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Estimation of An Expectations-Augmented Phillips Curve for Alberta

by

Duane Bruce

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Estimation of an Expectations-Augmented Phillips Curve for Alberta" submitted by Duane Bruce in partial fulfillment of the requirements for the degree of Master of Arts.

Supervisor, Dr. Ron Kneebone, Dept. of Economics

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Dr. Mark Dickerson, Dept. of Political Science

January 22, 1993
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Abstract

This thesis deals with the estimation of an expectations-augmented Phillips curve for the Alberta economy. This process will provide a base for estimating the natural rate of unemployment, measures of nominal and real wage rigidity, and sacrifice ratios for the province. This work intends to show that regional impacts are significant, and that EAPCs estimated for the Canadian economy are of little use when assessing the impacts of monetary policy at the provincial level.

Dedication and Acknowledgements

I dedicate this thesis to my wife, Lynn, and daughter, Jordan. Without the love and support of them, I would not have completed this project. Many times during the process of writing this document, it was very difficult to continue. But, some words of encouragement from my wife or a smile from my baby daughter gave me the strength to endure. Although you did not actually write any of the words, this thesis belongs to you.

Thank you Lynn for providing me with the opportunity to attend university. My days at the University of Calgary have provided me with the prospect of a rewarding and fulfilling career. From the day I decided to quit my job and attend university, you supported me financially and emotionally through some difficult times. I can't remember a single time that your support for my decision wavered.

I would like to acknowledge the contribution of several persons to this thesis: Ron Kneebone, my thesis supervisor, for his patience, commitment, and expert advice; Frank Atkins and Mark Dickerson for their comments and guidance; my senior co-workers: Doug Beck, Al Gray, and Norm Carruthers for their words of encouragement; and my family and friends who supported me throughout my academic career: Robin and Adeline Bruce, Don and Marg Martel, Bev and Marty Schenk, and Wayne Taylor.

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Chapter 1: Introductory Chapter

1.1 - Introduction

The goal of this thesis is the estimation of an expectations-augmented Phillips (EAPC) curve for the Alberta economy. The estimation of an EAPC provides a robust base from which several important measures can be derived. These measures include the natural rate of unemployment, the effect of government policies upon this natural rate, and sacrifice ratios for Alberta.

The primary rationale for the estimation of the natural rate of unemployment is that it is an essential benchmark against which to measure the effects of federal monetary policy upon the Alberta economy. For example, suppose the federal government chooses to pursue a tight monetary policy to temper an overheated economy in Central Canada, and thus they decrease the growth rate of the nominal money supply. The short-run effects of this policy upon the Alberta economy may be either beneficial (i.e. easing of inflation) or harmful (i.e. increased unemployment gap) depending upon Alberta's observed unemployment rate relative to its natural rate. If Alberta's observed unemployment rate is above its natural rate, and the federal government decreases the growth of the nominal money supply, then the federal government's policy exacerbates the unemployment situation in Alberta. On the other hand, if Alberta's observed unemployment rate is below its natural rate, then the policy will have its intended effect of easing inflationary pressures in the provincial economy as unemployment increases toward its natural rate.

Furthermore, if the observed unemployment rate is greater than the natural rate, it is likely that there will be a substantial impact upon the Alberta government's fiscal position through lower tax revenues and higher welfare expenditures. This effect should be anticipated when forecasting annual deficits, and could be used as evidence of how harmful the action of the federal government has been or could be to Alberta.

There exists a general consensus that the natural rate of unemployment has changed over time. There are many explanations offered (see Chapter 2) for this change, and thus any estimation of the natural rate must include these as explanatory variables. This process provides us with important information as to the direction, either positive or negative, and the magnitude of the effect that past or future federal and provincial government policies had or will have upon the natural rate of unemployment in Alberta. Important initiatives in this area are changes in the unemployment insurance program, the minimum wage, and the level of the average tax rate.

Of these important policy areas, both the level of the minimum wage and the tax rate are under the jurisdiction of the provincial government. Therefore, if the level of either of these variables are significant determinants of the natural rate of unemployment, the Alberta government has the ability to lower the level of the natural rate.

The next issue to be dealt with is the calculation of sacrifice ratios. Intuitively, this ratio measures the cumulative impact that a unit decrease in inflation has upon unemployment [1]. In times when policies are implemented with the intention of lowering the rate of inflation, the sacrifice ratio is important because it estimates the costs, in terms of unemployment, that the Alberta economy must bear to decrease the rate of wage inflation.

Hysteresis is a relatively new theory which suggests that changes in the natural rate of unemployment are largely explained by movements in the observed rate of unemployment. Implicitly, this argument suggests that other explanations of changes in the natural rate (i.e. institutional and structural, see Chapter 2) are relatively unimportant.

Finally, in Chapter 3, it will be shown that past estimates of the natural rate of unemployment for Alberta are varied, and that one of the primary reasons for this discrepancy is model specification. Therefore, a statistical test for correct model specification will be applied.

1.2 - Provincial versus National Phillips Curves

To conclude this introductory chapter, two primary justifications for the estimation of provincial EAPCs as opposed to national ones will be outlined. The first

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[1]. A more detailed discussion of sacrifice ratios can be found in Chapter 5.

justification was discussed by Day(1989). Day suggests that the argument for the estimation of provincial EAPCs as opposed to national EAPCs is based upon an important weakness of national aggregate Phillips curves. That is, changes in the distribution of unemployment across provincial labour markets may lead to an increase in the rate of inflation, despite the fact that the aggregate unemployment rate remains unchanged (Day(1989)).

Suppose that the macro economy is made up of two regions, A and B, and that the provincial or regional Phillips curves have the following form:

(1.1) $$w_i = p^e_i + f_i (U_i - U_i^*)$$

where i = A,B. and $f_i'(..)<0$ and $f_i''(..)>0$, w_i represents the rate of wage inflation, U_i is the rate of unemployment, U_i^* is the natural rate of unemployment and p^e_i is the expected rate of inflation in region i. The aggregate wage inflation and the unemployment rate are defined as:

(1.2) $$w_N = a\, w_A + (1-a)\, w_B$$

and

(1.3) $$U_N = a\, U_A + (1-a)\, U_B$$

where a is the share of the total labour force in region A.

Given Equations (1.2) and (1.3), the aggregate Phillips curve (1.1) can be written as:

(1.4) $$w_N = a\, p^e_A + (1-a)\, p^e_B + a\, f_A (U_A - U_A^*) + (1-a)\, f_B (U_B - U_B^*)$$

Now, suppose that the unemployment rates in the two regions change such that the aggregate unemployment rate remains unchanged:

(1.5) $$dU_N = a\, dU_A + (1\text{-}a)\, dU_B = 0$$

Also, suppose that $U_A > U_B$, and that $(U_A - U_A^*) > (U_B - U_B^*)$.

Given these assumptions, (1.5) brings about a greater dispersion of unemployment rates across the two regions if unemployment rates of region A increases and region B decreases. This greater dispersion leads to a change in aggregate wage inflation ***without a change in the aggregate unemployment rate.*** This result is obtained if and only if the individual regional Phillips curves are not identical. This result can be shown by totally differentiating (1.4), and assuming that the U*'s and price expectations remain constant:

(1.6) $$dw_N = a\, f_A'(..)dU_A + (1\text{-}a)\, f_B'(...)dU_B$$

Then, using (1.5), we know that:

(1.7) $$-a\, dU_A = (1\text{-}a)\, dU_B$$

Therefore, (1.6) becomes:

(1.8) $$dw_N = a\, [\, f_A'(..) - f_B'(..)\,]\, dU_A$$

Equation (1.8) reveals the important conclusion that if the slopes of the two regional Phillips curves are not equal (i.e. $f_A'(..)$ is not equal to $f_B'(..)$), increases in the dispersion of regional unemployment rates will unambiguously lead to changes in the rate of wage inflation [2]. In the n-region case, Day reaches ambiguous conclusions. Nonetheless, she offers the following general conclusion:

"*..it remains the case that a change in the distribution of unemployment between labour markets will shift the relationship between aggregate wage inflation and the aggregate unemployment rate. In other words, the relationship between these two aggregate variables will be unstable unless all regions have identical Phillips curves. If they do not, the behaviour of aggregate wage inflation will be best understood by studying the individual regional Phillips curves.* " Day(1989)

A second justification for the estimation of a provincial EAPC is that estimated coefficients in a national EAPC are weighted averages of regional or provincial coefficients. A weighted average implies that some of these provincial coefficients are less than the national weighted average and some greater than this value. Therefore, it would misleading, at best, to rely on national EAPCs to measure the impact of changes in monetary policy upon regions or provinces in Canada.

This thesis is an effort to estimate one of Canada's regional Phillips curves -- that of Alberta.

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[2]. We know this result to be true because if a) $f'_A(..) > f'_B(..)$, then w_N will increase, or b) $f'_A(..) < f'_B(..)$, then w_N will decrease. It should be remembered that it is assumed that $du_A > 0$.

Chapter 2: Theoretical Background

2.1 - Introduction

In this chapter, the theoretical foundations of the Phillips curve will be explored. First, the seminal work of Phillips to develop the concept of an unemployment/inflation tradeoff, and Friedman's expectations augmented Phillips curve will be discussed. Second, the microeconomic justification for the Phillips curve will be documented. This discussion will focus upon the central issue of the Phillips curve, that is, the short run tradeoff between inflation and unemployment produced by nominal and real wage rigidities. Thirdly, the determinants of the natural rate of unemployment will be documented. Finally, this chapter will conclude with a discussion of wage spillovers which are relevant to the estimation of a provincial Phillips curve as opposed to an aggregate national Phillips curve.

2.2 - The Phillips Curve

A relationship between nominal wage inflation and unemployment was first examined empirically by A.W. Phillips(1958). This relationship was formulated on the basis of a fundamental characteristic of economic markets. In the words of Phillips:

" *When the demand for a commodity or service is high relatively to the supply of it we expect the price to rise, the rate of rise being greater the greater the excess demand. Conversely when the demand is low relatively to the supply we expect the price to fall, the rate of fall being greater the greater the deficiency of demand. It seems plausible that this principle should operate as one of the factors determining the rate of change of money wage rates, which are the price of labour services.* " (Phillips(1958))

Thus, the aggregate labour market should react like all economic markets in that when there is a "deficiency of demand" or excess supply in the market, then the rate of change of money or nominal wages (i.e. wage inflation) should be low, and vice versa. Phillips provided empirical evidence to suggest that this relationship generally existed over the period 1861-1957 in the United Kingdom. Given this evidence obtained by Phillips, one could express the above inverse relationship (assuming a linear functional form) as:

(2.1) $$w = aU \; ; \; a<0$$

where U is the unemployment rate, w is the rate of change of nominal wages in the period t, and a is a negative parameter measuring the sensitivity of the rate of change in nominal wages to changes in the unemployment rate.

2.3 - The Expectations-Augmented Phillips Curve

This original formulation of the Phillips curve came under much scrutiny in the late 1960's and early 1970's. Milton Friedman first suggested that economic agents do not focus on the rate of change of nominal wages, but rather on the expected rate of change of real wages (Friedman(1968)).

Economic theory suggests that profit-maximizing firms hire workers until the real wage is equal to the marginal product of the last worker hired. Utility-maximizing workers supply labour according to the real wage in that a rise in the real wage induces an increased quantity to be supplied.

Friedman hypothesized that at the beginning of a period, firms and workers sign fixed nominal wage contracts which, in combination with their expectations of inflation, form the expected real wage. The expected real wage then determines the quantity of labour which will be demanded and supplied respectively. These agents must form expectations at the beginning of period t because firms and workers do not know with certainty by what amount the current price level will change over period t. Using this above argument, (2.1) can be transformed into:

(2.2) $$w = aU + p^e \; ; a<0$$

where w and U are defined in (2.1), and p^e is the expected rate of change in the general price level in current period. Equation (2.2) and variants of it are usually referred to as the ***expectations-augmented Phillips curve (EAPC).***

During the 1960's, when rates of inflation were reasonably constant, (2.1) performed well. That is, the coefficient on the unemployment rate was consistently significant, possessed the expected sign, and was stable over time. But, with the high rates of inflation of the 1970's and early 1980's, Equation (2.1) tended to perform very poorly, since it did not take into account inflation expectations which are an important determinant of nominal wage increases in times of high inflation. Thus, the EAPC of (2.2) described the behaviour of nominal wages much more effectively, and performed well statistically.

It is usually asserted that (2.2) has the characteristic that the coefficient on expected inflation is equal to unity. That is, nominal wages increase by an amount exactly equal to the change in the expected inflation rate. If this condition holds, then the long-run EAPC is exactly vertical, and thus there is no long-run tradeoff between inflation and unemployment.

This relationship holds because economic agents behave so as to exactly offset ***expected changes*** in the general price level. Suppose there occurs an anticipated increase in the nominal money supply which will lead to an increase in aggregate demand. Each individual firm experiences an increase in demand, and charges a higher product price which increases the general price level. But, if workers and firms had previously expected this change in the money supply, they would have negotiated a nominal wage increase exactly equal to the expected rise in the general price level. Thus, there is no change in the aggregate real wage ($w(t)=p(t)$), no change in aggregate labour demand or supply, and therefore no effect upon the unemployment rate in the economy.

But, in the case of ***unexpected shocks***, there still exists the short-run tradeoff between unemployment and inflation. Suppose that there occurs an unexpected increase in the growth rate of nominal money supply which would lead to an unexpected increase in aggregate demand and hence excess demand in the goods market. Firms would move to increase their demand for labour to expand production, and thus excess demand would result in the labour market. In the short run, unemployment would fall as firms are able to hire more labour at a lower real wage than expected.

In the long run, wages and prices must adjust to eliminate this excess demand for labour and the expectations errors. But, how quickly will prices and nominal wages adjust? The speed of adjustment of wages and prices is of central importance since it determines the length of time that the economy will experience real effects upon output and employment. If wages and prices are slow to change, the real effects in the short-run can be quite lengthy and substantial.

The speed at which the labour market adjusts to unexpected shocks is said to be a function of the degree of wage "rigidity" in the economy. The literature has distinguished between two types of wage rigidity. Real wage rigidity (RWR) is said to occur when real wages adjust less than instantaneously to changes in the degree of labour market tightness. Nominal wage rigidity (NWR) is said to occur when observed nominal wages fail to respond instantaneously to changes in desired nominal wages.

The literature offers a number of theoretical explanations for the existence of both NWR and RWR. In the next two sections, these explanations are discussed.

2.4 - Nominal Wage Rigidities

2.4.1 - Staggered Wage Contracts

Staggered nominal wage contracts were first offered as an explanation of nominal wage rigidity by Taylor(1979). This explanation suggests that since contracts are not all agreed to and signed at the same point in time, nominal wages cannot adjust immediately to shocks. Instead, wages adjust as contracts expire.

In Taylor's model, the degree of nominal wage rigidity is determined by elasticity of the current contract with respect to the previous contract (denoted by b) and the next future contract (denoted by d) where $b+d=1$, and $0 \leq b \leq 1$ and $0<d<1$ [3]. If an unexpected increase in the growth rate of the nominal money supply occurred, and $b=3/4$ (i.e. wage setters are primarily "backward-looking"), the nominal wage would be very rigid, because agents would react very slowly to current shocks in the economy. Rather than current conditions, agents may be concerned with past deferred wage cuts or increases. Hence, as b increases (and therefore d decreases), nominal wages become more rigid. Taylor(1979) simulates this result for the U.S. economy, and finds that nominal wages are particularly rigid for $b \geq 0.6$.

