKNOWLEDGEMENTS

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THE PROCESS OF WAGE DETERMINATION: A SURVEY OF SOME RECENT WORK

INTRODUCTION

Despite its significance as one of the most important behavioural relationships in macroeconomics, a relationship moreover, that is fundamental to an analysis of the twin evils of inflation and unemployment, a great deal of uncertainty still remains over the proper specification of the wage equation. For example, what role do labour market conditions play in the process of wage determination? (Specifically, does the amount of excess demand [or supply] affect the rate of wage inflation, or the equilibrium wage level?) What role do expectations regarding future inflation have? Is there such a thing as a "natural rate" of unemployment? If so, what is it and what are the factors that determine it?

These questions, which highlight some of the key issues in the debate over the process of wage determination, have received a good deal of attention during recent years in the Research Department at the Bank of Canada. It is the purpose of this paper to survey some of this work to see what answers, if any, have been found.

1 THE PROCESS OF WAGE DETERMINATION: TWO BASIC APPROACHES

In very general terms, two alternative approaches to the process of wage determination can be distinguished. These have been labelled by Benjamin Wurzburger (1977) as the "Keynesian" approach and the "Phillips curve" approach. However, these labels can be very ambiguous. Each, in fact, may imply a variety of specifications. For example, we sometimes include the specification of a "Real Wage" equation under the umbrella of a Keynesian approach, even though Keynes' original work focussed on nominal wages and regarded money illusion as an important phenomenon. The Phillips curve, in fact, was originally regarded as a useful extension of the Keynesian view of the world, providing a bridge between Keynes' assumptions of wage inflation at full employment and complete wage rigidity at anything less than full employment. However, the Phillips curve literature has since taken on a life of its own, precipitated, to some extent, by the incorporation of inflationary expectations into the specification. Discussion is now largely dominated by the concept of a natural rate of unemployment.

To begin at the very simplest level, the basic difference between a Keynesian (KN) and a Phillips curve (PC) approach lies in whether the analysis is done in static or dynamic terms. Specifically, does the degree of "tightness" in the labour market affect wage levels, or the rate of wage inflation? The following equations can be used to illustrate the situation:

$$\log(W) = f(LMT) \quad (1)$$

$$\Delta\log(W) = g(LMT) \quad (2)$$

where

W represents the level of nominal wages or earnings,

LMT represents some measure of tightness or excess demand in the labour market (such as the unemployment rate, for instance), and

$\Delta\log$ refers to the change in the natural log from one quarter to the next. (This is essentially equivalent to writing $\dot{W}/W$.)

Thus, equation (1) states that a sustained rise in demand (evidenced by an increase in labour-market tightness) will lead to an increase in the level of nominal wages. This represents the static Keynesian hypothesis. Equation (2) reflects a dynamic (Phillips curve) interpretation, and suggests that the rise in demand will cause an increase in the rate of change of money wages.[1]

The implications of this basic difference can be illustrated clearly with the help of Figures A and B. Figure A shows the level of wages, and Figure B shows their rate of change (i.e., the rate of wage inflation), both as functions of time. The point in time when a permanent increase in demand is assumed to come into effect is represented by TD, and TE is the point in time when "equilibrium" is re-established. Thus the Figures allow for some lags in adjustment even though they were not suggested by the above equations. The labels KN and PC refer, respectively, to the Keynesian and Phillips curve specifications.

Figure A

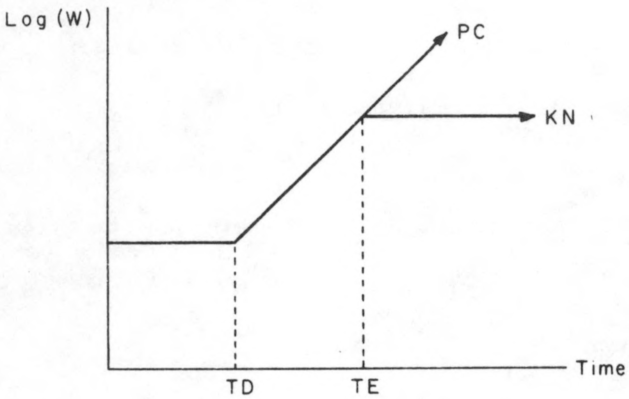
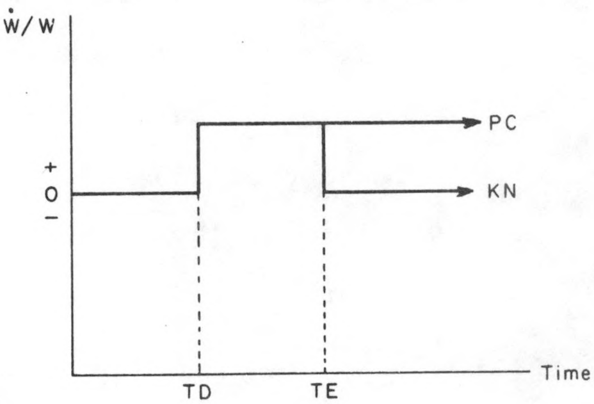


Figure B



Let us assume an initial situation where there is no wage inflation. This is represented by the flat portions of Figures A and B up to time TD. Then, suppose there is an increase in aggregate demand that is maintained indefinitely into the future. This would cause an increase in tightness in the labour market - a reduction in the unemployment rate, for example. For the moment, ignore the immediate effects and focus on the period subsequent to time TE (when final equilibrium states have been reached). For the KN equation, this new state means a higher level of wages, as indicated in Figure A, but a return to a zero rate of wage inflation, as shown in Figure B. For the PC equation, it means some continuing (but steady) positive rate of wage inflation, as can be seen in Figure B, and thus, an ever-increasing level of wages, as illustrated in Figure A. As for the period of adjustment between TD and TE, equations (1) and (2) say nothing. I have simply assumed that this period is characterized by increasing levels of wages, and, by implication, some positive rate of wage inflation. The adjustment paths in Figures A and B have been drawn as straight lines, although such abrupt changes are obviously not realistic.

While it is impossible in Figures A and B to distinguish between a KN and a PC approach during the adjustment period, the long-run implications <u>are</u> quite different. A permanent increase in aggregate demand (an attempt to reduce once and for all the rate of unemployment, for instance) can result, when equilibrium is finally established, in continuing inflation or in no inflation at all. Hence it is important to try to determine which formulation more accurately describes the real world.

2 A SURVEY OF SOME SPECIFIC WAGE EQUATIONS

Before any actual estimates are examined, two issues must first be discussed since they are relevant no matter which specification is being considered. This is done in Section 2.1. Section 2.2 reviews an early study by Wurzburger (1977) in which he estimated a "general" wage equation to see if the data tended to favour either a KN or a PC approach. Although he found a KN approach to be favoured, it can be argued that his results do not offer conclusive proof of the superiority of a Keynesian specification.

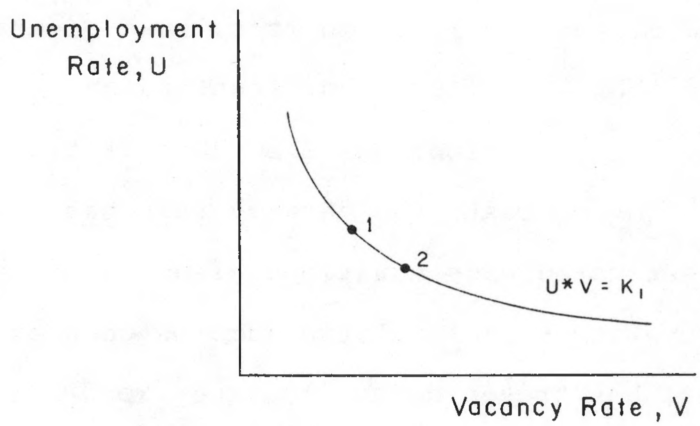
A few modifications to Wurzburger's KN equation give the wage equation used in RDX2, the Research Department's econometric model. The RDX2 wage equation is examined in Section 2.3. Recent estimates of this specification, however, reveal that the coefficients are not very stable. Indeed, some have changed quite dramatically, a fact which casts some doubt on the validity of a KN approach. Therefore, in Section 2.4 a number of Phillips curve alternatives are presented and discussed.

2.1 Preliminary Considerations

(a) Is the Unemployment Rate an Adequate Indicator of Conditions in the Labour Market?

The measured unemployment rate (U) was regarded for some time as a reliable indicator of excess demand (or supply) conditions in the labour market. The data generally revealed a stable inverse relationship between U and the vacancy rate (V) such that their product (U*V) equalled a constant. Changing demand conditions in the labour market were reflected by movements along a U-V curve, such as that shown in Figure C. Thus, an increase in demand produced a simultaneous reduction in the unemployment rate and an increase in the vacancy rate (movement from point 1 to point 2). With a stable relationship like this, either U <u>or</u> V would be equally useful as an indicator of labour market conditions. In Canada, since data on unemployment were thought to be more reliable, U was used in preference to V in most early studies.