In a later article, Taylor(1983) provides empirical evidence to suggest that wage

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[3]. If the economy is dominated by unions, a high number of contracts would be signed and hence the tendency of workers to be backward-looking would be increased. Thus, b would increase. In the opposite case, if unions come to play a small role in the economy, b would be lower.

contracts are slow to react to changes in nominal money, and that "..it is only after the new negotiations are well beyond the overhang of ***past deferred wage changes*** that noticeable declines in the inflation rate occur [emphasis added]." Admittedly, Taylor's(1983) analysis was based on a period of disinflation (i.e. a decrease in the growth rate of the nominal supply of money) while this chapter has been concerned with the opposite policy. Yet, it would seem plausible that Taylor's conclusion would still hold in the opposite scenario. If workers and firms are backward-looking, and if the past economic conditions were those of wage cuts, firms and workers and the contracts they negotiate would be slow to react to an expansion of the nominal money supply in the present. Nominal wage rigidity would be the result.

2.4.2 - Informational Problems

Nominal wages may also be rigid due to informational problems (Friedman(1968)) which will lead to a short-run tradeoff between inflation and unemployment. As the increase in aggregate demand occurs, due to, say, an unexpected change in the growth of the nominal money supply, firms see their individual product prices increase and thus act to supply more goods by increasing the nominal wage to attract more workers. Workers, on the other hand, who use the price level of a bundle of consumption goods (the CPI, for example) as the denominator in their real wage calculations, cannot tell if the general price level has increased due to the enormous amount of information required. Assuming expectations of a stable general price level, workers believe that their real wage has increased since their nominal wages have increased. Thus, more output is produced as firms demand more labour (the real wage that they pay has declined) and workers supply more labour (the perceived real wage they receive has increased) simultaneously.

Ex post, workers will come to realize that in fact their expectations of the price level were wrong. The general price level was not stable over the period, but in fact increased by, say, 5%. Workers will revise their expectations of the price level to 5%, and subsequently will demand higher nominal wages to return the real wage they receive to its previous level. This increase in nominal wages will eventually return the economy to a long run level of unemployment (Friedman(1968)).

2.4.3 - Adjustment Costs

Scarth(1988) discusses these types of costs. Suppose the observed rate of nominal wage inflation, w, is greater than the desired or equilibrium rate of nominal wage inflation, w*. In this case, firms are incurring a cost, since they would be paying a wage above the long-run norm. Workers, on the other hand, would not be eager to forgo this higher rate of wage increase.

To alleviate this situation, lengthy meetings, or perhaps, strikes and lockouts would likely occur to reach conditions under which the long-run equilibrium (w=w*) could be reached. These negotiation costs may translate into lost output and income for both firms and workers. Hence, even if w is not equal to w*, firms and workers may be willing to accept this situation for a period of time in order to avoid these potentially substantial costs. Nominal wage rigidity is the result.

2.5 - Real Wage Rigidities

2.5.1 - Efficiency Wages

The theory of efficiency wages is based on the principle that the effort exerted by workers is functionally related to the real wage. Following from this proposition, all firms should seek to equate the real wages that they pay their workers. If a firm fails to pay a real wage equal to other competing firms, this firm will face several possible consequences such as: a) less effort being exerted by their workforce; b) more shirking of responsibilities; c) higher turnover and therefore higher training costs; and d) the loss of good-quality labour to better-paying firms (Yellen(1984)).

Akerlof and Yellen(1985) have suggested that firms tend to follow a "rule of thumb" when setting wages and prices, and thus tend not to react to current changes in the money supply. This behaviour thereby implies that prices and nominal wages are rigid. The rationale for this behaviour is that it is much easier to equate real wages when nominal wages and prices are set at frequent and set intervals (i.e. rule of thumb behaviour), than at infrequent and random intervals (i.e. in reaction to unexpected nominal money shocks).

But, is this behaviour rational? Akerlof and Yellen(1985) term the behaviour as "near rational" . If B firms adopt the efficiency wages argument and follow a rule of thumb to set wages and prices, and 1-B firms adjust prices and wages immediately in response to a change in money, the loss in profits to the B firms is very small (Akerlof and Yellen(1985)). This result is derived in Appendix 1.

2.5.2 - Implicit Contracts

A second explanation for real wage rigidity is long-term implicit contracts. This explanation suggests that firms and workers enter into long-term implicit contracts and when the macro economy experiences an aggregate demand shock due to a change in the growth rate of the nominal money supply, wages cannot be changed immediately.

The implicit long-term contract entails the payment of a stable average real wage over the span of workers' careers. The desire for a stable real wage is a result of the degree of risk aversion exhibited by workers and firms. Workers are generally thought to be risk averse because they usually have limited access to markets to insure themselves against loss of wages (Hall,Taylor,and Rudin(1990)). Hence, workers prefer an average real wage over time as opposed to being paid the real wage appropriate to the present state of the economy. On the other hand, firms are risk-neutral for reasons such as access to insurance for losses, and ownership by many persons in which the investment in one particular firm is a small part of their portfolio (Hall,Taylor,and Rudin(1990)). Therefore, firms are indifferent between paying an average wage and a wage given the present state of the economy. Hence, these two parties willingly enter into long-term employment contracts and thereby forgo the ability to react quickly to nominal shocks in the economy (Hall(1980)).

2.5.3 - Menu Costs

The theory of menu costs posits that firms are reluctant to alter prices for at least two reasons. First, price changes involve administrative costs related to new price lists, informing dealers and salespersons, and so on. If these administrative costs are relatively high, the firm will be reluctant to change prices. Second, costs are incurred by the firm via the "..implicit cost that results from the unfavourable reaction of customers to large price changes." (Rotemberg(1982))

This second reason can be rationalized as follows. If prices change by a large amount at infrequent intervals (say in response to a change in nominal money), consumers over time will deduce that a particular item price has a low probability of changing. Hence, consumers will decide that they can take considerable time to consider the desirability of purchasing that particular item. The implicit cost involved is a result of the period of low demand that occurs because consumers do not buy the good immediately. Instead, the consumers are deciding whether or not to purchase the product. On the other hand, if prices change by small amounts at frequent intervals, consumers will know that the probability of a price change is high, and thus will take less time to consider the purchasing of the item. Less time taken to consider purchasing the good translates into no or less implicit cost because the period of low demand does not occur (Rotemberg(1982)).

Given this argument, firms should choose to change prices at frequent intervals. This pricing behaviour will lead to the use of rule of thumb to set prices (e.g. raise prices by 1% every quarter). Hence, we find that firms do not react to the current changes in the nominal money supply, and therefore nominal money has real effects in the short run.

2.6 - The Modelling of Wage Rigidities

Based on the methods adopted by several previous studies, we can model NWR by positing a partial adjustment model of nominal wages:

(2.3) $$w - w(-1) = h\,(w^* - w(-1))\ ;\ 0 \leq h \leq 1$$

or, more generally:

(2.4) $$w - \Sigma\, b_i\, w(-i) = h(w^* - \Sigma\, b_i\, w(-i))\ ;\ i=1..4;\ 0 \leq h \leq 1$$

Equation (2.3) is typically used by those employing annual data such as Fortin and Newton (1982); Grubb, Jackman, and Layard(1982 and 1983); Kahn(1984); and McCallum(1986). Equation (2.4) is used by those applying quarterly data such as Cozier(1990) and Prachowny(1991), and will be employed in this thesis.

In the case of (2.4), if h=1, we see that w=w* so that observed nominal wage inflation is equal to desired (or target) nominal wage inflation. But, if there are overlapping nominal wage contracts, how can all of the rates of change in wages agreed upon in past quarters adjust to a common value of w*? In other words, if w(-1) was written in a multi-period contract one period ago, how can it now adjust to w* in the current period? In this context, h must measure not only the degree of rigidity imposed by contracts, lack of information, etc, but also the degree of cost-of-living allowances (COLA) embedded in contracts. Therefore, the larger is h, the larger the COLA escalator in nominal wage contracts, up to the limiting case where h=1, COLA = 100% *and* no nominal wage rigidities exist.

If h=0, then (2.4) suggests that w is a weighted average of wage inflation ($w = \Sigma b_i\, w(-i)$) settled upon by parties negotiating contracts in past periods, and each b_i measures the fraction of the labour force that signed a nominal wage contract i periods ago. In this context, Σb_i should equal unity to account for the whole labour force. Since there is no change from negotiated values of inflation in the past, the COLA escalator is equal to zero, and nominal wages are perfectly rigid due to nominal wage rigidities exerting their full influence.

In general, the larger is h, the more flexible are nominal wages because i) large COLA provisions make wages more responsive to current inflation, and ii) small effects of the various sources of nominal wage rigidity make it easier to negotiate a wage appropriate to current labour market conditions. Therefore, (1/h) is a measure of nominal wage rigidity.

If we assume that w* can be modelled as (2.2), then (2.4) becomes:

$$(2.5) \qquad w = (1\text{-}h)\ \Sigma\ b_i\ w(\text{-}i) + ha\ U + h\ p^e$$

where w is the current rate of wage inflation, w(-i) is the rate of wage inflation i periods ago, U is the unemployment rate, and p^e is the expected rate of change in the general price level in period i.

Estimation of (2.5) would yield separate estimates of parameters h and a. Rewriting equation (2.2) as:

$$(2.2') \qquad w - p^e = aU$$

emphasizes that the estimated coefficient a measures the responsiveness of the real wage to labour market conditions. If a is large, real wages are said to be very sensitive to the labour market. As a becomes smaller, the less responsive is the real wage to conditions in the labour market. Thus, (1/a) is a measure of real wage rigidity (RWR) since when real wages are very sensitive to the labour market (a is large), RWR is very low.

2.7 - The Natural Rate of Unemployment (U*)

In equation (2.5) discussed above, the appropriate measure of labour market slack or tightness was assumed to be the observed unemployment rate. This formulation implicitly assumes that the natural rate of unemployment, U*, has not changed over time. But, there is a considerable amount of evidence to the contrary [4]. Thus, to properly measure labour market tightness, the time path of U* must be estimated, and U replaced by (U-U*) to adequately measure labour market tightness.

Factors which have been identified in the literature as having an influence on U* include the generosity of the unemployment insurance program, the changing demographic characteristics of the labour force, the presence and actions of labour unions, the level of the minimum wage, the dispersion of employment across sectors or regions, and the lagged observed unemployment rate.

In the case of unemployment insurance generosity, the effect upon U* will be expected to be positive. The literature has identified three major reasons for this relationship. First, unemployment insurance (UI) affects the currently unemployed by reducing the costs of job search. The more generous the UI benefits relative to the average wage, the less costly it would be to be unemployed, and the longer the average job search would be. This longer job search would increase U*.

Second, UI provides incentives to those who are currently employed that causes U* to increase (see Phipps(1991) and Fortin (1984) for a careful theoretical discussion).

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[4]. Two references are Pierre Fortin and Keith Newton, " Labour Market Tightness and Wage Inflation in Canada ", Workers, Jobs, and Inflation, pg.243-278, 1982; and David E. Rose, The NAIRU in Canada: Concepts, Determinants and Estimates, Bank of Canada Working Paper, December 1988.

That is, up to the point where the minimum number of weeks employment necessary to collect UI benefits is reached, every week of employment is compensated by payment of the actual wage plus the value of an extra week of UI entitlement. Eventually, the worker reaches a point in time where the number of weeks worked allows the worker to be eligible for UI benefits for the rest of the year. Any work past this point, up to the maximum number of weeks one can collect UI, is implicitly taxed since, for each additional week worked over the minimum requirement, he or she is giving up UI benefits. The wage subsidy, then, encourages workers to enter the workforce, and the implicit tax acts to encourage these same workers to leave their jobs once the number of weeks worked allows them to collect UI benefits for the remainder of the year.

The third reason for expecting a positive relationship between U* and the degree of UI generosity has to do with the effect of the UI program on the seasonality of employment. Bailey (1977) was the first to show that a more generous UI scheme increases the seasonality of employment (see Burdett/Wright(1989) for a more recent treatment). This effect occurs because firms who face seasonal variation in demand can layoff workers, and be confident that those workers will not seek other employment. That is, the more generous the UI scheme, the greater the likelihood workers will collect UI benefits until firms are ready to rehire these workers. Firms can then more freely layoff workers in the off-season and thereby increase the seasonality of employment and U*. Kaliski(1976) found empirical support for this relationship in Canada.

Demographic changes in the composition of the labour force may have also acted to increase U* because women and youth tend to have higher unemployment rates than men. Participation rates of women in the workforce have increased from 24 percent in the 1950's to 44 percent in 1988. This increase in participation rates may have led to a "general absorption problem" as the unexpected entrance of this group into the labour force could not be absorbed. Rose(1988) reports that indeed female unemployment rates were consistently higher than comparable male rates, especially over the 1970's. This same argument is expounded for youths (ages 15-24) in that youth participation rates have climbed from 22 percent in the early 1960's to over 27 percent by the mid-1970's (Rose(1988)).

The minimum wage effect is less straightforward in that it has several competing influences upon employment. First, an increase in the minimum wage would be expected to lead to a decrease in employment for certain workers due to the lower quantity of labour demanded by firms, thereby increasing U*. Second, an increase in the minimum wage may lead to a lower probability of attaining a job and thus discourage many workers from declaring themselves as looking for work, thereby lowering the active labour force and U*. And finally, an increase in the minimum wage may induce some workers to enter into the labour force and actively seek work. If this increased amount of labour supplied is not absorbed into the employed labour force, U* will increase. Therefore, these various competing effects suggest an ambiguous effect upon U*. Johnson and Kneebone(1991) estimate unemployment equations for all of the Canadian provinces, and find that the minimum wage effect was significant in four provinces. Of these four provinces, Newfoundland, New Brunswick, and Saskatchewan had positive coefficients, and Alberta exhibited a negative effect.

Traditionally, the presence of labour unions is thought to increase the natural rate of unemployment. This effect occurs because unions tend to raise their members' nominal wages relative to workers in the non-union sector of the economy. This differential in nominal wages leads to less employment in the union sector, and thus an increased labour supply in the non-union sector. This reallocation of resources may lead to a situation where non-unionized firms may not be able to employ all available workers and thus a higher U* would result (Barro(1987)).

This union effect is often measured by using the level of union membership as a fraction of the labour force or total employment as an explanatory variable of changes in U* (see Fortin(1989)). But, it seems that a more suitable explanatory variable would be union militancy. After all, unions can be rather docile and cooperative and if union membership increases substantially, there will be no effect upon the union-non-union nominal wage differential. On the other hand, suppose that union membership does not change but, rather that the current union membership becomes very militant and aggressive in its nominal wage demands. The union-non-union nominal wage differential will increase, and thus an increase in the natural rate of unemployment may follow. Hence, a more reasonable measure of a union effect might be the total strike days.

Another effect upon the natural rate of unemployment that is often cited is taxes. The effect of an increase in income taxes is the reduction of the after-tax real wage, ((1-tax rate) W(t)/P(t)). This reduction in the real wage makes leisure in period t less expensive. Thus, an intertemporal effect results such that workers reduce the amount of labour supplied (i.e. increase leisure time) in period t, and will then increase their supply of labour when the after-tax real wage improves in a future period (Barro(1987)). On the demand side of the labour market, corporate taxes reduce the real output accruing to firms from labour's marginal product i.e. (1-tax rate) MPL. Thus, an increase in corporate taxes will lead to a decrease in the demand for labour. Overall, since both labour supply and demand are reduced, the level of employment will unequivocally decline, and the natural rate of unemployment will increase.

Another effect, first measured by Lilien(1982) and Samson(1985), that could theoretically impact U* is the variability of employment across sectors or regions of the economy. For instance, if employment declines in one sector, structural unemployment will increase temporarily as the recently unemployed from this sector seek training or alternative employment. As this process became more widespread across all or most of the sectors in the economy, U* would increase.

A final theoretical effect upon the natural rate of unemployment is hysteresis. The argument for hysteresis suggests that the natural rate of unemployment tends to change as the level of the actual rate of unemployment changes. One rationale for hysteresis is that unemployment "..destroys human capital, undermines the work ethic, and if accompanied by low investment, reduces the stock of capital." (Coe(1985)) Thus, if the economy suffers increases in actual unemployment, the destruction of human capital and so on will lead to increases in the natural rate of unemployment.

A derivation of the theory of hysteresis was provided by Blanchard and Summers(1987). They argue that the short-term unemployed exert downward pressure on wages. Thus, they suggest that deviations from equilibrium unemployment in firm i depends on expected short-term unemployment in the whole economy. Algebraically:

(2.6) $$En_i - n_i(-1) = b\,(n(-1) - En)$$

where n(-1) is last period's level of employment, and En is expected employment in the current period. Those variables with subscripts added refer to an individual firm i's past level of employment and current expected employment.

Aggregating across identical firms (i.e. $n(-1) = n_i(-1)$), (2.6) becomes:

$$En = n(-1) + b\ (n(-1) - En)$$

$$(1 + b)\ En = (1 + b)\ n(-1)$$

(2.7) $$En = n(-1)$$

In aggregate, Blanchard and Summers' labour demand function implies:

(2.8) $$n = m - w \quad \text{or} \quad w = m - n$$

where m equals the level of the nominal money supply and w is the nominal wage.

Taking expectations of (2.8) results in:

(2.9) $$En = Em - Ew$$

Substituting (2.7) and (2.8) (since Ew=w) into (2.9) leads to:

(2.10) $$n(-1) = Em - (m - n)$$

Rearranging (2.10) gives:

(2.11) $$n = n(-1) + (m - Em)$$

which suggests that the time path of employment follows a random walk.

This stochastic process can be interpreted as follows. If the equilibrium level of employment is defined as the number of workers employed last period, i.e. n(-1), a "long sequence" of adverse monetary shocks will lead to an "..increase in equilibrium unemployment for some time." (Blanchard and Summers(1987)) Using (2.11) and assuming a long sequence of adverse monetary shocks (where Em>m):

$$n = n(-1) + (m - Em)$$

$$n(+1) = n + (m(+1) - Em(+1))$$

$$n(+2) = n(+1) + (m(+2) - Em(+2))$$

$$n(+3) = n(+2) + (m(+3) - Em(+3))$$

where $n(+3) < n(+2) < n(+1) < n < n(-1)$.

If the equilibrium level of employment is defined as last period's level of employment, the equilibrium level is decreasing subsequent to every monetary shock. U* is continually increasing, and given that hysteresis exists, ***U* would never return to its initial level.***

The hysteresis argument implies that the coefficient on the lagged unemployment rate is equal to unity. Ignoring all other possible influences upon U* for the moment, and assuming that the coefficient on U(-1) was found to be unity, (2.5) could be transformed to:

(2.5') $$w = (1-h)\, \Sigma\, b_i\, w(-i) + ha\, (U-U(-1)) + h\, p^e$$

That is, hysteresis implies that the rate of change of nominal wages, w, depends only on the *change* in the unemployment rate, and is therefore independent of the *level* of the current period's unemployment rate.

A related notion is that of "persistence" as discussed by Burns(1990b). Burns suggests that persistence "...refers not to the failure of unemployment to return to its previous state [hysteresis] but its sluggishness in doing so." Unlike hysteresis, in the case of persistence (coefficient on U(-1) less than unity), a series of adverse monetary shocks would increase U* for some time, but *eventually U* would return to its initial level.* As the coefficient on U(-1) approaches unity, the degree of persistence increases, and the longer the time period required for U* to return to its initial level.

2.7 - Wage Spillovers

A final consideration for the specification of a provincial EAPC has been discussed by Drewes(1987) and Day(1989). These authors suggest that the rate of wage inflation in one region may be in part determined by rates of wage inflation in other regions. This phenomenon is termed "wage spillovers". The explanation of this phenomenon usually include the arguments that national unions and firms bargain in many regions, workers across regions may have similar expectations of inflation, or workers may simply be concerned with keeping their wage increases comparable to workers in other regions. Whatever the explanation, the "stylized fact" of the matter is that rates of wage inflation across regions have remained remarkably similar over time (Day(1989)). The implication of the argument is that rates of wage inflation in other regions should be included as explanatory variables in any single provinces EAPC.

2.8 - Conclusion

This chapter sought to outline the theoretical foundations of the EAPC. Building from the early work of Phillips and Friedman, the microeconomic justifications of the inflation-unemployment tradeoff were established. The theoretical existence of such a tradeoff was justified by reference to wage rigidities caused by staggered contracts, implicit contracts, wage adjustment costs, efficiency wages, menu costs, and informational limitations. The chapter continued by documenting two important specification issues. It was argued that the specification of the EAPC must include explanatory variables to explain changes in natural rate of unemployment over time, and to test for the effects of wage spillovers. The determinants of the natural rate of unemployment were argued to be the level of unemployment generosity, demographic changes in the labour force, labour union militancy, the level of the minimum wage, taxes, the dispersion of employment across sectors and regions, and last period's actual unemployment rate.

Chapter 3 - A Review of the Empirical Evidence

3.1 - Introduction

In this chapter, empirical results found in the literature will be surveyed. In particular, three empirical issues will be reviewed: a) the existence of a vertical long run EAPC (the estimated coefficient on expected inflation is equal to unity), b) the "proper" measure of labour market tightness or slack, and c) estimates of the natural rate of unemployment (U*).

3.2 - The Vertical Long-Run Phillips Curve

The proposition that the estimated coefficient on expected inflation is not statistically different from unity has received much attention in the empirical literature,and generally found support. Studies by Turnovsky(1972), Vanderkamp(1972), Beare-(1973), Christofides, Wilton, and Swidinsky(1980a, 1980b), Riddell and Smith(1982), Fortin and Newton(1982), Christofides and Wilton(1985), and more recently, Fortin(1989), Cozier and Wilkinson(1990), and Fortin(1991) have all found statistical support for the price coefficient being equal to unity.

At the regional and provincial state level in Canada, the seminal work on the estimation of provincial Phillips curves was performed by Thirsk(1973). He found evidence of considerable variation across provinces with respect to the coefficient on price changes. Also, Thirsk found that the estimated price coefficient in Quebec's Phillips curve was the only one close to unity. Of the remaining estimates, Nova

Scotia, all of the Prairie provinces, and British Columbia were greater than unity, and the remaining provinces' estimated coefficients (Newfoundland, New Brunswick, and Ontario) were all less than unity (Thirsk(1973)).

A more recent study by Wilton and Prescott(1990) found a similar result to Thirsk(1973) in that the price coefficient varied across regions, although the variation was quite different from Thirsk's. For non-COLA contracts, Wilton and Prescott(1991) consistently found that the sum of the coefficients on inflation expectations and the catch-up term was greater than unity. For COLA contracts [5], they consistently find that the coefficient on price expectations was less than one, but with the addition of a statistically significant catch-up variable, Ontario and Quebec appeared to approach unity. The catch-up variable for British Columbia was not significant which implies a wide confidence interval. Thus, it is difficult to draw any firm conclusions about the sum of price expectations and catch-up coefficients in this province.

It is interesting to note that both Thirsk(1973) and Wilton and Prescott(1990) doubt that their results justify a rejection of the natural rate hypothesis. First, Thirsk(1973) uses the current rate of inflation, as measured by the Consumer Price Index, for the explanatory variable. But, as Chapter 2 suggested, the explanatory variable should be

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[5]. Wilton and Prescott did not estimate wage equations for the Prairie Provinces or the Maritimes.

an indication of inflation expectations, and not a measure of current inflation. Thus, as Thirsk admits "the variety" in his results "may only indicate the presence of measurement error in the price variable" (Thirsk(1973)). Also, Wilton and Prescott(1990) suggest that the coefficients on inflation expectations in their non-COLA contract equations were biased upwards (coefficients ranged from 1.0 to 1.2) [6].

Furthermore, as noted in Chapter 2, the natural rate of unemployment has changed over time. Unlike most work at the national level, Thirsk(1973) and Wilton and Prescott(1990) at the provincial level fail to adapt their Phillips curve specifications to this possibility. This oversight is also a likely cause of the variety of coefficients on the price variables across regions.

To conclude this section, it is necessary to emphasize two important points. First, these above studies use two different types of data. Turnovsky(1972), Vanderkamp(1972), Beare(1973), Thirsk(1973), Riddell and Smith(1982), Fortin and Newton(1982), Fortin(1989), and Cozier and Wilkinson(1990) use aggregate wage data for the dependent variable. Riddell(1979); Christofides, Swidinsky and Wilton-

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[6]. Their estimates are considered biased upwards because their dependent variable measures the annual percentage change in the base wage rate. But, since most workers earn more than the base wage rate and all workers in a bargaining unit receive the same absolute increase in wages, the actual annual percentage of wage changes may be much lower than the above measure. Thus, if the measure of wage changes could have been more accurate, the coefficients on inflation expectations would likely have been closer to unity.

(1980a,1980b), Christofides and Wilton(1985), and Wilton and Prescott(1990) all use individual wage contract data. Second, these studies use many different techniques to model inflation expectations. Despite these differences, these authors arrive at the same general result at the national level: the accelerationist hypothesis is empirically valid. At the provincial level, the results are varied, but in both instances, Thirsk(1973) and Wilton and Prescott(1990) provide plausible explanations of the variation across provinces or regions. To summarize, there exists both theoretical and empirical evidence to support an ***a priori*** expectation of a unity coefficient on the expected price inflation variable.

3.3 - Measures of Labour Market Tightness or Slack

Throughout this literature, many different measures of labour market slack or tightness have been used. In Chapter 1, it was mentioned that Phillips suggested that the relationship between the unemployment rate and the rate of change of nominal wages was non-linear (see Phillips(1958)). In the early 1970's, Turnovsky(1972) and Vanderkamp(1972) both found that the inverse of the national unemployment rates had high t-scores and the expected signs. Beare(1973) used the inverse of the squared national unemployment rate, and obtained the expected signs and high t-scores with this variable.

But, estimation of this non-linear relationship in the late 1970's and early 1980's produced some rather perverse results. For example, the estimated Phillips curves in

Christofides, Swidinsky, and Wilton(1980a) all had the wrong sign on the coefficient for the inverse of the unemployment rate (i.e. negative) [7]. This type of result may have been a product of the change in the underlying structure of unemployment in that the equilibrium rate of unemployment was altered, due to demographic and policy-induced changes. Thus, the unemployment rate was not the proper measure of excess demand.

Two approaches have been adopted to overcome this problem: a) the use of help-wanted index or job vacancy data as a measure of labour market tightness, and b) the estimation of the changes in the equilibrium or natural rate of unemployment. The use of help-wanted indices was adopted because it was assumed that those forces that changed the equilibrium unemployment rate (changing proportions of females and youths, changes in unemployment insurance, changes in minimum wages, etc.) did not act to change the equilibrium or natural rate of job vacancies [8]. Thus, Christofides, Swidinsky, and Wilton(1980a,1980b), Fortin and Newton(1982), and Christofides and Wilton(1985) found that using the vacancy rate or help-wanted indices gave satisfactory results.

This approach is unsatisfactory for two reasons. First, the use of the help-wanted

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[7]. See Christofides, Swidinsky, and Wilton(1980a), pp. 166 and 170.

[8]. This assumption seems justified given the evidence of Reid and Meltz(1979), pp. 472 and 474; and Christofides, Swidinsky, and Wilton(1980a), pg.173.

index would not allow the estimation of U*, which is of interest in this thesis. Secondly, data availability is a problem. The variable is available from 1962, but the variable is for all of the Prairie provinces combined. It is also available for cities (Calgary and Edmonton) but this series only begins in 1981.

The second method of dealing with the change in the underlying natural unemployment rate is to include variables that have changed the aggregate natural rate of unemployment in the estimated Phillips curve. This technique involves using the actual unemployment minus its equilibrium value as a measure of excess demand in the Phillips curve equation. This technique has been recently outlined by Rose(1988), and has been used in the past by Riddell and Smith(1982). Fortin and Newton(1982) use a somewhat similar measure.

Riddell and Smith obtained good results by using the unemployment rate, and correcting for changes in U*. These changes in U* were corrected by including a variable, (DEM(t)), to measure the fraction of younger workers and women in the labour force [9], and another variable, (UIC(t)), to account for changes in the generosity of the unemployment insurance system during the sample period [10]. The

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9. This measurement is denoted as DEM where DEM(t) is the fraction of the seasonally adjusted labour force consisting of men and women aged fifteen to twenty-four and women twenty-five years of age and over.

10. Riddell and Smith(1982), pg. 385. Unemployment insurance generosity is measured by: UIC(t)= (INS(t)/LF(t))*(BEN(t)/AWW(t))*SCALE(t) where INS(t)/LF(t) is the fraction of the labour force covered by unemployment insurance,

results were quite good for the unemployment rate (correct sign and high significance) and UIC(t) (correct sign). The DEM was later dropped from the equation because its coefficient displayed the wrong sign (despite being statistically significant). Cozier and Wilkinson(1990) obtained good results using this same type of measure of excess demand [11].

Fortin and Newton's measure of excess demand was Us/U and the results of this measure in their Phillips curves were very good [12]. In fact, they found that their Us/U had the lowest standard error and highest t-statistic compared to all other measures of excess demand they utilized, including vacancy rates and the prime-aged

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BEN(t)/AWW(t) is the ratio of average weekly UI benefits to average weekly wages, and SCALE(t) equals 1 up to 1971 and .8 thereafter.

[11]. Cozier and Wilkinson(1990) obtained their estimate of U* from the Bank of Canada RDXF model (Cozier and Wilkinson(1988),pg.23). The series can be determined from their Appendix.

[12]. Fortin and Newton's Us is not the natural rate of unemployment. Rather, it is an estimated "standardized rate" following the technique used by Wachter(1976). One estimates several regressions like the following:

$$u_i = a0 + a1\, u_{pm} + a2\, Z$$

where u_i is the age-sex unemployment rate (i.e. unemployment rate for males aged 16-19, females aged 16-19, males aged 20-24, and so on). u_{pm} is the unemployment rate of males twenty-five years of age and older, and Z is a vector of variables thought to have changed the aggregate unemployment rate (proportion of population aged 16-24 years, cost of being unemployed, etc.). Then, once one has estimated these several regressions and obtained the fitted values for each u_i ,one can calculate a weighted unemployment rate (Us) for the aggregate labour force (males and females, aged 16-65+) at each point in time.

male (aged twenty-five years and older) unemployment rate lagged one period.

At the regional, provincial, and state level, Thirsk(1973) used the provincial and national unemployment rates, and Ontario's unemployment rate as a proxy for this province being a wage leader for all other provinces. But, he found that outside (national and Ontario's) labour market conditions were not statistically relevant. In forty-four estimated equations for nine provinces using the provincial unemployment rate, all but one of these estimated coefficients were correctly signed. Yet, only ten of these coefficients were statistically significant at the five percent level of confidence.

Prescott and Wilton(1990) used the provincial (Ontario, Quebec, and British Columbia) or regional (Maritimes and Prairies) unemployment rates for 1979-1988 with no reference to natural rates, vacancy rates, or any other measure. They obtain desirable results and state that their evidence suggests that wage changes depend on the level of the unemployment rate, not the change in the unemployment rate, thereby rejecting the theory of hysteresis (see Wilton and Prescott(1990)).

In sum, since 1980 (see Table I on following page), at the national level, there seems

Table I — Measures of Labour Market Tightness or Slack

National	Linear	Non–Linear	U	1/U	ΔU	U/U*	PMA U(t)	Vacancy Rates	Us/U
Turnovsky(1972)		X		X					
Vanderkamp(1972)		X		X					
Beare(1973)		X		X					
Riddell(1979,1980)		X		X	X				
Christofides, Swidinsky and Wilton(1980a,1980b)	X							X	
Fortin and Newton(1982)	X	X					X	X	X
Riddell and Smith(1982)	X					X			
Christofides and Wilton(1985)	X							X	
Fortin(1989)	X						X		
Cozier and Wilkinson(1990)	X					X			
Fortin(1991)	X				X*		X		

Provincial or State(U.S.)	Linear	Non–Linear	U	1/U	ΔU	U/U*	PMA U(t)	Vacancy Rates	Us/U
Thirsk(1973)	X		X						
Blackley(1988)		X		X					
Wilton and Prescott(1990)	X		X						

Notes:
PMA = prime aged males
*denotes ΔU for PMA

to be a consensus that the aggregate unemployment is not the correct measure of labour market tightness and that the correct relationship between the measure of excess demand and inflation is a linear one. At the provincial level, Table I shows that the empirical relationship between inflation and unemployment has been found to be linear, and the provincial aggregate unemployment rate seems to be the variable of choice, despite substantial evidence of a changing U*.