Figure C



Since 1971, however, the U-V relationship has broken down. Specifically, it seems to have shifted out, such that $U^*V = k_2$, where $k_2 > k_1$. Both O'Reilly (1976) and Freedman (1976) sought to determine whether this shift was due primarily to: (i) a change in the underlying structural relationship between excess demand in the labour market and measured unemployment; or (ii) a change in the relationship between excess demand and vacancies. Their methodology closely followed some earlier work done by Meltz and Reid (1976), and involved "purging" the measured vacancy and unemployment rates of quantifiable factors that may have caused the structural shift. In his study, Freedman subsequently tested these "corrected" measures to see which performed best as an indicator of labour-market tightness in a wage equation.[2]

If the outward shift in the U-V curve could be attributed primarily to a change in the underlying structural relationship between excess demand for labour and vacancies (i.e., a shift to the right in Figure C), then the over-all unemployment rate should still perform satisfactorily as a measure of tightness in the labour market. That it does not has been widely reported. (See Freedman (1976), Auld et al (1979), Riddell (1979), and Bilkes (1979).) In fact, most recent studies have not only found that U is less significant as an explanatory variable in the wage equation, but also that it tends to enter with the wrong sign. In contrast, the vacancy rate has continued to perform fairly well in estimated wage equations, leading one to conclude that it has been the structural relationship between excess demand for labour and U that has broken down. In other words, the curve in Figure C has shifted up rather than to the right.

Even though the over-all unemployment rate may no longer be adequate, it has been suggested that the unemployment rate for adult males (UMA) should still be a reliable indicator. Bilkes (1979), for example, places considerable faith in it. However, although one may eliminate the influence of demographic factors by focussing on UMA, a second assumption is also required - that legislative or policy factors (changes in the unemployment insurance programme) have had no discernible effect on adult male workers. This assumption is accepted explicitly in a paper by Fortin and Phaneuf (1979). However, the results reported by Freedman, Auld, Riddell, and others have shown that UMA does not perform satisfactorily in estimated wage equations. Further, the specific assumption made by Fortin and Phaneuf has been challenged and refuted by Aubry (1979).

The papers by O'Reilly (1976) and Freedman (1976) also demonstrated that the underlying structural relationship between measured unemployment and the degree of excess demand in the labour market has broken down over time, but since the details of their approach are somewhat peripheral to the discussion at this point, their work is described in Appendix B. Their basic conclusion, though, was that the vacancy rate (V) or an unemployment measure that had been corrected for the influence of various policy and demographic changes provided a good indicator for labour-market tightness in an estimated wage equation. Most of the recent studies done outside the Bank of Canada (all of those surveyed in Riddell (1979) for example) use V. However, there may be some difficulty posed for future work because of the recent decision by Statistics Canada to discontinue its vacancy survey as a cost-cutting measure.[3]

Studies done within the Bank have used a variety of measures of labour-market tightness. In the RDX2 wage equation (Bank of Canada Technical Report 5), Wurzburger used the following expression:

[(NMMOBD-NMMOBS)/NMMOBS].

The variable NMMOBD is the desired level of employment - i.e., that level which, when combined with the existing capital stock and trend productivity, should produce enough output to satisfy the current level of aggregate demand; NMMOBS is the potential labour force, assuming <u>given</u> participation rates. Specifically, NMMOBS is the current labour force less some estimate of "frictional" unemployment - or, in other words, the total number of employed persons plus those who are unemployed owing to deficient aggregate demand.

In Technical Report 11 (1977), Wurzburger developed a somewhat more sophisticated measure designed to include the effects of changes over time in labour-force participation. He used the geometric mean of the product of two ratios - the ratio of total employment to the total non-institutional population over 14 years of age, and the ratio of desired employment to potential labour supply:

$$WURZ = \sqrt{(NE/NPOP)*(NMMOBD/NMMOBS)}.$$

A measure of labour-market tightness that has been used in a number of recent wage equation estimates at the Bank was developed in 1978 by Jean-Pierre Aubry. This measure is defined as the difference between the measured unemployment rate in any quarter (U) and the natural rate prevailing at that time: RUJP = U - RNAT. His estimated RNAT varied over time with legislated changes in unemployment insurance benefits and regulations, such as those that occurred in 1955, 1959, 1968 and 1971.

(b) Which Price Deflator is Appropriate?

Although equations (1) and (2) in Part 1 overlooked the possibility of price changes affecting nominal wages, this influence cannot be ignored indefinitely. As we shall see, the effects of prices on wages (and vice versa, the effects of wages on prices) are vitally important. At this point, however, the question to be dealt with concerns the appropriate price deflator to include in the wage equation. The three main candidates are: PGNE (the deflator for gross national expenditure); PCPI (the consumer price index); and PGPP (the deflator for domestic private-sector output evaluated at factor cost).

Theoretically, there are arguments in favour of using either consumer prices (PCPI) or product prices (PGNE or PGPP). For example, in terms of a neoclassical theory of the labour market, real wages are determined by the interaction of labour supply and labour demand. Workers are assumed to make their labour supply decisions by comparing the utility they would derive from leisure versus that derived from having a greater income. If this is so, a consumer price index is more relevant to them since it indicates the amount of consumption goods that their incomes can actually buy. Firms, on the other hand, base their labour demand decisions on the marginal revenue product of their workers, and these "calculations" would be done on the basis of product prices.

One may prefer a bargaining interpretation of the wage determination process over the neoclassical approach. The theory outlined by Kuh (1967) suggests that labour bargains for a given share of national output per worker. If this is correct, then a product price deflator is appropriate here. On the other hand, if workers are assumed to be more concerned about their real standard of living - as usually seems to be the case - then a cost-of-living index such as PCPI is more suitable. As for the firms' side of the bargaining picture, their "ability to pay" would be best reflected by a product price index.

The preceding discussion would seem to favour the inclusion of a consumer and a product price index in the wage equation, since wage determination appears to depend on them both. In his April 1977 paper, Freedman used a weighted average of PCPI and PGNE, and, in the current version of the Research Department's forecasting model (RDXF), both PCPI and PGPP appear in the wage equation. Most studies, however, use only one deflator - typically PCPI.

Possibly the most important consideration in choosing between the deflators is that they react very differently to relative changes in foreign prices because of their differing emphases on imports and exports. The GNE deflator places more weight on foreign prices of resources (our major exports), and relatively less on the foreign prices of manufactured goods (our major imports) than does the consumer price index. Thus, if our terms of trade deteriorate (if import prices rise relative to export prices), the CPI will increase more than the GNE deflator, while if our terms of trade improve, the GNE deflator will rise by more. Obviously, important implications are involved depending upon whether PCPI or PGNE is used as the deflator in the wage equation. If PCPI is used, the assumption is that workers demand a real income in consumption goods regardless of terms of trade movements. Thus, a deterioration in the terms of trade would lead to some combination of reduced profits, increased unemployment and higher inflation. Alternatively, if PGNE were used as the deflator, the assumption would be that labour is prepared to accept its share of any loss in real income if the terms of trade deteriorate, meaning that the same reduction in profits or increase in unemployment and inflation would not be expected.

2.2 A Comparison of the Two Approaches with a General Specification

In Technical Report 11, Wurzburger tested a general specification that included both Keynesian (KN) and Phillips curve (PC) equations as special cases. His equation had essentially the following form:

$$\Delta\log(W) = a0 + a1*\log(P) + a2*\log(q) + a3*LMT - a4*\log(J1L(W)) + a5*E(PDOT) \quad (3)$$

where

P represents the level of prices,

q represents productivity or output per worker,

E(PDOT) represents the expected rate of price inflation, and,

J1L is an operator referring to a one-period lag.

As before, $\Delta\log(W)$ represents $\dot{W}/W$, the percentage change in nominal wages, and LMT is a measure of tightness in the labour market.

Equation (3) obviously goes substantially beyond the simple formulations of equations (1) and (2) and suggests that the increase in nominal wages from their level of the preceding period is determined by productivity, the degree of tightness in the labour market, the level of prices, and the rate at which prices are expected to increase for some time into the future.

How are the competing KN and PC approaches reflected in equation (3)? Let us start with a traditional Keynesian hypothesis that workers bargain with their employers for a nominal wage, with prices (P), productivity (q), and conditions in the labour market (LMT) all being determinants of the final wage settlement. Thus, the following equation would define the static equilibrium condition:

$$\log(W) = b0 + b1*\log(P) + b2*\log(q) + b3*LMT \quad (4)$$

If wages adjusted completely to equilibrium each period (quarter), we could define the change in wages, $\Delta\log(W)$, by simply subtracting the last quarter's wages, log(J1L(W)), from both sides of equation (4). However, we know that some wage rigidity does exist - in other words, that nominal wage rates are "sticky". This rigidity is due not only to the existence of labour unions with their negotiated contracts, but also to the existence of a large "non-entrepreneurial" sector composed of government, regulated industries and non-profit institutions.[4] Thus, only partial adjustment towards equilibrium occurs in each period. If a4 represents the speed of adjustment, i.e., the proportion of any disequilibrium that is removed in a quarter, then the observed change in wages would be given by:

$$\Delta\log(W) = a4*[b0+b1*\log(P)+b2*\log(q)+b3*LMT-\log(J1L(W))] \quad (5)$$

If we define a0 as a4*b0, and a1 as a4*b1, and so on, then equation (5) can be rewritten as:

$$\Delta\log(W) = a0 + a1*\log(P) + a2*\log(q) + a3*LMT - a4*\log(J1L(W)) \quad (6)$$

This equation, representing a Keynesian approach, needs only the E(PDOT) term to make it identical to equation (3). Thus, if estimates of equation (3) reveal that coefficient a5 is not significantly different from zero, the KN approach would appear to be favoured.

The inclusion of a price expectations term gives the equation the "forward-looking" flavour commonly associated with a Phillips curve interpretation of the wage formation process. But even a significant coefficient on E(PDOT) would not be sufficient to make equation (3) valid as a PC approach. The problem concerns the appearance of the lagged level of wages on the right-hand side of the equation. As described in Part 1, the PC approach should give an ever-increasing level of wages and a positive rate of wage inflation following a permanent increase in labour-market tightness. If the lagged level of wages is included as an explanatory variable, however, wage inflation will return to zero in the long run. In other words, an equation such as

$$\Delta \log(W) = f(LMT) - \gamma \log(J1L(W))$$

is indistinguishable in the long run from log(W) = f(LMT), our KN formulation. Thus, if a PC hypothesis is supported by the data, the lagged nominal wage term should not be significant.[5]

In Technical Report 11, Wurzburger used the RDX2 data base to estimate a form of equation (3) over the period 1Q57 to 4Q75.[6] He found that coefficient a4 was large and significant, and that a5 was not significantly different from zero. His results therefore favoured a KN interpretation of the wage determination process.

In passing, it is interesting to note two points with respect to Wurzburger's equation. First, the estimated coefficient on lagged wages (a4) was larger than the estimated coefficient on prices (a1). In fact, the long-run (equilibrium) elasticity of wages with respect to prices was only 0.57. Money illusion was clearly indicated. Second, it was not felt that Wurzburger's results justified the exclusion of a PC interpretation from further consideration. His failure to obtain a significant coefficient on inflationary expectations could have been due to collinearity between E(PDOT) and the lagged price level term. It may also have been due to his estimation period, which included only a few of the years during which inflation has been so "visible". Inflationary expectations were simply not important in wage bargaining during the 1950s and 1960s, and recent studies tend to confirm this.

Freedman (1976) for example, estimated a wage equation over two sub-periods of his total sample and found that the price expectations term had a larger and more significant coefficient in the regressions over the more recent period. Similar results are reported in Auld et al (1979) and elsewhere.

2.3 The RDX2 Wage Equation

The wage equation that appears in RDX2 is described in detail in Wurzburger (1976). Essentially, the equation is just a modified version of Wurzburger's KN equation, (equation number (6)):

$$\Delta \log(W) = c0 - c1*\log(J1L(W/P)) + c2*\log(J1L(q)) + c3*LMT \tag{7}$$

The price level (P) and productivity (q) are both lagged because of the assumption that wage bargainers are unaware of current conditions. More importantly, however, note that the coefficients on lagged wages and prices are constrained to be equal. The RDX2 equation is, in fact, a "Real Wage" equation, with no allowance for money illusion. Wage levels catch up completely to price level changes in the long run. This is interesting because the estimates just cited for Wurzburger's general specification had indicated that money illusion <u>was</u> important.

As for the specific variables that appear in the RDX2 equation, some deserve additional discussion. For P, Wurzburger prefers the consumer price index (PCPI) because it is mentioned much more than any other deflator in actual wage negotiations, and because cost-of-living (COLA) clauses are usually expressed in terms of it. Further, he reports that PCPI performed better statistically in the equation than did PGNE in that it gave a larger corrected R-squared.

For productivity, Wurzburger did not use actual values for output per worker, but tried to come up with a specification that represented bargainers' expectations regarding equilibrium output per worker. He did this with two terms. The first reflects the simple belief that equilibrium output per worker grows exponentially at a constant rate per quarter. This constant-growth-rate term is represented by the "long-run labour efficiency factor", ELEFF. A more sophisticated model however, would allow for the fact that productivity increases might deviate from a simple growth path owing to changes in the capital to output ratio, i.e., the "capital intensity" of production. This is captured in a second term, UGPPA/NMMOBD, where UGPPA is a constructed measure of output, generally regarded as being an indicator of aggregate demand.

In addition, the RDX2 equation contains two terms that are necessary because the available data for W are not basic hourly wage rates, but rather, they are "average quarterly earnings". Because of this, fluctuations from quarter to quarter in hours worked will be an important determinant of changes in W. Also, because new employees are typically paid less than experienced workers, changes in the level of employment from quarter to quarter may have an important impact on average earnings.

The equation described above was originally fitted for the period

1Q57 to 4Q72. I recently re-estimated it over a later time period (2Q61 to 4Q75) using the RDXF data base. The details are reported in Merrett (1979). Although I used the same terms as Wurzburger had employed in the original RDX2 equation, my estimated parameters were very different. Four of the terms - the constant, the short-run productivity term, the LMT variable, and the change in employment term - had insignificant coefficients, and the latter two even had the wrong signs. In other words, the original RDX2 specification performs extremely poorly when fitted to more recent data.

In an attempt to improve the equation, I tested alternative specifications of the LMT and productivity terms and tried deleting some of the insignificant variables. Two measures of labour-market tightness performed better than the original RDX2 variable ((NMMOBD-NMMOBS)/NMMOBS), but only slightly so. These were the variables WURZ and RUJP (defined on page 10). I found no short-run productivity term that could consistently outperform the RDX2 variable (UGPPA/NMMOBD), and satisfactory equations were only obtained with UGPPA/NMMOBD when the long-run labour efficiency factor (ELEFF) was left out. When ELEFF was included, neither the short-run productivity term nor the labour-market tightness variable was significant.

2.4 Some Phillips Curves

Since the RDX2-style of Keynesian equation does not perform satisfactorily with more recent data (even when different measures of LMT are used), let us turn to a consideration of some Phillips curve specifications.

(a) Freedman's Estimates

Charles Freedman used an expectations-augmented Phillips curve in his 1976 paper, (i) to test a number of corrected vacancy and unemployment rate measures, as mentioned earlier, and (ii) to estimate the natural rate of unemployment, as will be discussed in Part 4. Freedman's equation had the following form:

$$\Delta \log(W) = c0 + c1*(LMT) + c2*E(PDOT) + c3*Z \qquad (8)$$

where

LMT refers to a measure of tightness in the labour market,

E(PDOT) refers to expected price inflation, and

Z represents a vector of "other variables" that may be important in the wage determination process.

In addition to actual vacancy and unemployment rates, Freedman tested his series of corrected measures of labour-market tightness. (The development of these measures is examined more fully in Appendix B.) Freedman noted that many other specifications for the LMT variable are suggested in the literature. He tried the change in the unemployment rate and the level of the unemployment rate (rather than its inverse) but neither gave results that were as good as his corrected measures. He also tried lagging his various measures, but found that this reduced their significance as explanatory variables.

Expected price inflation was modelled by a 12-quarter distributed lag on past rates of price inflation as measured by changes in the consumer price index. Freedman tried using the deflator for gross national expenditure (PGNE) in place of PCPI, but found that it eliminated the significance of his LMT variables.

Some of the "other variables" that Freedman tested included the rate of change in hours worked, the profit rate of the corporate sector, the rate of change in corporate profits and the rate of change in productivity. Only the hours term was found to be a useful addition. This term is important (as discussed earlier) because aggregate wage data in Canada are in fact for average weekly or quarterly earnings, and not basic hourly wage rates.

(b) Merrett's Estimates

In my 1978 study I estimated expectations-augmented Phillips curves that had a basic form identical to that of equation (8), but with a few differences in the details.

For labour-market tightness, I used two measures that were provided for me by J.P. Aubry: RUJP, defined earlier as U-RNAT, and an "inverse" or non-linear measure, defined as RUJPI = (1/U)-(1/RNAT).

I modelled expected price inflation with the usual distributed lag on past inflation rates, with lengths varying from 8 to 16 quarters. As Freedman had done, I tested both PGNE and PCPI as the price variable, but did not encounter the same difficulties he had experienced with PGNE; the substitution of PGNE for PCPI had almost no effect on the coefficients for my LMT variables. In fact, the equations with PGNE might even be regarded as superior in that they had larger corrected R-squareds than the equations with PCPI.

For other variables, I tested a change in hours worked term, a change in employment term and a dummy variable for the period of wage and price controls administered by the Anti-Inflation Board (AIB). As had occurred with Freedman's equations and the RDX2 estimates discussed earlier, the hours term entered strongly. The change in employment term, used in RDX2 to capture the institutional fact that new workers are paid less than experienced workers, was not significant and had the wrong sign. The AIB dummy was included because my estimates extended from 1961 through to the fourth quarter of 1977, thus covering two years of the controls programme. Freedman did not include such a variable because his estimates stopped in 1975.