3.4 - Estimates of the Natural Rate of Unemployment

Another aspect of this literature that can be surveyed is the estimates of U* attained by various authors. National estimates have been provided by Riddell and Smith(1982), Miller(1987), Fortin(1989), Cozier and Wilkinson(1990), and Burns-(1990a). These results are presented in Table II.

Several techniques can be used to estimate the natural rates of unemployment, U*. First, one can estimate an EAPC, using the observed unemployment rate as a measure of labour market tightness, and interpret the constant term as the natural rate. But, as noted in Chapter 2, the natural rate of unemployment is thought to have changed over time, and thus inferring the natural rate from a constant term would be erroneous (see Rose(1988)). Second, one can estimate an EAPC using some measure of the difference between the observed and natural unemployment rates (such as U-U*) as the measure of excess demand, and substitute in an equation for

U*. For the national level, Riddell and Smith(1982) use this method by substituting in U* = a0 + a1 UIC(t) + a2 DEM(t) into their EAPC, estimating the EAPC, and then deriving the point estimates of a1 and a2 from the estimated EAPC [13]. Thirdly, one could estimate an unemployment rate equation composed of cyclical, policy, and structural elements. Then, by setting the cyclical gap equal to zero, one can estimate U*, and the effects that structural and policy changes had on this equilibrium rate (see Coe(1990) and Burns(1990a) for Canada ; Burns(1990b), and Johnson and Kneebone(1991) for each province in Canada; and Miller(1987) for Canada and regional estimates).

Given this brief discussion, some estimates using either the second or third method of estimation described above are provided in Table II. It is interesting to note that the estimates of the time path of U* for Canada are extremely varied. All of the national estimates suggest a general upward trend from 1966 to 1972. From 1972 to 1980, Miller(1987) and Burns(1990) estimate that the national U* remained steady. Fortin, on the other hand, estimated that the Canada U* increased steadily until 1978, and then began to decline. Finally, from 1980 onward, the national U* either continually declines (Fortin(1989)), or increases (Burns(1990) and Miller(1987)). Cozier and Wilkinson(1990), using estimates from the RDXF model of the Bank of

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[13]. Their estimate of a0 was obtained by setting a0 equal to 6.6 percent in 1978(Fortin and Newton's estimate), and inferring what the NRU would be in the pre- and post- 1978 time periods by estimating the changes caused by movements in UIC(t). (DEM(t) was dropped from the estimated EAPC).

Table II
Estimates of Natural Rates of Unemployment, Canada
Various Time Periods

	Riddell and Smith (1982)	Miller (1982)	Fortin (1989)	Cozier and Wilkinson (1990)	Burns (1990a)
1966	4.8	2.7	5.8	5.6	4.8
1967	4.8	2.9	5.9	5.5	5.0
1968	4.9	3.9	6.0	5.7	5.4
1969	5.0	5.0	6.2	6.2	5.5
1970	5.0	4.7	6.6	6.1	6.5
1971	5.1	6.4	6.8	7.3	6.3
1972	6.5	6.2	7.1	8.2	6.5
1973	6.5	6.9	7.1	8.2	6.3
1974	6.5	7.1	7.2	8.2	7.3
1975	6.5	7.2	7.5	8.2	7.3
1976	6.5	7.9	7.8	8.2	7.4
1977	6.5	7.5	8.0	8.2	7.5
1978	6.6	8.1	8.0	8.2	7.1
1979	6.2	8.0	7.8	8.2	6.7
1980		8.2	7.7	8.2	7.2
1981		8.5	7.5	8.2	8.0
1982		8.4	7.5	8.2	9.7
1983		9.2	7.3	8.2	8.5
1984			6.9	8.2	8.7
1985			6.4	8.2	8.9
1986				8.2	7.9
1987				8.2	
1988				8.2	

Canada, offer a constant U* from 1972 on.

Of these estimates, Fortin(1989) in particular has been tested by other authors. McCallum(1987) found that Fortin's estimates of the Canadian U* were an accurate description of Canada's level of frictional unemployment, at least up to 1983 (McCallum(1987)). Like McCallum, Johnson and Kneebone(1991) also find that Fortin(1989) was somewhat low in his post-1983 estimates.

Despite support for Fortin's estimates as opposed to the other national estimates, a recent study suggests that all U* estimates should be treated with caution. A study by Setterfield, Gordon, and Osberg(1992) recently concluded that "..estimates of the NAIRU [or U*] are ***extremely sensitive to model specification***, [and] the definition of variables..[emphasis added]" (SGO(1992)). In a thorough examination to test how sensitive estimates of U* are to various specifications and variable definitions, Setterfield, Gordon, and Osberg found that their range of estimates was 5.5 percentage points. As they state:

" Indeed, the size of this range is so great that it covers virtually the entire range of male unemployment rates in Canada since 1956. This means that we could find a NAIRU model with desirable econometric properties to recommend almost any feasible male unemployment rate as the NAIRU in Canada in the mid 1980's." (SGO(1990)).

They close their argument by suggesting that "even the best available technology fails to recommend any consensus value of the NAIRU in Canada." While their argument is important and seemingly valid, Setterfield, Gordon and Osberg(1992) overlooked an important set of econometric tests - specification tests such as the RESET test. Upon applying these tests to their estimated regressions, one might find that many of their specifications do not satisfy this test. This process might have led to the elimination of many of their estimates of U*, and thus a more limited and reasonable range of national natural rates.

Until recently, estimates of the regional or provincial U* have been sparse. Miller(1987) estimated natural unemployment rates for the Atlantic provinces, Quebec, Ontario, the Prairie Provinces, and British Columbia. Two studies of more recent publication are Burns(1990b) and Johnson and Kneebone(1991). These two studies estimate natural rates of unemployment for each province in Canada. All of these estimates for the Prairies or Alberta are provided in Table III.

In Table III, one can see that the estimates for Alberta of Burns, and Johnson and Kneebone are substantially different. From 1966 to 1975, Johnson and Kneebone's estimates tend to travel around a value of 6%. Burns' estimates, on the other hand, increase dramatically from 3% in 1966 to 5.8% in 1972. Burns' estimates then decline to 3% in 1975. From 1975 to 1986, the differences are again large. Johnson and Kneebone estimate a steady decline in Alberta's U* from 1976-1986 to a value of 4.5% in 1986. Over the same time period, Burns estimates a general and persistent increase for Alberta to a maximum of 8.5% in 1985.

Table III
Estimates of Natural Rates of Unemployment, Alberta
Various Time Periods

	(A) Miller (1987)	(B) J & K (1991)	(C) Burns (1990)	(B) – (C)
1966	2.4	6.0	3.1	2.9
1967	2.2	5.8	3.6	2.2
1968	3.0	6.2	4.1	2.1
1969	4.1	6.5	4.7	1.8
1970	3.9	6.3	5.2	1.1
1971	5.0	6.2	5.8	0.4
1972	4.6	7.0	5.8	1.2
1973	4.9	6.7	5.2	1.5
1974	4.8	6.6	3.7	2.9
1975	4.6	6.2	3.0	3.2
1976	4.4	6.7	4.3	2.4
1977	4.7	5.3	4.6	0.7
1978	5.2	5.5	4.1	1.4
1979	5.4	4.4	3.3	1.1
1980	5.5	4.0	3.2	0.8
1981	5.8	3.8	5.2	−1.4
1982	6.3	3.9	7.1	−3.2
1983	6.6	4.0	8.0	−4.0
1984		4.1	7.7	−3.6
1985		4.2	8.1	−3.9
1986		4.5	7.4	−2.9

Hence, we find that the estimates of U* for Alberta cover a wide range. On average, the estimates of Burns(1990) and Johnson and Kneebone(1991) vary by plus or minus 2.13 percentage points, and the maximum difference was 4 percentage points in 1983 [14]. This range of estimates, like the national estimates, is likely a result of different model specifications and variable definitions.

In the case of Burns' estimates, one finds that the primary determinant of the U* estimates is the relative price of energy (Energy Price Index/provincial CPI). Burns finds that the sources of change of the unemployment rate in Alberta, i.e. structural, policy, and terms of trade contributed 5.29%, -.69%, and -1.62% respectively, where the only structural variable in the regression was the relative price of energy. In the case of Johnson and Kneebone's regression equations, the relative price of energy is not even included as a determinant of the Alberta U*.

Johnson and Kneebone did not include the price of energy as a determinant of U* due to a consideration offered by Coe(1990). As Coe suggests:

"..[s]upply or demand shocks, such as changes in oil prices...may be associated with changes in the unemployment that may last for some time if real wages fail to adjust. Should there be an impact on the natural rate, however, the ultimate cause would not be the shocks per se, but rather those structural aspects of the economy that prevent the adjustment of real wages." (Coe(1990))

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[14]. The time periods for which Alberta's NRU was estimated was 1962-1986 in Johnson and Kneebone(1991), and 1963-1986 for Burns(1990b).

If nominal wages and prices were very flexible, an oil price shock would have no effect upon the natural rate of unemployment. But, as discussed earlier, it may be plausible to assume that nominal wages and prices are not very flexible due to staggered contracts, efficiency wages, menu costs, and so on. The source of any change in the natural rate is a product of these wage and price rigidities which can be taken into account when constructing the equation to be estimated (see Equation (2.4)). Therefore, one can justify omitting the oil price variable from any attempt at estimating the natural rate of unemployment.

Another problem involves the variable defining unemployment insurance generosity. Johnson and Kneebone(1991) use the variable definition given by Fortin (1989) while Burns omitted an important element of this definition, the duration ratio. Fortin(1989) measured unemployment insurance generosity as the product of three ratios: i) *the replacement ratio* measuring the average weekly benefit to the average weekly wage, ii) *the coverage ratio* which measures the fraction of the labour force covered by UI, and iii) *the duration ratio* which is the ratio of the maximum number of weeks one is entitled to collect benefits to the number of weeks one must work to be eligible to collect benefits. Fortin(1984) warns of "spurious results" if this duration ratio is omitted from the regression since the revisions to the Unemployment Insurance Act in 1971 legislated a substantial change in this ratio.

It would seem that there is adequate evidence to suggest that the conclusions of

Setterfield, Gordon, and Osberg(1992) hold for Alberta's U*. That is, it can be said that there does not exist a "consensus value" for Alberta, and that the range of estimates covers a wide range.

3.5 - Conclusions

Several conclusions can be made based on this review of the EAPC literature. First, it is common to find that the coefficient on expected inflation is equal to unity, and therefore, that there is no-long run tradeoff between inflation and unemployment. Second, a linear functional form of the EAPC is commonly used. Third, a changing U* has been modelled at the national level, but little work has been done at the provincial level in an EAPC framework. Fourth, the natural rate estimates for Alberta cover a wide range. Finally, Setterfield, Gordon, and Osberg(1992) suggest the one of the main reasons for this range of U* estimates is model specification. This thesis will attempt to overcome this problem by using a specification test.

Chapter 4: Foundations for Empirical Work

4.1 - Introduction

In Chapter 2, it was posited that nominal wages could be modelled as a partial adjustment model outlined in Equation (2.4):

$$(2.4) \qquad w - \Sigma\, b_i\, w(-i) = h(w^* - \Sigma\, b_i\, w(-i)) \;;\; i=1..4;\; 0 \leq h \leq 1$$

The target wage, w*, is modelled by the following Phillips curve:

$$(4.1) \qquad w^* = g^e + a\,(U-U^*) + p^e + \beta X$$

where g^e is an expected rate of labour productivity growth, and X is a vector of other factors that affect the rate of change in the target wage, such as the AIB (Anti-Inflation Board) controls of 1976-78, seasonality, and wage spillovers.

The assumption of a unity coefficient on the expected rate of labour productivity growth, combined with the unity coefficient on expected inflation (explicitly tested), implies that in the long run, the real wage grows at the same rate as labour productivity. This assumption is consistent with standard neoclassical growth theory.

Substituting (4.1) into (2.4) results in:

$$(4.2) \qquad w = hg^e + (1-h)\,\Sigma\, b_i\, w(-i) + h\, p^e + ha\,(U-U^*) + h\beta X$$

At this point, we must substitute for the processes that determine: i) U*; ii) the expectations of inflation; and iii) the expected growth rate of productivity.

4.2 - The Estimating Equations

4.2.1 - The U* Equation

The function for U* will be modelled as a linear equation:

$$(4.3) \quad U^* = \alpha_0 + \alpha_1 U(-1) + \alpha_2 MINW + \alpha_3 TAX + \alpha_4 STRK + \alpha_5 RR + \alpha_6 MAXMIN + \alpha_7 SIGMA$$

where U(-1) is the observed unemployment rate lagged one period, MINW = the ratio of the minimum wage compared to the average wage, TAX = the average tax rate, STRK = number of strike days, RR = the ratio of the average weekly unemployment insurance benefit to the average weekly wage, multiplied by the percentage of the labour force covered by unemployment insurance, MAXMIN = the ratio of the maximum number of weeks that a person (with a relatively short work history) can collect UI benefits to the minimum number of weeks that one must work to be eligible for benefits, and SIGMA = the dispersion of employment across sectors of the economy. All of these variables are defined in detail in Appendix 2.

4.2.2 - Expectations of Inflation

An important specification issue is the modelling of inflationary expectations. The two prominent theories concerned with the formation of inflationary expectations are rational and adaptive expectations. The rational expectations method would require the estimation of the structural model that generates inflation. This method assumes that economic agents utilize this model of the economy to form their expectations of inflation. Adaptive expectations theory suggests that economic agents find the estimation of a structural model to be too costly relative to the benefits that such estimation provides, and hence form their expectations of future inflation using less expensive forecasting techniques. In particular, the theory of adaptive expectations suggests optimizing agents use past rates of inflation as an inexpensive way of forecasting future rates of inflation.

In empirical work, it seems that adaptive expectations is the dominant scheme for modelling expectations. Riddell and Smith(1982), Fortin and Newton(1982), Fortin(1989), Cozier and Wilkinson(1990), Cozier(1990), and Fortin(1991) are examples of the adoption of this methodology. This dominance is likely a result of two main criticisms against the use of rational expectations. First, economic agents will find that the costs of acquiring the necessary information to construct a structural model are too high relative to the benefits obtained (Fiege and Pearce(1976)). Secondly, it is unlikely that economic agents' will have knowledge of the true structural model that generates inflation. As a result, the structural model used to determine inflation expectations will be misspecified. This misspecification will lead to estimated coefficients of the structural model that will be far from the "true" coefficients (Friedman(1979)), and hence will produce inaccurate forecasts of inflation.

These shortcomings of the rational expectations argument cause agents to rely on the simpler method of past rates of inflation as an indication of the future. Fortin(1991) suggests that this simpler method has relatively few costs associated with it since the size of the errors are typically small. The primary reason for these small errors is that the annual change of "...Canadian CPI inflation for 1955-90...has exceeded two percentage points only four times..." . In short, " ...simply expecting inflation to continue at its current rate [or, at last period's rate], which is known to be a common labour and business practice, may in fact be extremely hard to improve upon." (Fortin(1991)).

An examination of the data over the sample period, 1967.3 to 1990.3, confirms that this argument also holds for Alberta. The annual change in wage inflation has exceeded two percentage points only five times suggesting that the error associated with inflation forecasts based on rates in the recent past would be relatively small.