The following quarterly equations are a sample of the results I obtained. The t-statistics are in parentheses.

$$\Delta\log(W) = \underset{(8.1)}{.00753} - \underset{(2.8)}{.00182}\ RUJP + \underset{(10.9)}{0.995}\ E(CPDOT) - \underset{(2.4)}{.00486}\ QAIB + \underset{(3.9)}{0.339}\ (\Delta\log(HRS)) \qquad (9)$$

$$D.W. = 1.46 \qquad \bar{R}^2 = 0.77$$

$$\Delta\log(W) = \underset{(8.0)}{.00720} + \underset{(2.3)}{.0333}\ RUJPI + \underset{(10.4)}{0.939}\ E(GPDOT) - \underset{(2.7)}{.00696}\ QAIB + \underset{(3.9)}{0.318}\ (\Delta\log(HRS)) \qquad (10)$$

$$D.W. = 1.66 \qquad \bar{R}^2 = 0.80$$

Here, RUJP and RUJPI are the labour-market tightness variables described earlier, so the signs on the coefficients are correct. E(CPDOT) is an inflationary expectations term generated by an 8-quarter distributed lag on PCPI, while E(GPDOT) is generated by a 12-quarter distributed lag on PGNE. QAIB is the dummy for the controls period, and has the value "1" starting in 1Q76 and the value "0" before that. The size of the coefficients on QAIB suggests that during the controls period, wage increases were held below what they otherwise would have been by approximately 2 percent per year.

(c) The RDXF Wage Equation

The current (December 1979) wage equation in the Research Department's forecasting model is an expectations-augmented Phillips curve:

$$\Delta\log(W) = \underset{(3.2)}{.00655} - \underset{(1.8)}{.00254}\,RUJP + \underset{(6.3)}{0.971}\,E(PDOT)$$

$$- \underset{(2.5)}{.00922}\,QAIB + \underset{(1.8)}{0.307}\,(\Delta\log(HRS)) \qquad (11)$$

$$D.W. = 1.67 \qquad \bar{R}^2 = .492$$

The form of this equation is almost identical to that of equation (9), but it was estimated over a shorter period (starting in 1964 rather than 1961). There were also two important differences in specification. First, the wage variable used was WNIC, a constructed series based on data for all establishments in the industrial composite, rather than WAWEA, the Statistics Canada series based on a survey of only those establishments with 20 or more employees. Second, a product price index (PGPP) was used as well as PCPI for the generation of expected price inflation; specifically, E(PDOT) was a 12-quarter distributed lag on the following variable:

$$(\Delta \log(J1L(PCPI)))*(PGPP/PCPI)$$

Note that these modifications made quite a difference in the estimation results. The coefficients on labour-market tightness (RUJP) and on QAIB are substantially larger than those in equation (9), and are larger than the corresponding parameter estimates typically obtained in other studies. It is generally agreed that the data for small establishments tend to be erratic, a fact that should be kept in mind when considering the reliability of the WNIC series.

Since the RDX2 specification had performed so poorly when estimated over different periods, it was thought advisable to try a stability test on a Phillips curve specification. Thus, a Chow test was performed on the RDXF equation, with the sample being split at 1971. The results indicated that the estimated coefficients for the two sub-periods were not significantly different.

3 WAGE EQUATION DYNAMICS

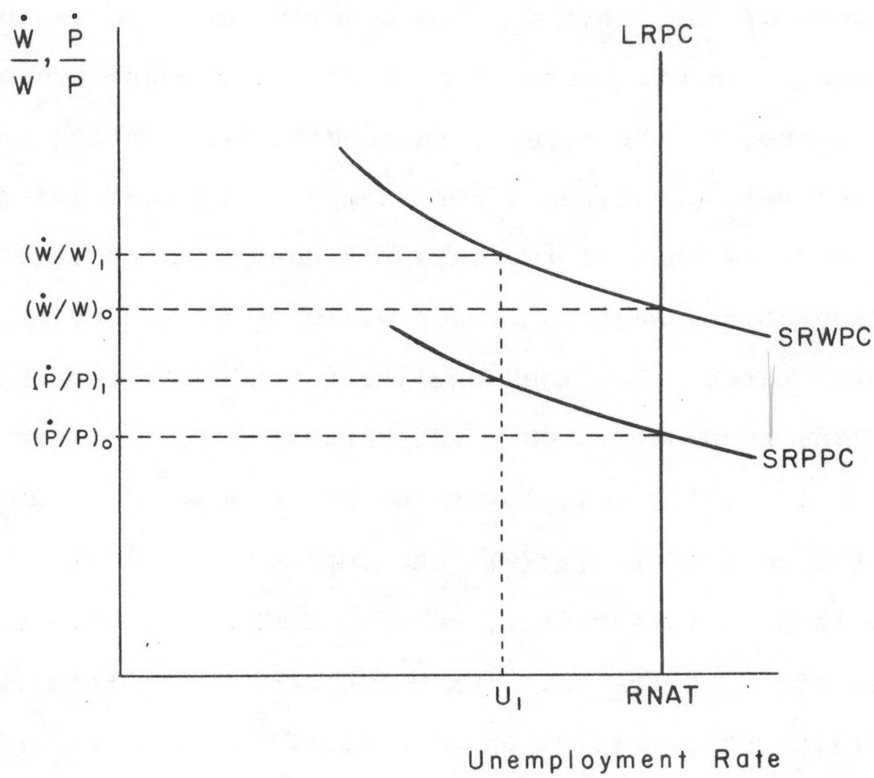
3.1 The Phillips Curve

The question of whether the wage equation is examined in isolation or whether the feedback through prices is made endogenous is crucial to the dynamics of the Phillips curve. The distinction between the short run and the long run is also important.

When we speak of the short run, we usually mean the response of wages to a change in labour-market tightness. The magnitude of this response is indicated by the size of the coefficient on LMT in the various estimated wage equations. For example, the coefficient from equation (9) indicates that if the measured unemployment rate increased by one percentage point, wage increases would be slowed by around .75 percent at annual rates. For the non-linear trade-off represented by equation (10), the response is only .25 percent for unemployment rates around the natural level. This lower number is generally supported by the studies cited in Riddell (1979), and implies a short-run "wage" Phillips curve that is rather flat, such as SRWPC in Figure D.[7]

The nature of the price Phillips curve depends on both the mechanism of price determination and the coefficient on expected price inflation in the wage equation. It is usually assumed that the price equation is homogeneous in nominal costs; in other words, the markup is roughly constant. If wage costs are the sole element of costs (or if other costs rise proportionately to wages) and if it is assumed (i) that productivity grows at a constant rate over time, and (ii) that there are no lags in the pass-through of costs, then the short-run trade-off between prices and unemployment (SRPPC in Figure D) will be parallel to the short-run wage Phillips curve, but below it by the amount of constant productivity growth.

Figure D



In a Phillips curve wage equation, the long-run feedback of prices onto wages is indicated by the coefficient on expected inflation. If the price equation is homogeneous, then a long-run trade-off between wages and unemployment is only possible if the coefficient on E(PDOT) is less than one. Conversely, if that coefficient is one, the long-run Phillips curve is vertical at unemployment rate RNAT (corresponding to LRPC in Figure D). The mechanism can be easily explained. Both short-run curves in Figure D are drawn for a certain level of price expectations. Suppose that we start from a position of equilibrium where the unemployment rate is RNAT, and expected price inflation corresponds to the actual value of $(\dot{P}/P)_0$. If unemployment is lowered to U_1, this will result in a rise to $(\dot{W}/W)_1$ in the rate of wage inflation and a rise to $(\dot{P}/P)_1$ in the rate of price inflation. But workers' price expectations will then no longer correspond to the actual rate, so SRWPC will eventually shift up by the amount of the discrepancy. This new curve (not shown) will give an even higher rate of wage increase at unemployment rate U_1, which will lead to higher price inflation, and so on. Thus, when the linkages via prices and price expectations are accounted for, any rate of unemployment lower (higher) than RNAT will produce ever-accelerating (-decelerating) inflation.

In all my Phillips curve estimations with an 8-quarter lag on PCPI, I obtained coefficients that were less than one standard error from 1.0. When more than 8 quarters were used, the size of the coefficients increased. Freedman (1976), using 12-quarter distributed lags, obtained coefficients that were consistently greater than one, but always within two standard errors of it. Most of the studies quoted in Riddell (1979) also report coefficients on price expectations that do not differ significantly from one, and those that do, contain "catch-up" terms as well as the E(PDOT) term. As for studies done at the Bank, only in some estimations using PGNE as the price variable (see Merrett (1978) and Aubry et al (1979)) did the coefficients fall significantly below one. The majority of the evidence therefore, supports the idea of a vertical long-run Phillips curve at the natural level of tightness in the labour market (indicated in Figure D by RNAT). The estimation of RNAT will be the subject of Part 4 of this paper.

3.2 Another Look at The "Two Basic Approaches"

It was suggested In Part I that the Keynesian and Phillips curve wage equations implied different responses to changes in labour-market tightness. Specifically, an increase in LMT would lead to an increase in the level of nominal wages with a Keynesian equation (such as equation (1) on page 3), and to an increase in the rate of change in nominal wages with a Phillips curve (equation (2)). It should be clear from the discussion in the preceding section, however, that the dynamics of wage equations cannot be examined independently of price determination and price expectations.

In Bank of Canada Technical Report 8 (1977) Charles Freedman used three different wage equations and two types of price equations to explore this situation. His wage equations included: (i) an expectations-augmented Phillips curve with no money illusion; (ii) an expectations-augmented Phillips curve with money illusion; and (iii) an RDX2-style of "Real Wage" equation. These can be represented with symbols as follows:

(i) and (ii): $$\Delta\log(W) = c0 + c1*(LMT) + C2*E(PDOT) \qquad (12)$$

(iii): $$\Delta\log(W) = b0 + b1*(LMT) - b2*LOG(J1L(W/P)) \qquad (13)$$

where, as before,

LMT represents tightness in the labour market, and

E(PDOT) is a distributed lag on past rates of inflation.

Freedman noted that the E(PDOT) term could be interpreted as representing either inflationary expectations <u>or</u> catch-up. The difference between (i) and (ii) in equation (12) would be the size of the coefficient c2: money illusion would be evidenced by c2 being less than one. Equation (13) represents the RDX2 equation if we omit the institutional terms and assume that productivity changes are zero.

The long-run price equation was assumed to take the following form:

$$\log(P) = a0 + a1*\log(W). \tag{14}$$

Here, whether the coefficient a1 is equal to one or less than one indicates whether complete or incomplete markup (i.e., a homogeneous or non-homogeneous price equation) is being assumed. The idea of a homogeneous equation is theoretically more appealing since it implies that profit margins are not eroded in the long run by cost increases. However, the non-homogeneity property shows up frequently in estimated price equations. In RDX2, for example, the estimated elasticity of the consumer price index with respect to total costs is only 0.87. Freedman examines both alternatives in Technical Report 8, and even considers two different possibilities for the complete markup alternative - one in which the recovery of cost increases occurs immediately, and one in which a lag is involved.

The results of Freedman's simulations blur the distinction that was made earlier regarding the fundamental difference between a Keynesian and a Phillips curve specification. Depending on the form of the price equation, the two can produce similar dynamics. If the price equation is homogeneous, a permanent shock to unemployment produces a higher rate of inflation even with an RDX2 equation, rather than just a higher level of wages and prices - an identical result to that obtained for a Phillips curve with money illusion. If the coefficient on E(PDOT) is equal to one, however, the result is an accelerating rate of inflation.

If the price equation is not homogeneous, then the unemployment shock will lead to higher inflation (but not acceleration) for either form of Phillips curve, but only to higher levels of wages and prices with the RDX2 equation. These are the results that were suggested by Figures A and B.

Freedman's simulation results can easily be confirmed analytically. The long-run solution requires that E(PDOT) = $\Delta \log P$. So, by combining equations (12) and (14) and solving for $\Delta \log W$, we get

$$\Delta \log(W) = \frac{1}{(1-c2*a1)} (c0 + c1(LMT)). \tag{15}$$

There is a long-run trade-off between wage change and LMT only if either c2 or a1 is less than one (since each is bounded by unity). If there is no money illusion and prices are homogeneous, then accelerating inflation obviously results from permanent labour-market tightness in excess of the natural level.

For the RDX2 case, the combination of equations (13) and (14) will give, if the price equation is homogeneous, (i.e., if a1=1):

$$\Delta \log(W) = (b0 + b2*a0) + b1(LMT) \tag{16}$$

while an equilibrium wage level will result in the long run if the price equation is not homogeneous:

$$\log(W) = \frac{1}{b2(1-a1)} [(b0+b2*a0) + b1(LMT)]. \tag{17}$$

The simulation results obtained by Freedman with a foreign price shock (during which labour-market tightness was maintained at its natural level) are also of interest. For the non-homogeneous price equation, all three wage equations gave only a new level of wages and prices. For the homogeneous price equation, both the RDX2 equation and the Phillips curve with no money illusion produced a higher rate of inflation, while the Phillips curve with illusion produced only a higher level of wages and prices.

It is interesting to note that the nature of the simulation results is often identical for the RDX2 equation and for the vertical Phillips curve. It would appear that, depending on the price equation, continuing inflation (a wage-price spiral) can result from either a KN or a PC wage specification. This conclusion justifies Freedman's contention that wage equations must be analyzed in the context of a "model" in order for their dynamics to be fully revealed. However, it should also be emphasized that these results do depend on the special nature of the RDX2 equation. As a "Real Wage" specification, the RDX2 equation simply does not permit any permanent erosion in real wages. A KN specification that would allow for some money illusion would not have led to a similar wage-price spiral. Freedman's study was perhaps incomplete in omitting this type of wage specification.

4 ESTIMATION OF THE NATURAL RATE OF UNEMPLOYMENT

Two different approaches can be taken in the estimation of the natural rate of unemployment, and these are dealt with separately in the sections that follow.

4.1 Method One: Quantifying the Demographic Changes

The natural rate of unemployment (RNAT) supposedly represents that level of unemployment that corresponds to "full employment" in the economy. In other words, it embodies all those causes of unemployment that are not directly attributable to insufficient aggregate demand. Some economists do not like the expression "natural rate" of unemployment because they believe that it gives two impressions that are fundamentally incorrect. First, the phrase has a normative sound to it, since the word "natural" conveys the meaning of good or socially optimal. Alternatively, it could give the impression of being a level of unemployment that must be accepted as given, in the sense of representing some irreducible lower limit. This, of course, is not the case. The natural rate of unemployment is determined by structural conditions in the labour market, and it will change over time as structural changes occur. Developments such as the increased participation in the labour force by women and youths and the declining importance of agricultural employment have been important factors recently. So, too, have legislated changes in minimum wages and unemployment insurance.

A description of the first method for estimating RNAT follows logically from the discussion thus far. First, one should choose some year when the economy seemed to be operating at full employment. The measured rate of unemployment at that time is presumed to be the natural rate for that period. As just suggested, however, the RNAT for today would probably be somewhat different due to various demographic and policy changes that have occurred. To determine what today's RNAT is, one must estimate the extent to which each of these changes has affected the measured rate of unemployment.

This approach is certainly evident in the 1976 studies by O'Reilly and Freedman. They were concerned with developing a corrected unemployment rate in order to reflect more accurately the degree of tightness in the labour market. They did this by purging the measured unemployment rate of the structural changes that were thought to have taken place. Their corrected measure of unemployment for any particular quarter, however, was not an estimate of RNAT. Rather, it represented the natural (and actual) rate of unemployment in their base year (1965-66) plus the amount of current unemployment that was due to deficient aggregate demand. Some hypothetical numbers should serve to clarify this. Suppose that the current unemployment rate is measured at 7.5 percent, but when "corrected", it comes out to be 4.5 percent. If this number (4.5) is compared to the 4 percent rate of unemployment which prevailed during their base period, it would imply that the economy was currently operating at slightly less than full capacity.

The logical extension of this, of course, is to say that if 3 percentage points of today's measured unemployment rate are due to the structural changes that have occurred since 1965-66, then RNAT today must be 7 percent (i.e., 3 plus 4). However, neither Freedman nor O'Reilly actually make this final calculation. Instead, Freedman estimates RNAT using the second method, to be discussed below.

One estimate of RNAT derived from this first method is that of Kierzkowski (1977). He begins with the premise that measured unemployment must equal the natural rate of unemployment plus (or minus) deviations from the natural rate. In a Keynesian framework, these deviations might be regarded as the result of deficient or excess aggregate demand, but Kierzkowski justifies their existence on the basis of a divergence in expectations between workers and firms. He specifies an equation with the measured rate of unemployment as the dependent variable, and the following explanatory variables: the proportion of the labour force made up of women (SF); the proportion of the labour force made up of youths (SY); several terms for unemployment insurance benefits and coverage and, finally, a term designed to capture cyclical deviations from RNAT. When he estimated the equation, he found that it explained the behaviour of the dependent variable fairly well, but that in terms of individual parameters, the only variable that had a significant impact on RNAT was the proportion of the labour force that was composed of females (SF)! This result led him to the following simple equation which could be used to calculate RNAT at any point in time:

$$RNAT = -0.052 + 0.335*SF \qquad (18)$$

With this equation, Kierzkowski obtained an estimate for RNAT of

6.5 percent for 1975. If labour force statistics for 1979 are used to determine SF, equation (18) gives an estimate for current RNAT equal to 7.2 percent.

Perhaps a note of caution is necessary here before one places too much faith in this equation. Kierzkowski himself points out that SF displays a very strong time trend. In fact, an almost identical series for RNAT can be generated by expressing it as a linear function of time. Thus, it is doubtful that increased participation by women in the labour force is the sole cause of the upward movement in RNAT. Most other studies (such as those to be considered in Section 4.2) suggest that revisions to the Unemployment Insurance Act are at least as important as any demographic changes.

4.2 Method Two: Locating the Long-run Phillips Curve

In terms of Figure D (page 26), this approach is basically an attempt to determine exactly where LRPC intersects the horizontal axis. In other words, what is the rate of unemployment where, if expected and actual inflation rates were equal, inflation would neither accelerate nor decelerate?