Fortin(1991) summarizes the weaknesses of the rational expectations hypothesis:

" ...the 'rational expectations hypothesis'...as applied to expectations of inflation is a rather extreme characterization of the optimization problem faced by economic agents. The loss function is quadratic, the constraint is a linear representation of the true model of the entire economy, knowledge of the economic structure is costless and perfect, and computational abilities suffer no limit. The reason why this ***extreme hypothesis*** *[my emphasis added] has been so popular in macroeconomic thinking in the last twenty years is difficult to understand...."* (Fortin(1991))

In this thesis, the model of expectations will be expressed as:

$$(4.4) \qquad \dot{p}^e = \pi\, \dot{p}(-1)$$

where $\dot{p}(-1)$ is the inflation rate lagged one period, and π is the estimated coefficient that is expected to be equal to unity.

4.2.3 - Expected Rate of Productivity Growth

It is assumed that the expected rate of long-run productivity growth in Alberta is determined by the following linear equation:

$$(4.5) \qquad g^e = \delta + \Sigma\, \tau_i\, oil(-i)$$

where δ denotes a constant rate of productivity growth, and $\dot{oil}(-i)$ is the rate of change in the real price of oil lagged i periods. Any deviation from the constant rate of productivity growth, δ, is brought about by anticipated changes in the real price of oil. Anticipated changes in real oil prices are derived from an adaptive scheme consistent with the treatment of price expectations.

It is expected that an increase in the real price of oil will tend to increase expectations of labour productivity in Alberta because these higher prices should increase revenue and thereby increase capital investments. An increase in capital investments should lead to higher output per worker employed.

4.2.4 - The Equation to Be Estimated

Substituting equations (4.3)-(4.5) into (4.2) results in:

$$(4.6) \qquad w = (h\delta - ha\alpha_0) + (1\text{-}h)\, \Sigma\, b_i\, w(\text{-}i) + h\pi\, p(\text{-}1) + ha\, U$$
$$- ha\alpha_1\, U(\text{-}1) - ha\alpha_2\, MINW - ha\alpha_3\, TAX - ha\alpha_4\, STRK - ha\alpha_5\, RR$$
$$- ha\alpha_6\, MAXMIN - ha\alpha_7\, SIGMA + h\beta X + h\, \Sigma\, \tau_i\, oil(\text{-}i) + e(t)$$

The vector X consists of AIB controls, wage spillovers, and seasonal variables. Substitution of these variables into (4.6) produces:

$$(4.7) \qquad w = (h\delta - ha\alpha_0) + (1\text{-}h)\, \Sigma\, b_i\, w(\text{-}i) + h\pi\, p(\text{-}1) + ha\, U$$
$$- ha\alpha_1\, U(\text{-}1) - ha\alpha_2\, MINW - ha\alpha_3\, TAX - ha\alpha_4\, STRK - ha\alpha_5\, RR$$
$$- ha\alpha_6\, MAXMIN - ha\alpha_7\, SIGMA + h\beta_1\, AIB76 + h\beta_2\, AIB77$$
$$+ h\beta_3\, AIB78 + h\beta_4\, Q1 + h\beta_5\, Q2 + h\beta_6\, Q3 + h\beta_7\, wont(\text{-}1)$$
$$+ h\beta_8\, wque(\text{-}1) + h\beta_9\, wman(\text{-}1) + h\beta_{10}\, wsask(\text{-}1)$$
$$+ h\beta_{11}\, wbc(\text{-}1) + h\, \Sigma\, \tau_i\, oil(\text{-}i) + e(t)$$

where i = (1..4) for oil(-i) and i=(1...5) for w(-i).

Equation (4.7) will be the basic linear equation used in the empirical work that follows.

The various variables are defined as follows: w is the rate of wage inflation in Alberta and w(-i) is the rate i periods ago; p(-1) is the rate of CPI inflation one period ago; U is the current unemployment rate and U(-1) is the unemployment rate lagged one period; AIB76, AIB77, and AIB78 are dummy variables for the period that the Anti-Inflation Board existed (1976 to 1978); Q1, Q2, and Q3 are quarterly dummy variables; oil(-i) is the rate of change in the real oil price i periods ago; and wont(-1), wque(-1), wman(-1), wsask(-1), and wbc(-1) are the rates of wage inflation in Ontario, Quebec, Manitoba, Saskatchewan, and British Columbia lagged one period. All of the other variables are as defined in Equation (4.3) above. Further detail on any of these variables can be found in Appendix 2.

Equation (4.7) provides a robust base for testing several hypotheses. First, one can determine the magnitude of α_1, and test the hypothesis that this coefficient is not statistically different from unity by imposing the restriction that (ha-haα_1) = 0. If this hypothesis cannot be rejected, the equation provides evidence of hysteresis. On the other hand, if this hypothesis is rejected, the magnitude of the coefficient measures how persistent is the natural rate of unemployment.

Second, one can test for the statistical significance of all of the remaining α's in (4.7) by imposing the restriction that (ha-haα_i) = ha or -haα_i = 0. This latter restriction can be tested by referring to the t-statistic reported in the results of (4.7). If ha (the coefficient on the unemployment rate) is found to be significant and the t-statistic for the coefficient, -haα_1, is close to zero, the coefficient from the natural rate equation (4.3), α_i, can considered not statistically different from zero.

Finally, one can simultaneously test that i) all of the labour force has been taken into account in terms of labour contracts signed in the past (Σ b_i = 1) and ii) the accelerationist hypothesis holds (π = 1), by imposing the restriction that sum of all of the coefficients on lagged rates of wage inflation (the w(-i)'s) and price inflation (π) is equal to unity (i.e.$(1-h) \Sigma b_i + h\pi = 1$).

One difficulty associated with (4.7) is that one cannot recover α_0 (the constant term in the natural rate equation (4.2)) from the estimated constant term, ($h\delta - ha\alpha_0$), since the value of δ is not known. This problem was first dealt with by Riddell and Smith(1982) by assuming that U* was equal to the observed U in a chosen year. Using this technique, α_0 can be determined by solving equation (4.2), since the value of all of the natural rate determinants are known and the corresponding coefficients can be recovered from (4.7).

4.3 - Statistical Tests of Interest

4.3.1 - RESET Tests

The RESET is a general test for specification error caused by both omitted variables and the use of an incorrect functional form (Hall, Johnston, and Lilien (1990)). The test is applied by running the original regression, calculating the predicted values of the dependent variable (YHAT), and then re-estimating the original regression with various powers of YHAT as additional independent variables. If these additional variables are found to be jointly insignificant, the null hypothesis that the given specification is correct cannot be rejected. The RESET test has an F-distribution with i, and N-k-i degrees of freedom where N is the number of observations, k is the number of explanatory variables in the original regression, and i is the power of the RESET test.

Various RESETs were calculated for each estimated equation. RESET(1) estimates a test regression with YHAT squared as an additional independent variable. RESET(2) estimates a test regression with YHAT squared and cubed as additional variables. A RESET(3) test is usually suggested to be the most reliable (Hall, Johnston, and Lilien (1990)). The results of all of the RESETs are provided in Tables IV and VI.

4.3.2 - Q-Statistic

The Q-statistic is a commonly-used test for the null hypothesis that the residuals are white noise. If the calculated Q-statistic is less than the chi-squared critical value with K degrees of freedom [15], the null hypothesis that the residuals are white noise cannot be rejected. The Q-statistic is calculated by summing the autocorrelation coefficients squared over a specified number of lags and then multiplying this sum by the number of observations in the sample [16].

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[15]. K denotes the number of lags. In this thesis, the number of lags specified for the test was 12.

[16]. Pindyck, Robert S. and Rubinfeld, Daniel L. (1981), and Box and Pierce(1970).

4.4 - Graphs and Brief Discussion of Variables

Graphs of some of the data has been provided in Figures 1 to 8 (on the following pages). A brief discussion of some of these variables is provided below.

Figure 1 and 2 suggest that the same general pattern is exhibited in both series, and both series exhibit sharp declines during 1976. These sharp declines may have been caused by the guidelines set by the Anti-Inflation Board in 1976, and continued to issue guidelines until the end of 1978. Constant dummies are therefore used to measure the effect that the AIB had on wage inflation during its tenure.

Figure 3 provides a view of the substantial differences in the levels of the unemployment rate over the sample period. Compared to the late 1960's and all of the 1970's, the unemployment rates of the 1980's are extremely high.

The proposed U* determinants are presented in Figures 4 to 8 inclusive. The minimum wage (Figure 4) as compared to the average weekly wage, MINW, has declined substantially in recent times. In contrast, the level of the tax rate, TAX (Figure 5), has tended to trend upward over the sample period.

A brief look at Figure 6 and 7 illustrates the changes that have been instituted in the Unemployment Insurance system. The graph shows two distinct structural breaks in the level of the RR (replacement ratio * coverage ratio) and MAXMIN (duration ratio) following the 1971 and 1977 reforms. After these reforms, MAXMIN has been held constant, since both MAX and MIN are determined by the provincial unemployment rate in the post-1978 period.

Figure 8 shows that SIGMA, the dispersion of employment across sectors, has tended to trend slightly downward over the sample period.

The next chapter discusses the use of the above data to estimate the EAPC equations (4.7) and (4.8).

Figure 1. Wage Inflation (w)

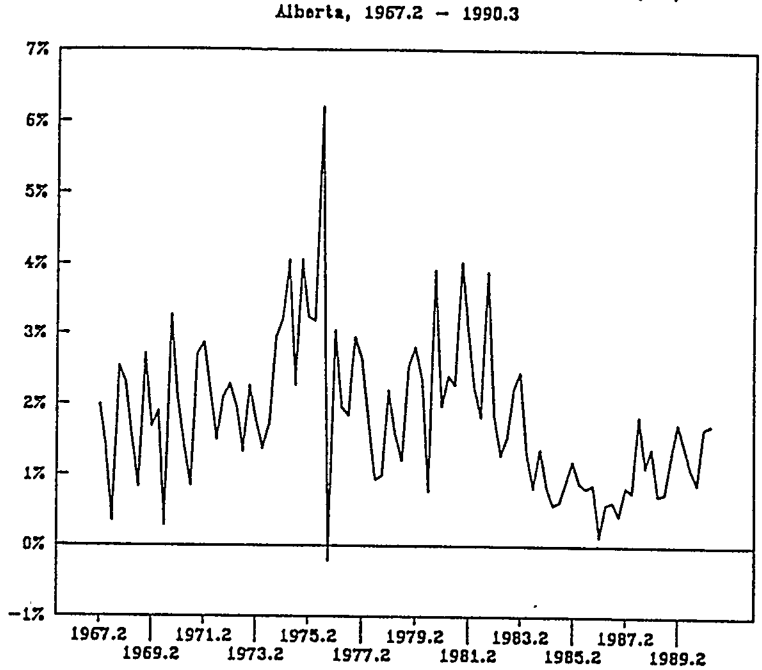


Figure 2. Price Inflation (p)

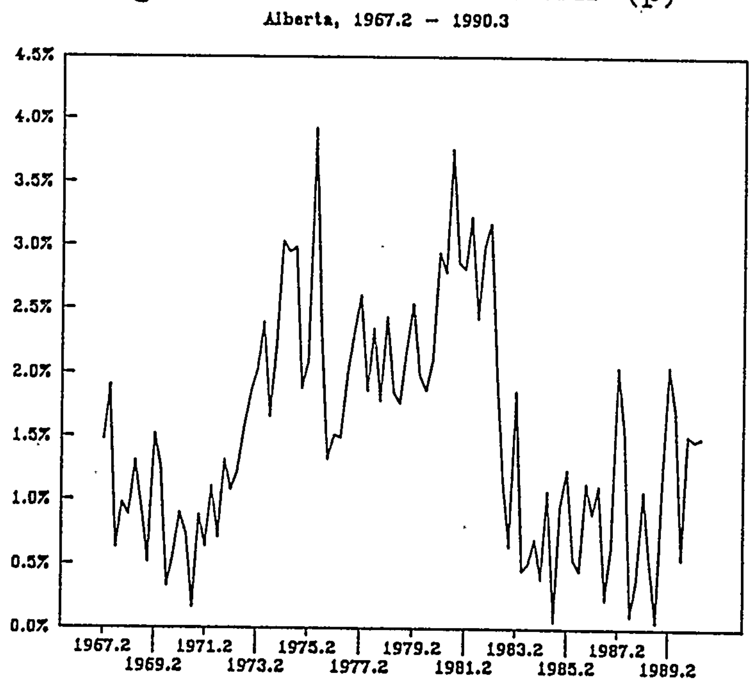


Figure 3. Unemployment Rate (U)

Alberta, 1967.2 – 1990.3

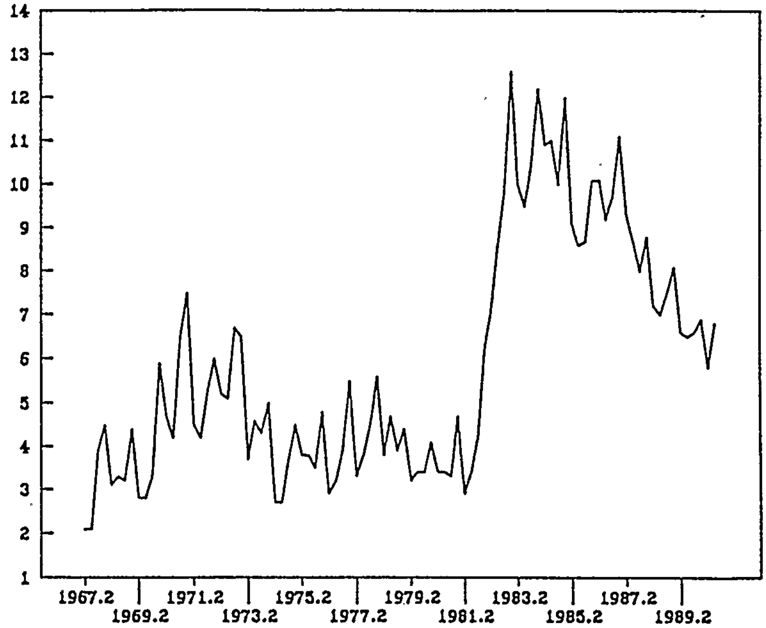


Figure 4. MINW

Alberta, 1967.2 – 1990.3

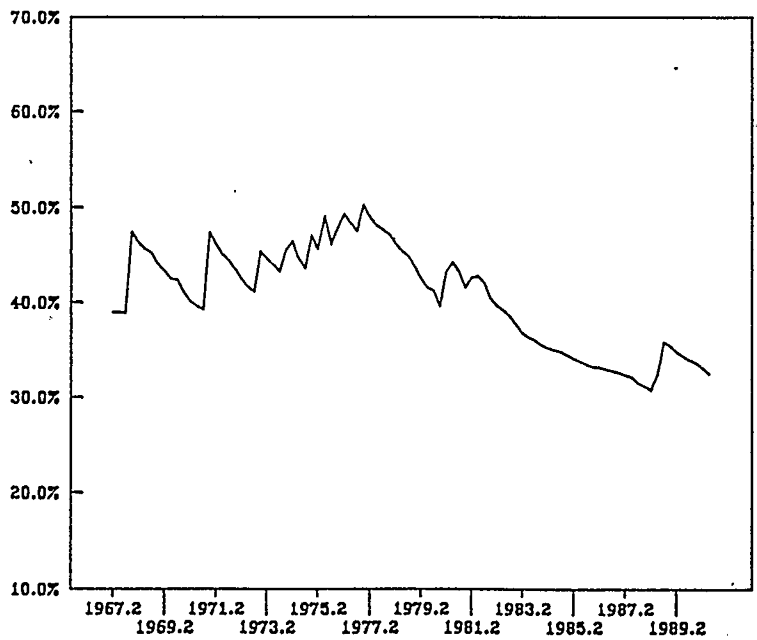


Figure 5. TAX

Alberta, 1967.2 - 1990.3

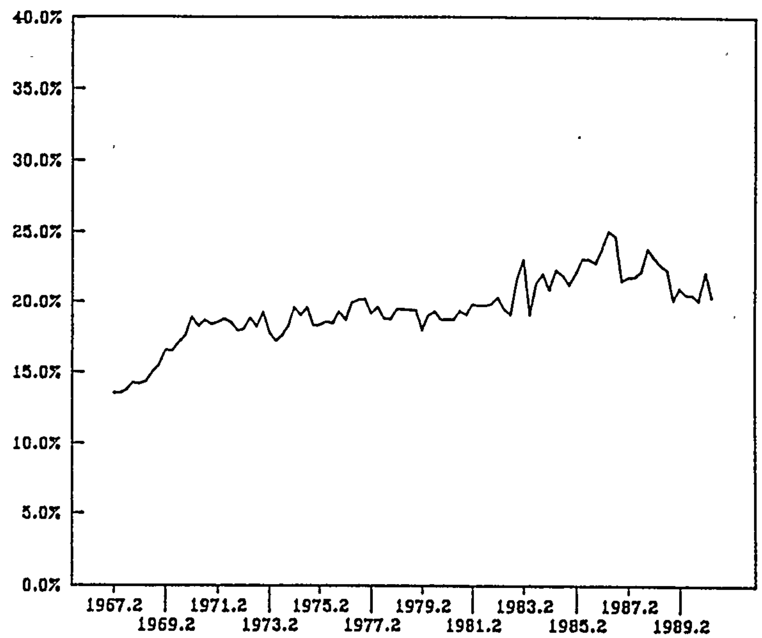


Figure 6. RR

Alberta, 1967.2 - 1990.3

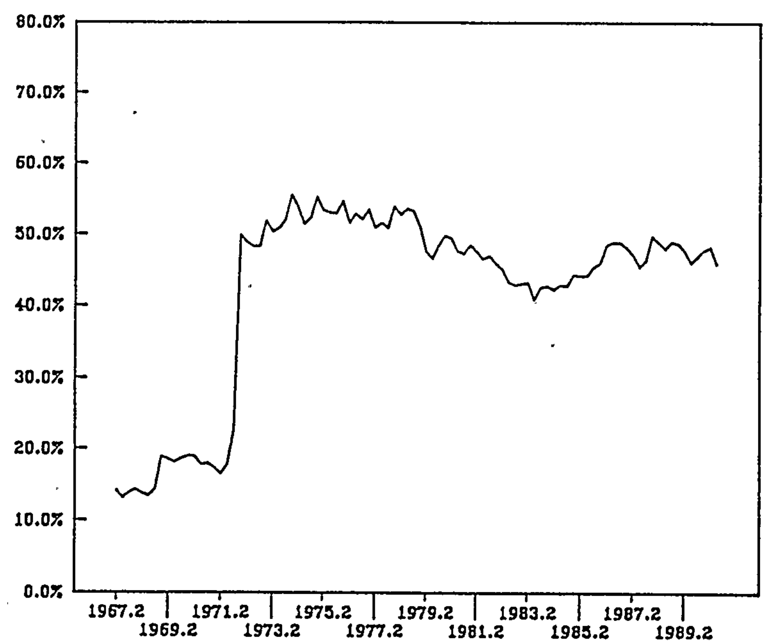


Figure 7. MAXMIN

Alberta, 1967.2 – 1990.3

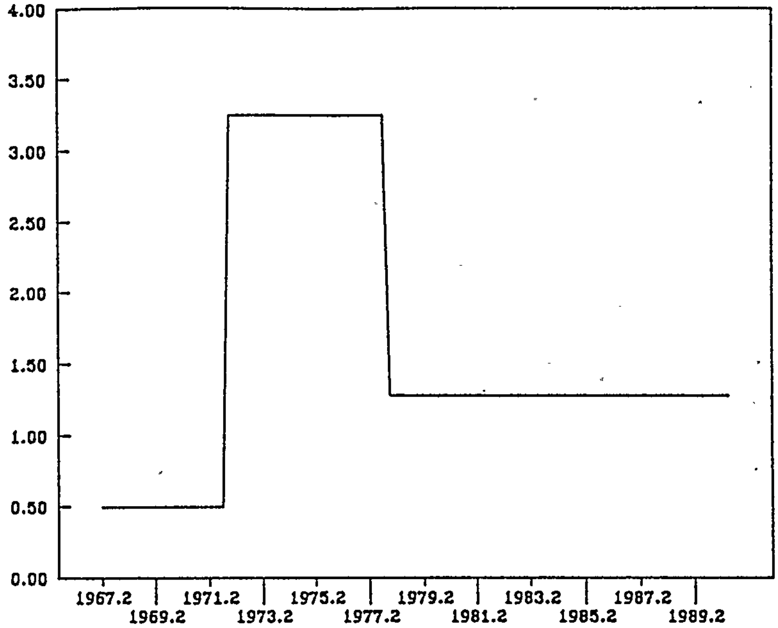
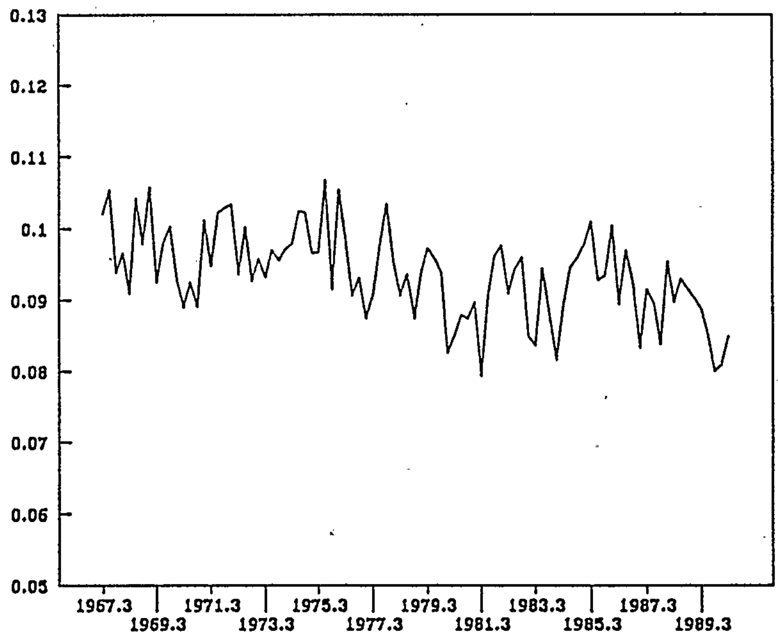


Figure 8. SIGMA

Alberta, 1967.3 – 1990.3



Chapter 5: Empirical Results

5.1 - Introduction

This chapter presents the empirical results of this thesis. The estimated equation was presented as equation (4.7) in Chapter 4.

5.2 - The Estimated EAPC

Based on the results presented in Table IV, the results should be considered quite good. The adjusted R-squareds are relatively high, the Q-stats indicate that the null hypothesis that the residuals are white noise could not rejected, and, in the preferred regression (Equation (3)), the RESET tests suggest no misspecification.

The first step in the estimation process was to estimate (4.7) (presented as equation (1) in Table IV), and test for the validity of the wage spillover hypothesis. An F-test was applied to the equations to test the hypothesis that the coefficients on wque(-1), wont(-1), wman(-1), wsask(-1), and wbc(-1) were jointly equal to zero. This null hypothesis could not be rejected (F=0.76 with a prob value of 0.58). Therefore, these variables were dropped from equation (1) and this new equation was estimated and is presented as equation (2) in Table IV.

An explanation for this rejection of the wage spillover hypothesis may be that Alberta's economy is largely made up of industries unique to Canada - especially the energy industry. Wage increases in the manufacturing sectors of Ontario and Quebec

Table IV – Estimated EAPCs
(Various Restrictions Imposed)

Variables	Equations (1)	(2)	(3)
Constant	−0.0399 (−1.57)	−0.0383 (−1.53)	−0.0343 (−1.43)
w(−i) ***	0.3393 * (5.49)	0.4742 * (5.12)	0.5759 * (8.93)
p(−1)	0.3925 * (2.47)	0.3982 * (2.61)	0.4241 * (2.92)
U	−0.3836 * (−3.00)	−0.3491 * (−2.98)	−0.3798 * (−3.65)
U(−1)	0.1874 (1.48)	0.1652 (1.42)	0.1945 ** (1.87)
Q1	0.0088 * (2.52)	0.0103 * (4.01)	0.0107 * (4.45)
Q2	−0.0005 (−0.13)	0.0013 (0.38)	0.0008 (0.23)
Q3	−0.0005 (−0.18)	0.0020 (0.85)	0.0018 (0.80)
AIB76	−0.0231 * (−4.61)	−0.0218 * (−4.58)	−0.0222 * (−4.72)
AIB77	−0.0093 ** (−1.84)	−0.0086 ** (−1.77)	−0.0079 ** (−1.69)
AIB78	−0.0090 ** (−1.71)	−0.0093 ** (−1.80)	−0.0080 ** (−1.72)
MINW	0.0240 (0.58)	0.0244 (0.60)	0.0093 (0.30)
TAX	0.2472 * (3.07)	0.2161 * (2.78)	0.2226 * (2.91)
STRK	−0.0006 (−1.16)	−0.0005 (−0.97)	−0.0005 (−0.93)
SIGMA	0.0579 (0.37)	0.0757 (0.50)	0.0786 (0.52)
RR	−0.0303 (−1.50)	−0.0261 (−1.34)	−0.0310 ** (−1.76)
MAXMIN	0.0022 (1.05)	0.0020 (0.98)	0.0023 (1.17)
oil(−i) ***	0.0184 (0.84)	0.0211 (0.90)	0.0206 (0.91)
wont(−1)	0.0801 (0.55)		
wque(−1)	0.1284 (1.36)		
wman(−1)	−0.0782 (−0.74)		
wsask(−1)	0.0783 (0.72)		
wbc(−1)	0.0019 (0.43)		
R−Squared	0.60	0.61	0.71
Q(12)	10.66	8.27	8.14
RESET(1)	12.08 *	13.38 *	0.18
RESET(2)	7.94 *	7.08 *	1.41
RESET(3)	5.43 *	5.01 *	0.94

* denotes significance @ 5% level of confidence
** denotes significance @ 10% level of confidence
*** denotes i = {1...5} for w(−i) and {1...4} for oil(−i)

Note: The values in brackets for w(−i) and oil1(−i) are F statistics for the hypothesis that all of the coefficients are jointly equal to zero. All other values in brackets are t−statistics.

should have little relevance to the energy sector workers in Alberta. Furthermore, while British Columbia and Saskatchewan have significant oil and gas related sectors, they are relatively small compared to Alberta's. Hence, Alberta's wage increases in the energy industry are more likely to exert some influence on these provinces' rates of wage inflation rather than vice versa.

The second step was to estimate equation (2) with the following hypothesis imposed: $h\pi + (1\text{-}h)\ \Sigma b_i = 1$ where $i=(1..5)$. This hypothesis jointly tests for the validity of: i) the accelerationist hypothesis (i.e. $\pi=1$), and ii) that all of the labour force has been taken into account in the nominal wage framework (i.e.$\Sigma b_i=1$). This hypothesis could not be rejected (F=0.34 with a prob value of 0.56). Equation (3) presents the estimated coefficients with this restriction imposed.

Finally, the third step in the process was to test for hysteresis. This restriction was tested by imposing the following restriction upon equation (3): $ha - ha\alpha_1 = 0$ (or the coefficient on the current unemployment rate plus the coefficient on the lagged unemployment rate sum to zero). This hypothesis was easily rejected (F=9.49) indicating the value of α_1 (equal to 0.51) is significantly smaller than unity. At the same time, statistical significance of the coefficient on U(-1) (t=1.87 with a prob value of .07) provides some support for the hypothesis that α_1 is greater than zero. These results suggest that unemployment in Alberta is characterized by persistence but not hysteresis. This finding will be discussed in more detail below.

Individually, several of the coefficients were found to be highly significant in equation (3). The coefficients on the lagged wage and price variables (the w(-i)'s and p(-1)), the current unemployment rate (U), one of the AIB dummy variables (AIB76), one of the seasonal dummy variables (Q1), and the current tax rate (TAX) were all significant at the 95% level of confidence. Two of the determinants of U* (the lagged unemployment rate (U(-1)) and the replacement ratio times the coverage ratio (RR)) and two of the AIB dummies (AIB7 and AIB78) were significant at the ten percent level. Only the sign of the estimated coefficient on RR was found to be opposite to a priori expectations.

5.3 - The Unemployment Insurance Generosity Variable(s)

In the preliminary work, one equation was estimated with RR and MAXMIN as separate variables, and another with the variable UIG (RR*MAXMIN) only. The results using the variable UIG were not reported in the thesis for reasons discussed below.

The sign of the estimated coefficient on the RR variable was found to be contrary to a priori expectations and significant, albeit at the ten percent level of significance. The MAXMIN variable, although of the expected sign, never proved to be statistically significant. Several attempts were made to further investigate the role of unemployment insurance. First, the MAXMIN variable was held constant after the 1978 reforms to unemployment insurance. This step was taken since the MAXMIN variable and U were highly correlated in the post-1978 period (both the MAX and MIN components of the ratio are determined by the provincial unemployment rate after 1978). Second, dummy variables were used to adjust for the unemployment insurance reforms in 1971 and 1978. Finally, following Riddell and Smith(1979), a variable defined as the product of RR and MAXMIN (UIG) replaced RR and MAXMIN in the regression.

All of the results were found to be of poorer quality than those presented in that the MAXMIN and RR, or UIG variables were usually incorrectly signed, and none of these variables or the dummy variables for the policy shifts were statistically significant.

Fortin, Keil, and Symons(1992) used an approach similar to the one finally adopted in this thesis, and obtained good results when estimating regional, rather than provincial, unemployment equations. The authors used no dummy variables for policy shifts, and the UIG variable was separated into its components parts, RR and MAXMIN. Hence, the approach taken in this thesis is not without precedent.

5.4 - U* for Alberta

5.4.1 - Recovery of the U* Coefficients

Using the results of equation (3) in Table IV, the coefficients for the U* equation (4.3) were recovered in the following manner. To recover the coefficients of the variables, U(-1), MINW, TAX, SIGMA, STRK, RR, and MAXMIN, one divides the estimated coefficients in the EAPC by the negative of the coefficient on the current unemployment rate, U. For example, in equation (4.7), the estimated coefficient on the variable, TAX, is $(-ha\alpha_3)$, and the coefficient on U is ha. If one divides the former by the negative of the latter coefficient, one recovers α_3, the coefficient on the TAX variable in the U* equation (4.3).

The estimation of the constant term in equation (4.3) is based on a technique employed by Riddell and Smith (1982). It is assumed that in the quarter period before the sample period (second quarter of 1967), the actual unemployment rate was equal to U*. Therefore, the constant term for (4.3) can be calculated as follows.

Remembering equation (4.3):

$$(4.3) \qquad U^* = \alpha_0 + \alpha_1\,U(-1) + \alpha_2\,MINW + \alpha_3\,TAX + \alpha_4\,STRK + \alpha_5\,RR + \alpha_6\,MAXMIN + \alpha_7\,SIGMA$$

Assuming U=U*=2.1 in 1967.2, (4.3) becomes:

$$\alpha_0 = 2.1 - [\alpha_1\,U(-1) + \alpha_2\,MINW + \alpha_3\,TAX + \alpha_4\,STRK + \alpha_5\,RR + \alpha_6\,MAXMIN + \alpha_7\,SIGMA]$$

Since one knows all of the estimated coefficients and the levels of the variables at 1967.2, α_0 can be readily solved for.