One possible approach is to take an estimated wage equation (such as number (8) on page 20) and solve it for the level of LMT where expected and actual PDOT are equal and are less than $\Delta\log(W)$ by the assumed rate of productivity growth. This level of LMT then simply has to be converted into its corresponding rate of unemployment in order to produce an estimated RNAT. Freedman uses this method in his 1976 paper, and comes up with a value of 7.2 percent for 4Q75.

Obviously, though, this particular estimate (or any other done in this manner) depends critically on the rate of growth of productivity that is assumed. Freedman used 3 percent. He points out that if a value of less than 3 percent had been used, his estimated RNAT would have been greater than 7.2 percent.

Freedman discusses two ways of getting around this problem of having to assume some value for the average rate of productivity growth. One method would be to bypass the productivity "link" between wages and prices by regressing wages on wages, or prices on prices, rather than wages on prices as in equation (8). For example, one could use a specification where the change in prices was the dependent variable, while labour-market tightness (LMT) and some function of lagged price changes (E(PDOT)) were the explanatory variables. Freedman obtained RNAT estimates of around 8 percent when he tried this approach. A second way to circumvent the problem, and the one actually preferred by Freedman, involves the use of a simple two-equation wage-price model. After first specifying a price equation, it is "solved" simultaneously with the wage equation to determine the equilibrium LMT (and thus, the natural rate). Freedman prefers this approach because he feels that a simple regression of prices on prices overlooks some variables that should possibly be included. In other words, the true structural equation for prices might include such factors as foreign prices and the exchange rate in addition to wages, productivity and market tightness. These extra variables can be included more easily when the price equation is specified separately as a structural equation, before it is combined with the wage equation in a wage-price model. When Freedman actually used this method to estimate RNAT, however, he obtained values of nearly 10 percent (which he felt to be implausibly high).

In a recent paper, P. Fortin and L. Phaneuf (1979) used a three-step approach very similar to Freedman's. First a corrected measure of labour-market tightness was constructed. Then a price Phillips curve was estimated from the solution of a two-equation wage-price model. Specifically, they regressed the rate of change in prices on: productivity, expected rates of price increase, their measure of labour-market tightness, the ratio of the minimum wage to average hourly earnings in manufacturing, terms for a variety of characteristics of the unemployment insurance system, various rates of taxation, and a dummy variable for the period of wage and price controls. When they had determined that their Phillips curve was vertical - i.e., that the sum of the coefficients on expected price inflation did not differ significantly from one - they proceeded to the third step. This involved calculating the "equilibrium" value of the constructed labour-market tightness variable and then translating it into a corresponding rate of unemployment. They obtained estimates of about 6.6 percent for most of the 1975 to 1978 period. This number, they suggest, may now be moving down, owing to the slowing of the "demographic tide", the stabilization of provincial minimum wages, and more severe restrictions on access to unemployment insurance and the benefits received from it.

Another recent attempt to estimate RNAT was done in the Research Department of the Bank by Aubry, Cloutier and Dimillo. They followed the approach of regressing prices on prices, using a Phillips curve of the following form:

$$\Delta \log(P) = c0 + c1*(GAP) + c2*E(PDOT) \qquad (19)$$

The GAP variable was a measure of the degree of tightness in the <u>product</u> market. Specifically, it indicated whether the economy was performing above, on, or below a trended average growth path. A 12-quarter distributed lag on PGNE was used to generate E(PDOT). However, whether a quarter to quarter <u>or</u> an annual inflation rate was used, they obtained a coefficient on this inflationary expectations term that was significantly less than one. Nevertheless, since a vertical long-run Phillips curve is necessary for an estimate of the natural rate of unemployment, they constrained the coefficient on E(PDOT) to be equal to one in order to carry on with their work. They solved equation (19) for the equilibrium value of product-market tightness (GAP) and then converted this value into a corresponding rate of unemployment. This conversion was done on the basis of an estimated Okun's law, a relationship which relates changes in the level of unemployment to changes in the aggregate level of economic activity. Their estimated Okun equation had the following form:

$$U = b0 + b1*(GAP) + b2*Z \qquad (20)$$

where U was the measured unemployment rate and Z was a vector of possible variables which could, over time, have shifted the basic structural relationship between U and GAP. Among the factors included in Z were: the ratio of maximum unemployment insurance benefits to the average weekly wage; participation rates and shares of women and youths in the labour force; a linear time trend, and dummy variables to mark the moments in time when revisions were made to the Unemployment Insurance Act. Their results, however, indicated that the unemployment insurance revision dummies alone were sufficient.[8] Their actual estimate of the total impact on RNAT of all unemployment insurance changes since 1953 was 3.2 percent, a number that was virtually identical to that reported by O'Reilly (1976). Their estimate of RNAT for the 1970s was 7.0 percent.

5 SUMMARY AND CONCLUSIONS

The purpose of this paper was to survey recent work on the wage equation, with particular emphasis on studies that were done at the Bank of Canada. These papers included both theoretical and empirical work using two different perspectives of wage determination. Ben Wurzburger termed these the "Keynesian" and the "Phillips curve" approaches, and in Technical Report 11, he came out in favour of a Keynesian interpretation. However, more recent studies (done not only here at the Bank, but elsewhere as well) have favoured some variation on a Phillips curve approach.

Although complete agreement is never reached in a discussion of economic issues, the evidence presented in this paper does point to a few important areas where agreement seems widespread. The discussion in Section 2.1(a), for example, emphasized that neither the measured over-all unemployment rate, nor even the rate for adult males, is adequate as an indicator of tightness in the labour market. Their usefulness seems to have been eroded, primarily since the mid-1960s, by various demographic factors and legislated policy changes. The suggestion that there has been a breakdown in the underlying structural relationship between excess demand in the labour market and the measured rate of unemployment is clearly related to the augmented Phillips curve notion that there has been a shift in the natural rate of unemployment. A number of papers have made efforts to estimate the natural rate in Canada, and several of these were discussed in Part 4. Although there were two different approaches used in the actual calculation of RNAT, and although there were substantial differences in what the various authors concluded were the crucial factors determining it at any point in time, there seems to be some consensus that RNAT in Canada in recent years has been around 7 percent.

The idea of a natural rate carries with it the implication that there is no possibility for trade-offs between inflation and unemployment in the long run. In the short run, owing to policy or external shocks, it is possible to observe deviations from the natural rate of unemployment. These shocks cause actual economic conditions to vary from what people had expected, moving the economy away from its "steady state". As expectations are revised to be again consistent with reality, the economy will move back towards the natural rate. Here, two points should be emphasized: (i) The empirical evidence suggests that the short-run Phillips curve is relatively flat, implying that if traditional demand-management policies are used in the fight against inflation, dramatic short-run results should not be anticipated. If inflationary expectations are truly formulated as a weighted average of past inflation rates, then expectations (and therefore inflation) will be quite slow to move to lower levels. However, it seems likely in practice that expectations are formed more rationally than is suggested by the simple adaptive expectations mechanism assumed in most of the studies discussed in this paper. Thus, it is possible that even though actual inflation may only fall slowly at first in response to restraints on macroeconomic activity, people may quickly reduce their inflationary expectations if they have confidence that the government's policies have prospects for continuing success. In this event, the reduction in inflation emanating from demand-management policies could be substantially greater than just implied. (ii) The second point to note is that the natural rate of unemployment is not something that is fixed or immutable. The rate of unemployment associated with non-accelerating inflation can increase or decrease over time. It has increased since the mid-1960s owing to various demographic factors and government policies, but it is believed that the demographic influences are now beginning to stabilize. This, combined with appropriate government policies, could soon reverse the upward trend in the natural rate. In other words, although long-run trade-offs between inflation and unemployment are not possible through traditional demand-management or macro tools, policies that concentrate on the micro level (to improve the functioning of the labour market, for example) may be successful in reducing that rate of unemployment that is consistent with a stable rate of price inflation.

Freedman's Technical Report 8 was possibly one of the most important studies reviewed in this paper because of its demonstration that a complete description of wage behaviour ultimately depends on the price equation. For example, it was shown that if firms and workers have no money illusion, a wage-price spiral could result from either a Phillips curve or a Keynesian wage equation. Specifically, if the price equation is homogeneous (reflecting complete markup), then either a Phillips curve with a coefficient on expected price inflation equal to one, or an RDX2-style of Keynesian equation (where real wages cannot be eroded) would result in continuing inflation following an exogenous shock.

APPENDIX A

STRUCTURAL CHANGES IN THE LABOUR MARKET

This Appendix briefly examines some of the changes in the labour market that have contributed to the breakdown in the basic relationship between demand and measured unemployment or vacancies. Both legislative and demographic factors have figured in this breakdown.

On the legislative or policy side, the liberalization of unemployment insurance benefits and regulations in 1968, and more importantly, in 1971, has reduced the "costs" to an individual of being unemployed. This has led to: (i) an increased amount of time spent by the unemployed in search activity, since there is less immediate pressure for them to accept a given job offer; (ii) an increase in labour-force participation by "secondary" workers, since the improved unemployment insurance benefits and easier qualification standards serve to raise the effective wage they receive from work; and (iii) an extra inducement for some employed people to become unemployed. (Note that this last factor need not be voluntary on the part of the worker. Improved unemployment insurance benefits may have contributed to an increase in the seasonality of some occupations, as employers find it easier, in terms of their own consciences and in terms of opposition from employees and unions, to lay off redundant workers.)