5.4.2 - Estimates

The U* estimates (presented in Table V), compared to the actual unemployment rate, suggest that the Alberta economy had a very small cyclical element until the recession of the early 1980's. Since that time, the economy has generally suffered from higher levels of cyclical unemployment. In fact, the average unemployment gap (U-U*) from 1967.3 to 1981.4 was 1.20, and this same statistic for 1982.1 to 1990.3 was 1.84. In other words, during the earlier period, the actual unemployment rate averaged about 1.20 percentage points above U*, while the same average for the latter period was 1.84 percentage points.

Another consideration was to compare these estimates with those found in the literature. Two recent studies which produced annual estimates of Alberta's U* are Burns(1990b) and Johnson and Kneebone (1991). The average was taken of the quarterly U* estimates generated in this thesis, and compared to the results of these studies found in the literature. Burns' and this thesis' estimates of U*, over the 1967 to 1986 period (Burns' estimates are only up to 1986), were very similar, and both series are plotted in Figure 9. This high degree of similarity is not surprising since both studies found nearly identical persistence effects: Burns' estimate was .56 and this thesis found an effect of .51. In contrast, Johnson and Kneebone's estimates were

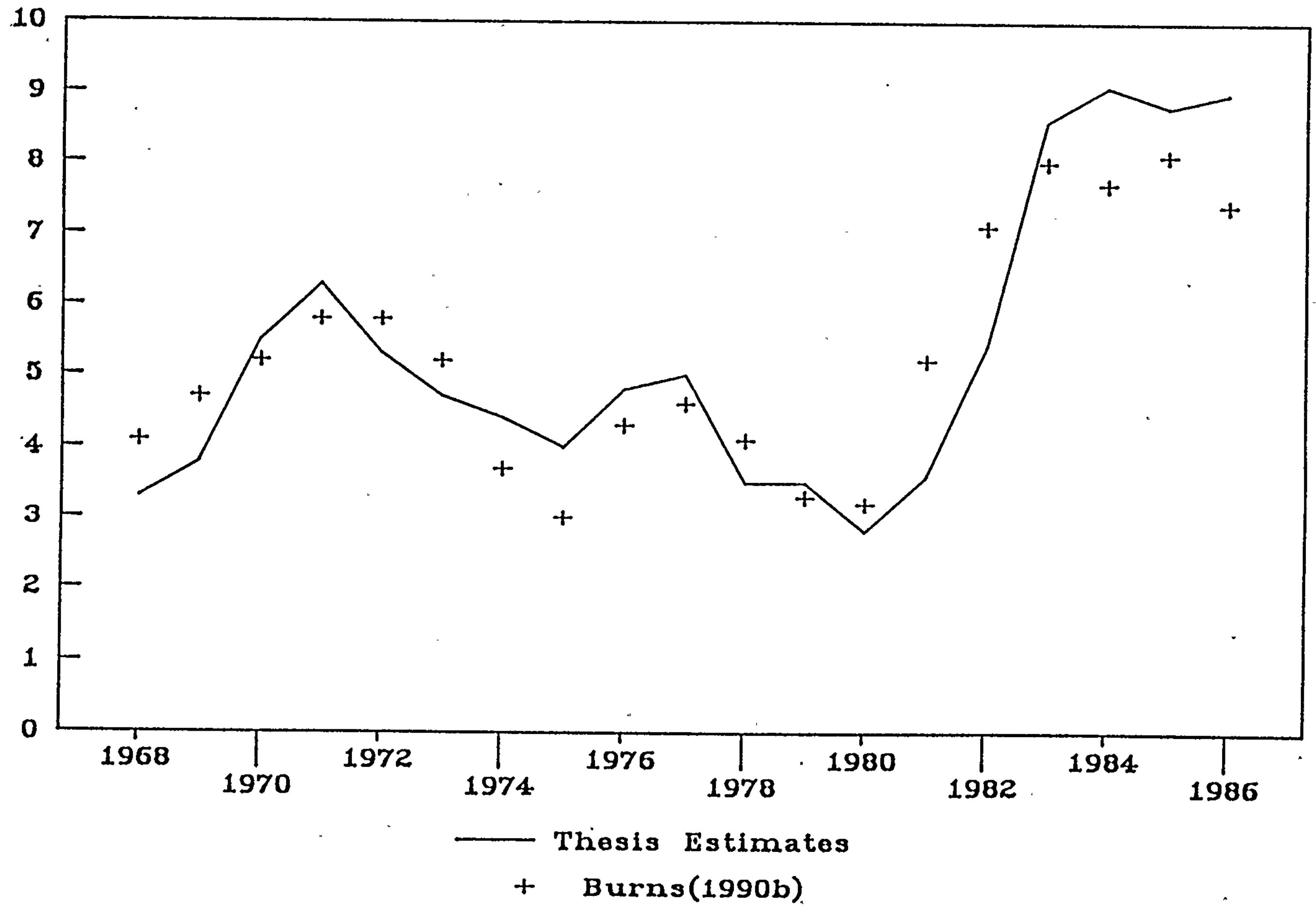
Table V – U Estimates for Alberta, Quarterly*
3rd Quarter 1967 – 3rd Quarter 1990

Quarter	Actual U	U*
1967.3	2.1	2.0
1967.4	3.9	2.1
1968.1	4.5	3.3
1968.2	3.1	3.6
1968.3	3.3	2.9
1968.4	3.2	3.4
1969.1	4.4	3.3
1969.2	2.8	4.6
1969.3	2.8	3.5
1969.4	3.3	4.0
1970.1	5.9	4.5
1970.2	4.7	6.5
1970.3	4.2	5.4
1970.4	6.5	5.5
1971.1	7.5	6.7
1971.2	4.5	7.5
1971.3	4.2	5.9
1971.4	5.3	5.3
1972.1	6.0	5.0
1972.2	5.2	5.5
1972.3	5.1	5.4
1972.4	6.7	5.0
1973.1	6.5	6.1
1973.2	3.7	5.3
1973.3	4.6	3.3
1973.4	4.3	3.9
1974.1	5.0	4.1
1974.2	2.7	5.2
1974.3	2.7	3.9
1974.4	3.7	4.3
1975.1	4.5	3.9
1975.2	3.8	4.1
1975.3	3.8	3.6
1975.4	3.5	4.4
1976.1	4.8	4.4
1976.2	2.9	5.2
1976.3	3.2	4.7
1976.4	3.9	4.8
1977.1	5.5	5.3
1977.2	3.3	5.6
1977.3	3.8	4.6
1977.4	4.5	4.6
1978.1	5.6	3.5
1978.2	3.8	4.3
1978.3	4.7	2.4
1978.4	3.9	3.7
1979.1	4.4	3.5
1979.2	3.2	3.3
1979.3	3.4	3.5
1979.4	3.4	3.6

Quarter	Actual U	U*
1980.1	4.1	3.1
1980.2	3.4	2.4
1980.3	3.4	2.3
1980.4	3.3	3.3
1981.1	4.7	3.0
1981.2	2.9	4.4
1981.3	3.4	3.2
1981.4	4.2	3.8
1982.1	6.2	3.8
1982.2	7.1	5.4
1982.3	8.6	5.8
1982.4	9.8	6.5
1983.1	12.6	8.6
1983.2	10.0	10.6
1983.3	9.5	7.1
1983.4	10.4	8.3
1984.1	12.2	9.0
1984.2	10.9	9.0
1984.3	11.0	9.2
1984.4	10.0	9.2
1985.1	12.0	8.2
1985.2	9.1	9.7
1985.3	8.6	8.9
1985.4	8.7	8.4
1986.1	10.1	8.3
1986.2	10.1	9.2
1986.3	9.2	9.2
1986.4	9.7	9.2
1987.1	11.1	7.8
1987.2	9.3	8.5
1987.3	8.7	8.0
1987.4	8.0	7.8
1988.1	8.8	7.3
1988.2	7.2	8.3
1988.3	7.0	7.1
1988.4	7.5	6.9
1989.1	8.1	5.8
1989.2	6.6	6.7
1989.3	6.5	5.8
1989.4	6.6	5.6
1990.1	6.9	5.2
1990.2	5.8	6.3
1990.3	6.8	5.1

Figure 9. Comparison of U* Estimates

1968 – 1986



found to very different from those estimated in this thesis. This difference in estimates can likely be attributed to Johnson & Kneebone not allowing for the possibility of persistence (or hysteresis) in their study.

5.4.3 - Hysteresis

A very important empirical question is whether or not hysteresis exists in the Alberta labour market. As reported earlier in this chapter, hysteresis could not be imposed upon the estimated equation (3) in Table IV. No evidence of hysteresis is important since it suggests that a policy induced recession would have only temporary costs in terms of higher unemployment as opposed to permanently higher U* in the case of hysteresis.

Nonetheless, U* is persistent in that any shock to actual unemployment will increase U* for several periods. Although the effect is temporary, the coefficient on U(-1) of .51 in the U* equation (4.3) suggests, ceteris paribus, a one-quarter shock to the actual unemployment rate would increase (or decrease) U* above (or below) its initial level for about five quarters. After five quarters have passed, U* would return 99% of the way back to its initial level. This analysis suggests that the level of persistence is fairly low in the Alberta economy.

5.5 - The Final Equation

The following EAPC equation will be used to estimate the measures of NWR and RWR, and the sacrifice ratios. Since we know the estimates of U* for the sample period, one can use these values to generate measures of the unemployment gap. The procedure eliminates all of the natural rate determinants from the equation (since their effects are embedded in the U* estimates), and thus will likely produce the best estimate of Alberta's expectations-augmented Phillips curve. The final equation is:

$$w = (h\delta - ha\alpha_0) + (1-h)\,\Sigma\, b_i\, w(-i) + h\pi\, p(-1) + ha\,(U-U^*) \quad (5.1)$$
$$+ h\beta_1\, AIB76 + h\beta_2\, AIB77 + h\beta_3\, AIB78 + h\beta_4\, Q1 + h\beta_5\, Q2$$
$$+ h\beta_6\, Q3 + h\tau_1\, oil(-1) + h\tau 2_2\, oil(-2) + h\tau_3\, oil(-3)$$
$$+ h\tau_4\, oil(-4) + e(t)$$

The estimated equation is presented in Table VI.

5.6 - Measures of Nominal Wage (NWR) and Real Wage (RWR) Rigidity

From the estimated EAPC (5.1), one can derive the estimates of nominal wage and real wage rigidity. Since the accelerationist hypothesis holds, both $\Sigma\, b_i$ and π equal unity. One can recover h (which provides for a measure of NWR (1/h)) from the equation, since it is the factor by which π is multiplied. Once one has recovered h from equation (5.1), the coefficient on the observed unemployment rate, ha, can be divided by h to recover the estimate of RWR, which is based on the parameter a (RWR = 1/a).

Table VI – Final Equation

Variables	
Constant	−0.0001 (−0.09)
w(−i) ***	0.5752 * (12.44)
p(−1)	0.4248 * (3.92)
(U−U*)	−0.3586 * (−5.58)
Q1	0.0104 * (4.71)
Q2	0.0011 (0.45)
Q3	0.0019 (0.90)
AIB76	−0.0230 * (−5.94)
AIB77	−0.0090 * (−2.57)
AIB78	−0.0088 * (−2.57)
oil(−i) ***	0.0191 (1.11)

R−Squared	0.73
Q(12)	7.64
RESET(1)	0.23
RESET(2)	1.48
RESET(3)	0.99

* denotes significance @ 5% level of confidence
** denotes significance @ 10% level of confidence
*** denotes i = {1...5} for w(−i) and {1...4} for oil(−i)

Note: The values in brackets for w(−i), and oil1(−i) are F statistics for the hypothesis that all of the coefficients are jointly equal to zero. All other values in brackets are t−statistics.

Based on the result of the estimated final equation in Table VI, h was found to be equal to 0.42 or NWR = (1/h) = 2.35. For comparison, Cozier(1990) estimates imply an h of 0.73 or an measure of NWR equal to 1.37 for the Canadian economy as a whole (see Cozier(1990), Table 6, Equation (3)). As mentioned earlier, if h=1 which implies NWR = 1, nominal wages are perfectly flexible in that the theoretical sources of rigidity exert no influence upon wage adjustment, and COLA indexation of labour contracts is 100%. If h=0 or NWR approaches positive infinity, nominal wages are perfectly rigid, and there is no COLA indexation. The estimates of this thesis suggest that nominal wages in Alberta are considerably less flexible or more rigid than the NWR for Canada as a whole.

The estimate of RWR (1/a) was found to be approximately 4.0 for Cozier's national estimate and 1.19 for Alberta using the equation estimated in this thesis. In this instance, Alberta's estimates are considerably lower than the national one of Cozier's, indicating a less rigid real wage for Alberta than for the national level. In other words, Alberta's real wages appear to be more sensitive (or less rigid) to current labour market conditions than do real wages at the national level.

These results provide evidence that justifies the estimation of provincial EAPCs across Canada. Labour markets behave differently in Alberta and Canada as a whole, and the estimation of a national EAPC is a poor guide for measuring the effects of monetary policy. Unfortunately, none of the published Bank of Canada research address these important differences in provincial labour markets. Alberta's labour market was found to be quite sensitive to current labour market conditions (relatively low RWR). Since the national coefficient derived from Cozier is simply a weighted average of all provincial coefficients, there must be some provinces with higher than national RWR. These provinces would suffer a great deal from a tightening of the money supply (more than Alberta), and estimation of these other provincial EAPCs would provide measures of the impact.

5.7 - Sacrifice Ratios

The sacrifice ratios were also calculated based on the final equations presented in Section 5.5. The sacrifice ratios depend upon the NWR and RWR estimates discussed in section 5.6 since the coefficient on the unemployment gap is -ha in (5.1) and (5.2) where (1/h) measures NWR and (1/a) measures RWR.

Essentially, the sacrifice ratio measures the cost of disinflation by estimating the cumulative amount that the unemployment gap must increase to decrease wage inflation by one percent. It is common when calculating sacrifice ratios to not take the adjustment of price expectations into account (see Fortin(1990), Scarth(1990), and Howitt(1990)). This oversight leads to an underestimation of the costs of disinflation since the adjustment process to a lower rate of inflation depends not only on the slope of the EAPC, but the speed with which price expectations adjust.

The procedure for calculating the sacrifice ratio for Alberta begins with finding the sum of the following five equations made up of various estimated coefficients from equation (5.1) and presented in Table VI. These five equations are derived as follows.