On the demographic side, there has been a significant increase in the proportion of the labour force that is comprised of young people and women, and a corresponding decrease in the proportion made up of adult males. (Specifically, in 1960, 60 percent of the labour force was made up of males 25 years of age and older. By 1978, this number had fallen to only 47 percent). Several factors have contributed to this turnabout: (i) the "coming of age" of the large number of young people born during the baby boom of the 1940s and 50s; (ii) the trend towards earlier retirement among older male workers; (iii) the increased desire on the part of women to have their own careers; and (iv) the desire of family units to have additional bread-winners in order to improve or maintain their standards of living. This change in labour force proportions has been important in at least two respects. First, to the extent that women and young workers are not perfect substitutes for adult males, there may be more "structural" unemployment in the labour market due to greater difficulty in matching available workers to available jobs. (Whether or not it is true that women and young people are less than perfect substitutes for adult males is not important as long as employers believe that it is true.) Second, since women and younger workers have higher unemployment rates than adult males, their presence in increased numbers in the labour force may not only cause higher levels of over-all unemployment, but will produce greater dispersion or variability in unemployment as well. (This increased dispersion is a concern because it will impart an upward bias to wages if the relationship between wage increases and unemployment is not linear.)

In addition to the policy and demographic factors discussed above, other structural changes that have been occurring in the economy have also contributed to an alteration in the perceived relationship between demand and unemployment or vacancies. Specifically, the persistent decline in the importance of the agricultural sector, in which unemployment is traditionally very low, has tended to have consequences for the unemployment rate similar to the demographic factors just discussed.

APPENDIX B

THE U-V RELATIONSHIP: CORRECTING THE MEASURED RATES

Some evidence was given in Section 2.1 suggesting that it has been the U part of the U-V relationship that has broken down over time. Brian O'Reilly and Charles Freedman reached this same conclusion in their 1976 papers. (As mentioned earlier, their studies followed previous work done by Meltz and Reid.) They began by constructing corrected vacancy and unemployment rates by eliminating from the actual measured rates the effects of the changed structural factors. To do this for the unemployment rate, for example, the following equation was estimated:

$$U = c0 + c1*(1/V) + c2*\Delta(1/V) + c3*SAG + c4*K + c5*SY + c6*SFA + c7*VARDEM \quad (A1)$$

where

c0 to c7 are the estimated coefficients,

U is the measured over-all unemployment rate,

V is the measured vacancy rate,

SAG is the proportion of the labour force employed in the agricultural sector,

K represents unemployment insurance benefits as a proportion of the average weekly wage,

SY is the proportion of the labour force comprised of youths (i.e., males and females 15-24 years of age),

SFA is the proportion of the labour force comprised of adult females, and

VARDEM is a weighted measure of the dispersion of the demographic unemployment rates around the "average".

Next, it was necessary to select an appropriate base year for values for the independent variables. The years 1965 and 1966 were chosen since they seemed representative of conditions of full employment (measured unemployment then being around 4 percent). Then, by using the estimated coefficients from equation (A1), the corrected unemployment rate at time t (1974 for example) could be determined by removing from the measured 1974 unemployment rate the changes in the independent demographic and policy variables from their values in the base year, each multiplied by its respective coefficient.

Three other specifications were estimated in addition to equation (A1) and the coefficients were used to specify alternative corrected measures of unemployment. In one instance, the variable K (the ratio of unemployment insurance benefits to the average wage) was replaced by a transitional shift dummy, Z, and the corrected unemployment rate determined from this was labelled UZ*. The other two specifications omitted the demographic variables (SY, SFA, VARDEM), relying only on

SAG and either K or Z to explain the U-V shift. Corrected unemployment rates from these were labelled UBK* and UBZ* respectively.

A procedure identical to that described above was used to obtain corrected vacancy rate measures. (The equation analogous to number (A1) would therefore have had V as the dependent variable (rather than U), with U appearing in place of V in the terms on the right-hand side.)

In all, ten measures of excess demand in the labour market were tested in a wage equation and their performances compared. The ten alternatives included the measured unemployment and vacancy rates as well as each of their four purged forms. Freedman found that the three measures with the greatest explanatory power were, in order, V, 1/UBZ* and 1/UBK*. Note that the uncorrected vacancy rate (V), was the best measure, followed by the two simpler corrected unemployment rates. These results unambiguously support the conclusion that the shift in the U-V curve in the 1970s was due to a change in the relationship between excess demand in the labour market and measured unemployment, rather than the relationship between excess demand and vacancies.

APPENDIX C

FINAL REMARKS AND CRITICISMS; AREAS FOR FURTHER WORK

Several issues came to my attention during the preparation of this survey. Some of these deal with possible shortcomings in the various papers we have produced at the Bank. At the very least, they emphasize the fact that much more work can still be done on the process of wage determination.

For example, equations (1) and (2) (on page 3) specify a nominal variable (wages) in terms of a real variable (some measure of tightness in the labour market). The implication of this is that a change in aggregate demand causes a change in LMT and this leads to a change in nominal wages. In other words, real or quantity adjustments precede nominal or price adjustments. Some explanation of the "stickiness" in prices or wages would seem to be called for. A fundamental answer would no doubt focus on the existence of transactions costs, and the fact that many wage changes are locked in by institutional factors such as contracts. There has been a dramatic <u>increase</u> in the length of the average contract in Canada since the 1950s, resulting in a reduction in the proportion of workers who negotiate wage changes in any given quarter. Consequently, not only will wages be slower to respond to changes in current conditions, but most of the change in wages in any quarter will be the result of <u>deferred</u> increases that are granted automatically on the basis of agreements negotiated some months (or years) previously. Further, not only has the proportion of the labour force negotiating new contracts in any quarter become smaller, but the proportion now varies to a greater extent from quarter to quarter. Riddell (1979) suggests that these variations may be responsible for a good deal of the quarter-to-quarter change in aggregate earnings data, and he claims that OLS estimating techniques are inadequate for dealing with these complications. Since OLS estimations and aggregate data (average quarterly or weekly earnings) have been used in most of the studies done at the Bank, this assertion cannot be overlooked.

The use of contract data can supposedly overcome the difficulties just described. Much of the recent work done outside the Bank has employed individual contract data, either by treating each settlement as an individual observation, or by developing an "aggregate" measure on the basis of a weighted average of the individual increases negotiated during the quarter. (For example, refer to the papers by Wilton (1977), Auld et al (1979) and Riddell (1979).) One possible advantage of using contract data is that the dependent variable in the wage equation can now be specified in terms of a basic hourly wage rate, rather than average quarterly or weekly earnings. This avoids the problems caused by variations in hours worked or changes in the mix of experienced and non-experienced employees. Freedman stated the obvious in his 1976 paper when he said that the proper dependent variable in the wage equation is the one that is actually determined in the wage-setting process. He went on to emphasize, however, that it is not clearly evident which wage variable this is. Even though contracts are typically expressed in terms of hourly wage rates, this does not mean that bargainers give no thought to what those rates imply in terms of weekly, quarterly or annual earnings. Similarly, although contracts without cost-of-living clauses appear to be specified solely in nominal terms, no one would claim that bargainers take no notice of what happens to real wages. Still another question to be considered is whether or not the wage variable ought to be expressed "net of taxes". In other words, we usually have a situation wherein contracts are signed in terms of nominal, gross-of-tax, hourly wage rates, whereas workers may be more concerned about their real, after-tax, annual earnings! Some studies have been done for Canada on the effects of direct taxes on wage settlements (such as the AIB study by Kotowitz), but there is a need for more work in all of these areas. Whatever the conclusions, note once again that the use of contract data does allow the researcher to avoid some of the "institutional" problems mentioned earlier; namely, there need be no difficulty caused by the existence of overtime premiums or by changes in the employment mix as long as basic hourly wage rate data are used.

Contract data are also conducive to more detailed work on a disaggregated basis - to examine the relationship between unemployment and wage behaviour at the regional (provincial) or industrial levels, for example.

One definite advantage of using contract data is that it is much easier to separate a catch-up phenomenon from forward-looking behaviour with regard to expectations about future rates of price inflation. The usual method of specifying inflationary expectations is to use a distributed lag on past price increases. Such a specification, however, could just as easily be interpreted as representing catch-up, where wage settlements may be adjusted to compensate for any price increases that have occurred since the last wage bargain. With only a price expectations term, as in the Phillips curve equations of Section 2.4, one is left with the problem of trying to explain how any errors in inflationary expectations become incorporated into wage changes. For example, even if the coefficient on expected price inflation was 1.0, if actual price increases over the life of the contract exceed expectations, workers will have lost in terms of real wages, and they appear to have no direct way of recovering these losses when negotiating a new contract if only expectations about future price increases appear in the wage equation. A roundabout answer to this dilemma is that the adjustments occur indirectly, through the labour market. Specifically, if real wages fall, owing to an underestimation of inflation, labour demand rises and labour supply falls, causing an increase in labour-market tightness. This, in turn, causes upward pressure on nominal wages until the appropriate real wage is restored. The inclusion of a separate price catch-up term in the wage equation allows this adjustment to occur directly, and leads invariably to a reduction in the significance of the labour-market tightness variable when the equation is estimated.