Ignoring all other variables except for the unemployment gap and lagged wage and price inflation variables in equation (5.1), one can re-write (5.1) as:

$$w = (1\text{-}h) \{ b_1 w(-1) + b_2 w(-2) + b_3 w(-3) + b_4 w(-4) + b_5 w(-5) \} + h\pi p(-1) + ha (U - U^*)$$

Solving for (U-U*) produces:

$$(5.2) \quad (U - U^*) = (1/ha) \{ w - (1\text{-}h)b_1 w(-1) - (1\text{-}h)b_2 w(-2) - (1\text{-}h)b_3 w(-3) - (1\text{-}h)b_4 w(-4) - (1\text{-}h)b_5 w(-5) - h\pi p(-1) \}$$

Now, the first step in determining the cumulative effect upon the unemployment gap of a permanent one percentage point decrease in wage inflation (w) is to take the partial derivative of (U - U*) with respect to w in (5.2):

$$(i) \qquad d(U - U^*)/dw = (1/ha)$$

This derivative only measures the impact of reducing w in the current period. In future periods, the effect of a permanent reduction will be felt until all wage contracts have expired. To illustrate this, one can rewrite (5.2) one period in the future as:

$$(U - U^*)(+1) = (1/ha) \{ w(+1) - (1\text{-}h)b_1 w - (1\text{-}h)b_2 w(-1) - (1\text{-}h)b_3 w(-2) - (1\text{-}h)b_4 w(-3) - (1\text{-}h)b_5 w(-4) - h\pi p \}$$

Since the reduction in w is permanent, w = w(+1). Furthermore, if the assumption is made that changes in w are fully incorporated into p by the next period, p = w. Therefore, the above equation becomes:

$$(5.3) \quad (U - U^*)(+1) = (1/ha) \{ w - (1\text{-}h)b_1 w - (1\text{-}h)b_2 w(-1) - (1\text{-}h)b_3 w(-2) - (1\text{-}h)b_4 w(-3) - (1\text{-}h)b_5 w(-4) - h\pi w \}$$

Taking the partial derivative of (5.3) will produce the impact of a permanent one percentage point reduction in w one period into the future. Hence:

$$\text{(ii)} \qquad d(U - U^*)(+1)/dw = (1/ha) \{ 1 - (1\text{-}h)b_1 - h\pi \}$$

By continuing this process, the following partial derivatives would be produced:

$$\text{(iii)} \qquad d(U - U^*)(+2)/dw = (1/ha) \{ 1 - (1\text{-}h)b_1 - (1\text{-}h)b_2 - h\pi \}$$

$$\text{(iv)} \qquad d(U - U^*)(+3)/dw = (1/ha) \{ 1 - (1\text{-}h)b_1 - (1\text{-}h)b_2 - (1\text{-}h)b_3 - h\pi \}$$

$$\text{(v)} \quad d(U - U^*)(+4)/dw = (1/ha) \{ 1 - (1\text{-}h)b_1 - (1\text{-}h)b_2 - (1\text{-}h)b_3 - (1\text{-}h)b_4 - h\pi \}$$

The final partial derivative would include the coefficient on w(-5) ((1-h)b_5). This partial derivative would sum to zero since the sum of the coefficients on lagged wage inflation and price inflation is restricted to equal unity. Therefore, the cumulative effect that a permanent reduction of one percentage point in w has upon (U - U*), is simply the sum of the partial derivatives (i) to (v).

Upon substituting in the appropriate coefficients from the results reported in equation 3, Table IV, the cumulative number of percentage points of unemployment estimated to result from a one percentage point reduction in w is calculated to be

10.47. That is, the unemployment gap would have increased by 2.79 percentage points in the first quarter, 2.39 in the second quarter and third quarters, 2.02 in the fourth quarter, and 0.88 percentage points in the fifth quarter. Since the sacrifice ratio is the cumulation of the impacts upon the unemployment gaps, its size depends upon the periodicity of the data. For comparison with other studies - studies which use annual data - we define the sacrifice ratio as the cumulative increase in the ***annual*** unemployment gap resulting from a permanent one percentage point decline in inflation. Therefore, in the first year, the annual unemployment gap would increase by an average of 2.40 percentage points (i.e. the average of 2.79, 2.39, 2.39, and 2.02). In the second year, the annual unemployment gap would increase by an average of 0.22 percentage points (i.e. the average of 0.88, 0, 0, and 0). One can see that the comparable sacrifice ratio derived from this thesis would be 2.62 (2.40 + 0.22).

How does this estimated cost of disinflation to Alberta compare to national estimates? While the approach taken earlier to calculate Alberta's sacrifice ratio cannot be applied to Cozier's(1990) estimated EAPC (the individual coefficients on the lagged wage and price variables were not reported in the article), a rough estimate of the sacrifice ratio would be the inverse of the coefficient on the linear unemployment gap. This calculation suggests that a permanent decrease in the rate of wage inflation could be purchased for a temporary increase of 6.5 percentage points in the linear unemployment gap. The comparable estimate for Alberta was found to be 2.79 (using the same rough estimate (1/ha from Table IV)). It appears that the costs of inflation are much lower in Alberta than at the national level. Again, this result implies that some provinces must have costs of disinflation not only higher than Alberta's, but higher than the national weighted average.

5.8 - Conclusions

Many conclusions have been drawn from the empirical results of this thesis. First, the estimated EAPC produced reasonable coefficients, estimates of U*, measures of NWR and RWR, and sacrifice ratios. The U* estimates were found to be very similar to Burns(1990b) estimates for Alberta, nominal wages were found to be less flexible (more rigid) than at the national level, and real wages were found to be less rigid. Secondly, wage spillovers were found to play no significant role in the determination of wage inflation in Alberta. Thirdly, no evidence of hysteresis was found. Instead, support for a persistent U* was established. The policy implications of these findings will be discussed in the next chapter.

Chapter 6: Policy Implications

6.1 - Introduction

Several policy implications can be discussed based on the empirical results of this thesis, which are reported in Chapter 5. Among the topics that will be discussed are:

i) provincial control over U*,

ii) current economic conditions, and

iii) various provincial effects of federal policies.

6.2 - Provincial Control Over U*

The results of this thesis suggest that there is one primary policy area within which the provincial government can act to lower U* in Alberta. In all of the estimated equations, the level of the tax rate was found to be significant. In this area, the provinces can direct some measure of control, and therefore could lower tax rates to effectively lower the natural rate of unemployment. The estimate provided by this thesis suggests that a one percentage point decline in the effective tax rate would decrease the natural unemployment rate by about 0.006 percentage points. Hence, even though it is statistically significant, the actual impact of a policy change is fairly small.

The only exclusive provincial jurisdiction is in the area of minimum wage setting. But, the econometric results suggested that the level of the minimum wages was not a major factor in the determination of the natural rate for Alberta. Therefore, the only policy area open to the provincial government in Alberta to effectively decrease U* is tax policy.

6.3 - Persistence and Current Economic Conditions

At present, the Alberta economy is experiencing some difficult times. Observed unemployment rates have climbed to relatively higher levels in the recent past, and given the evidence supporting persistence in U*, U* in this province has temporarily increased as well. This temporarily higher U* implies that if we could suddenly eliminate the cyclical element from the Alberta unemployment rate, ***any time during the five quarters that U* is higher than its initial level***, the number of unemployed workers would be higher than the period prior to the economic slowdown.

These higher levels of U and U* imply that the provincial government of Alberta is to be faced with lower tax revenues, and possibly, higher social assistance expenditures. The net effect would be a higher annual budget deficit in times when the voting public are very sensitive to higher levels of public debt. While the estimated costs are likely to be temporary, they are substantial nonetheless and part of these costs must be borne by a level of government that had little or no input into the initial policy decision.

6.4 - Provincial Effects of Federal Policies

As stated several times in this thesis, the estimation of a national EAPC provides no information as to how each individual province is affected by the federal government's actions. Yet, no published Bank of Canada reports address this issue. More research into the estimation of provincial EAPCs would provide support for the argument that the federal government's actions have caused various provincial effects.

Furthermore, Canada has a diverse economic base but, for the most part, each of these bases are found in a specific area of the country. For instance, Southern Ontario is the center of manufacturing in Canada while Alberta is a primarily energy-based economy. During the mid-1980's, the Ontario economy was undergoing a period of boom and the provincial government of Ontario "..refused to run budget surpluses..." (Scarth(1992)) which further fuelled the economy. On the other hand, the Alberta economy was performing poorly as oil and gas prices plummeted.

Hence, increasing interest rates to combat high inflation in Ontario was harmful and inappropriate for Alberta. While the effects of a one percentage point decrease in wage inflation is only temporary (in the sense that the natural unemployment rate will be higher only for 5 quarters), the short-term policy-induced recession may be difficult for some provinces to endure. One policy option that might ease these short-term difficulties may be increased transfers to provinces most affected by the recession. A more long-term solution may lie in regionally coordinated fiscal policies (see Scarth(1992)). In these ways, regions would either be compensated for the costs imposed by the recession or better able to control their own economies using regionally coordinated policy instruments.

6.5 - Conclusions

The following policy implications can be drawn from this thesis' empirical results. First, the provincial government does not have much control over this province's U*. The only area of influence that exists is tax policy and this effect was found to be quite small. Second, persistence implies that, in times of economic downturns, U* will increase substantially for about five quarters. At any time during these quarters, if the cyclical element of the Alberta unemployment rate could be suddenly eliminated, the number of unemployed would be considerably higher than before the economic downturn. Thirdly, higher levels of U and U* will result in higher budget deficits at the provincial level. Finally, more research and estimation of provincial EAPCs would enable provincial governments to lobby for assistance, and perhaps, provide a basis for the argument that monetary policy aimed at one region of Canada has lengthy and substantial effects on other areas of Canada. This argument could lead to increased transfers to affected provinces and perhaps, a discussion of regionally coordinated fiscal policy.

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Appendix 1 - Efficiency Wages and Real Wage Rigidities
(based on work by Akerlof and Yellen(1985) and Blanchard and Fischer (1989).

Let an individual firm's production function be:

(2.1.1) $$Y_i = (eN_i)^a$$

where e = e(W) where W is the real wage, and e is the average effort exerted by workers employed by the firm.

The individual firm's demand function is:

(2.1.2) $$Y_i = (P_i/P)^{-b}\ (M/P)$$

where P_i denotes the individual firm's product price, P denotes the general price level of the whole economy, and M, the aggregate nominal money supply..

By rearranging the production function, one can derive an expression for labour demand:

(2.1.3) $$Ni = Y_i^{(1/a)}\ /e(W)$$

We know that the profit function of an individual firm has the following form:

(2.1.4) $$\text{Profits} = P_iY_i - W_iN_i$$

where W_i denotes the nominal wage.

Substituting the firm's demand function (equation (2.1.2)) and the labour demand function (equation (2.1.3)) into (2.1.4) results in the following profit function:

(2.1.5) $$\text{Profits} = P_i\ (P_i/P)^{-b}\ (M/P) - W\ P\ (P_i/P)^{-(b/a)}\ (M/P)^{(1/a)}\ e(W)$$

Equation (2.1.5) is the profit function used by Akerlof and Yellen (1985), pg.831.

Differentiating (2.1.5) with respect to the real wage, W:

$$(P_i/P)^{(-b/a)} (M/P)^{(1/a)} P \{-W (e(W))^{-2} e'(W) + e(W)^{-1}\} = 0$$

or

$$-W (1/e(W)^2) e'(W) = -(1/e(W)) \qquad (2.1.6)$$

Multiplying both sides by e(W):

$$(W/e(W)) e'(W) = 1$$

This expression suggests that the first order conditions for the optimal real wage does not depend on the nominal money supply. Rather, the optimal real wage is selected where the elasticity of average effort with respect to the real wage is equal to unity. This result implies that firms will follow some rule of thumb to adjust wages, and not adjust wages instantaneously in response to a nominal shock.

Differentiating the profit function, equation (2.1.5) with respect to the product price results in:

$$(M/P)^{(1-b)} (1-b) P^{-b} - (W_i/e(W)) (M/P)^{(1/a)} (1/P)^{-(b/a)} p_i^{((-b/a)-1)} = 0$$

Taking logarithms and ignoring constants, one can obtain:

$$\ln M - \ln Pi + b \ln P - b \ln P - \ln W - (1/a)(\ln M - \ln P) + (-b/a) \ln P + (b/a) \ln Pi + \ln Pi = 0$$

Setting $P_i = P$ in the long run, and cancelling terms results in:

$$\ln P_i = \ln W_i + (c-1)(\ln M - \ln P)$$

where $c = (1/a)$.

One can interpret this expression as follows. Suppose an unexpected change in nominal money occurs. The immediate response of a profit-maximizing firm should be to decrease the real wage that they pay their workers. But, if a and thus c are close to one (i.e. constant returns to scale), the cost to firms who do not quickly adjust real wages will be small, because the right-hand side of the expression is only slightly greater than the product price, P_i. Thus, real wages may not change immediately due to the firm's adherence to a rule of thumb to set wages, and the cost in terms of less than optimal profits will be small.

Appendix 2 - The Data and Variable Definitions

The data used is quarterly and spans the period, 1966.1 to 1990.3 (n=99). Data that was available monthly was averaged to obtain quarterly estimates. Any data available on an annual basis was held constant for the four corresponding quarters.

To allow for lags, the actual sample period used was 1967.3 to 1990.3 (n=93). Variables in lower-case letters represent growth rates, while capital letters represent levels.

All of the data used is expressed in decimal form. For example, a 3 percent rate of change in wage inflation is expressed as .03.

The following data was used:

AWE_i = monthly average weekly earnings ("adjusted" Industrial Aggregate) for province i (where i = Ontario (Ont), Quebec (Que), Manitoba (Man), Saskatchewan (Sask), Alberta (Alta) and British Columbia (B.C.)) (Stats Can #72-002).

Note: A major change in the coverage of the labour force survey occurred in the second quarter of 1982. Prior to this time, the average weekly wage was measured by the Industrial Composite. After February 1982, this same indicator was measured by the Industrial Aggregate. The series overlap to some extent, and under the advice of Robert Keay of Statistics Canada, a factor was estimated to splice the two series together. The factor was simply the industrial aggregate AWE divided by the

Industrial Composite AWE which worked out to 0.9154 for Alberta. The Alberta Industrial Composite for all months previous to 1982.02 were multiplied by this factor. All other provincial AWEs were spliced using this same method. It was judged that the 1987 definitional changes had little effect on the AWE indicators.

CPI = monthly Consumer Price Index for Alberta (1981=100) (Stats Can # 62-010) Note: This monthly series was calculated from the Alberta CPI (1949=100) from 1966.01 to 1970.12, and the Calgary and Edmonton CPIs (1981=100) from 1971.01 on. The Calgary and Edmonton CPIs were weighted by the population of each city (obtained from Alberta Bureau of Statistics) to estimate an Alberta CPI for the latter period.

AWB = monthly, after-tax unemployment insurance benefit for Alberta (Stats Can #73-001).

MAX = maximum number of weeks one may collect unemployment insurance benefits, given a relatively short work history and that the applicant has worked the minimum number of weeks to be eligible to collect unemployment insurance.

MIN = minimum number of weeks one must work to be eligible to collect unemployment insurance benefits.

All information on MAX and MIN was obtained from Dingledine, G. (1980); A Chronology of Response: The Evolution of Unemployment Insurance from 1940 to 1980; Employment and Immigration Canada.

COV = annual, persons covered by unemployment insurance (Stats Can #73-201).

LF = quarterly labour force (Stats Can #71-201).

RR = replacement ratio = (AWB/((1-TAXRATE)*AWE_{Alta}))*(COV/LF).

MAXMIN = (MAX/MIN), held constant after 1978.1 (see Chapter 5).

MINHOUR = minimum hourly wage (Labour Standards in Canada and Calgary Herald), changed in quarter that new legislation introduced.

MINW = ((MINHOUR*37.5)/AWE_{Alta}).

YOUTH = data not available at the provincial level.

WOMEN = data not available at the provincial level.

PI = quarterly, personal income (Conference Board of Canada).

YD = quarterly, personal disposable income (Conference Board of Canada).

TAX = ((PI - YD)/PI).

STRK = monthly, number of person-days lost due to strikes (Bureau of Labour Information, Labour Canada).

E_i = total employment in industry i, series constructed by Ron Kneebone using data from Survey of Employment, Payroll, and Hours adjusted for definitional breaks in March 1983 and January 1987.

E = ΣE_i.

e_i = $\ln E_i - \ln E_i(-1)$.

e = $\ln E - \ln E(-1)$.

SIGMA = dispersion of employment across sectors = $\{\Sigma (Ei/E) * [ei - e]^2\}^{1/2}$.

w = $\ln(AWE_{Alta}) - \ln(AWE_{Alta}(-1))$.

p = ln(CPI) - ln(CPI(-1)).

U = quarterly, current period's rate of unemployment (Stats Can #71-201).

AIB76 = first year of AIB controls (1976.1-1976.4 = 1, else = 0).

AIB77 = second year of AIB controls (1977.1-1977.4 = 1, else = 0).

AIB78 = third year of AIB controls (1978.1-1978.4 = 1, else = 0).

Q1,Q2,Q3 = seasonal dummies for the first, second, and third quarters of the calendar year.

wont = $\ln(AWE_{Ont}) - \ln(AWE_{Ont}(-1))$. Similar variables were constructed for Quebec(Que), Manitoba (Man), Saskatchewan (Sask), and British Columbia (BC)