Inflationary expectations are unquestionably important in the process of wage determination. Thus, it is imperative that we have an adequate means of modelling them. As just mentioned, the most common procedure is to assume an adaptive expectations mechanism and to use a distributed lag on past rates of inflation to generate the desired series. However, as discussed in Riddell (1979) and Kennedy and Lynch (1979), this method has certain drawbacks. For instance, the estimated parameter values are treated as constants over the whole sample period - an undesirable characteristic in view of the fact that structural changes do occur over time in the economy (as evidenced by the extent of parameter drift in econometric models). A second problem is that the parameter estimates are based on the entire sample period. This assumes that people are in possession of information which they obviously do not have when they are making their forecasts in any but the very last year of the period. Riddell (1979, page 24) suggests the adoption of "a moving sample approach, such that forecasts are based on parameter estimates which are themselves based on only the inflationary experience up to that point in time." Kennedy and Lynch do exactly this with a model in which the parameters are continually revised in the light of new information.

A more direct measure of inflationary expectations would probably be preferred to any series that has to be constructed. A few such measures, based on survey responses, do exist for the United States, but similar measures are not available for Canada. Unfortunately, the U.S. numbers have limited usefulness in Canadian studies due to the differing inflationary experiences of our two countries since the mid-1960s.

Still on the subject of inflationary expectations, it may be important to recognize that a single number cannot properly reflect the expectations of a wide variety of market participants in any given quarter or period. Even for one individual, the forecast or expected rate of inflation really ought to be regarded as the mean of a subjective probability distribution. In other words, two individuals may both expect the rate of inflation to be 10 percent during 1980, but they may differ significantly in how certain they are about this prediction. Further, even if they held the same expectations with the same degree of uncertainty, it is still not clear that their resulting behaviour would be the same, since individual workers and firms differ in their aversion to risk.

In addition to the fact that inflationary expectations have been revised upwards during the past turbulent decade, there seems little doubt that uncertainty about inflation has increased as well. Riddell (1979) for one, believes that uncertainty about inflation (measured, perhaps, by the dispersion of forecast expectations) is an important missing variable in wage equation studies.

Still other areas that are open for further investigation include the factors determining contract length, and the effect of COLA clauses on wage bargaining. (Both questions are considered briefly in a recent Bank of Canada Review article.) Finally, one more area that requires further study is that of "fringe benefits". That their importance cannot be ignored is clearly demonstrated by figures compiled by the "Thorne Group". As a proportion of total labour costs, they estimate that fringe benefits have increased from 15 percent in 1953-54 to 32 percent in 1977-78.

FOOTNOTES

1. It is important to emphasize at this point that equations (1) and (2) imply that neither productivity nor prices (nor expectations) have any effect on W. In other words, either the wage equations are being viewed in isolation, or we are making the assumption that productivity and prices are not changing. These simplifications will be relaxed later.

2. Much attention has been given in the literature to the forces that have been important in causing the perceived shift. Both demographic and legislative or policy factors are usually cited. Any reader who is not familiar with these discussions is referred to Appendix A.

3. It should be mentioned that two vacancy measures are in fact available: the vacancy survey itself, and a help-wanted index. Although the vacancy survey has been discontinued, the help-wanted index is still compiled by Statistics Canada. Its reliability may be somewhat suspect, however, because it is calculated in a rather crude manner. Bilkes points out, for example, that the two measures give quite different readings of conditions in the labour market over the past few years (specifically, the vacancy survey has indicated a good deal more slack than has the help-wanted index).

4. More on wage rigidity can be found in the paper by Hall (1975).

5. I should point out that the analysis in this paragraph differs somewhat from that in Technical Report 11. There, Wurzburger followed the approach of McCallum (1974) to argue that a Phillips curve specification would be supported by identical coefficients on wages and prices. However, this conclusion was arrived at by considering the wage equation along with a price equation that was homogeneous in nominal costs (wages). The interaction of wages and prices is something I would prefer to postpone until later (see Part 3). At this point, the focus is still on an "isolated" wage equation.

6. As well as the one-period lag on W, Wurzburger also lagged the price and productivity terms on the assumption that wage bargainers would not be aware of current developments. He did not, however, lag his measure of labour-market tightness, and he gives no argument either for or against doing so. Note, however, that because bargainers may also be unaware of current conditions in the labour market, this is not sufficient justification for lagging the LMT variable. In fact, an argument can be made in favour of LEADING the LMT variable, particularly when it involves the measured rate of unemployment since we know that unemployment responds to changes in aggregate demand with a lag. (In other

words, producers do not adjust their levels of employment when fluctuations in demand for their output are observed. Rather, because of the significant fixed costs associated with hiring new workers or laying redundant ones off, producers may wait to make sure that the change in demand is relatively permanent before changing their behaviour. Thus, future unemployment rates may be better indicators of today's labour-market tightness than are current unemployment rates.)

7. Whether the curve is better characterized as being linear or non-linear is open to question, but will not be dealt with in this paper.

8. As an aside, it could be noted that it was from initial estimates of equation (20) that the RUJP measure of labour-market tightness evolved.

REFERENCES

Bank of Canada Papers

Aubry, J.P., Cloutier, P., and DiMillo, J. "An Estimation of the Natural Rate of Unemployment in Canada." RM-79-14, February 1979.

Aubry, J.P. "Why is the Unemployment Rate so High in Canada? Comments on Pierre Fortin's Paper." RM-79-68, May 1979.

Bank of Canada. The Equations of RDX2 Revised and Estimated to 4Q72 (Bank of Canada Technical Report 5). Ottawa, 1976.

Bank of Canada. "Technical note on cost-of-living adjustment clauses in major wage settlements." Bank of Canada Review, Ottawa (monthly), December 1979.

Bilkes, G. "The Current Degree of Slack in Canadian Labour Markets." RM-79-7, March 1979.

Freedman, C. "The Phillips Curve in Canada." RM-76-189, November 1976.

Freedman, C. Models of Inflation: A Taxonomy of Effects. Bank of Canada Technical Report 8, Ottawa, March 1977.

Freedman, C. "An Analysis of Recent Inflation and the Effects of Control and Decontrol." RM-77-41, April 1977.

Kennedy, M. and Lynch, K. "The Modelling of Inflation Expectations." ID-79-29, August 1979.

Kierzkowski, H. "Short-run Inflation-Unemployment Trade-offs and the Natural Rate of Unemployment." June 1977.

Merrett, D. "Estimation of a Simple Phillips-Curve Wage Equation." RM-78-159, December 1978.

Merrett, D. "Estimation of a Keynesian-style Wage Equation." RM-79-43, March 1979.

O'Reilly, B. "An Attempt to Adjust the Unemployment Rate for Institutional and Demographic Changes Over the Period 1953-1975." RM-76-192, December 1976.

Wurzburger, B. "The New RDX2 Wage Equation." Moddoc #44, RM-76-83, May 1976.

Wurzburger, B. A Neo-Keynesian Model of Nominal Wage Determination in Canada. Bank of Canada Technical Report 11, Ottawa, 1977.

Other References

Auld, D., Christofides, L., Swidinsky, R. and Wilton, D.A. "The Determinants of Negotiated Wage Settlements in Canada (1966-1975): A Microeconometric Analysis." Anti-Inflation Board, Canadian Government Publishing Centre, Hull, P.Q., 1979.

Fortin, P. and Phaneuf, L. "Why is the Unemployment Rate so High in Canada?" Paper Presented at the Meetings of the Canadian Economics Association, Saskatoon, May 1979.

Hall, R.E. "The Rigidity of Wages and the Persistence of Unemployment." Brookings Papers on Economic Activity, Issue 2, 1975, pp. 301-335.

Kotowitz, Y. "The Effect of Direct Taxes on Wages." Anti-Inflation Board, Canadian Government Publishing Centre, Hull, P.Q., 1979.

Kuh, E. "A Productivity Theory of Wage Levels - An Alternative to the Phillips Curve." The Review of Economic Studies, Volume 34 (4), October 1967, pp. 333-360.

McCallum, B.T. "Wage Rate Changes and the Excess Demand for Labour: An Alternative Formulation." Economica, Volume 41, August 1974, pp. 269-277.

Meltz, N.M. and Reid, F.J. "The Recent Shift in the Canadian Unemployment-Vacancy Relationship and Its Implication for Labour Market Policies." University of Toronto Centre for Industrial Relations, Working Paper 7601, July 1976. (An updated version of this paper appears in The Review of Economics and Statistics, August 1979, pp. 470-475.)

Riddell, W.C. "Recent Research on Wage Inflation in Canada." University of Alberta Department of Economics, Research Paper No. 79-6, April 1979.

Thorne Riddell Associates Ltd. Employee Benefit Costs in Canada 1977/78. Toronto, 1978.

Wilton, D.A. "The Wage Determination Process in Canadian Manufacturing Industries 1962-1975." Labour Canada Discussion Paper, Hull, P.Q., April 1977.

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