

# **Labour Market Models of Unemployment in Australia\***

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## **Abstract**

This paper reviews evidence on the equilibrium rate of unemployment and on causes of unemployment in Australia from empirical modelling of labour market outcomes.

Three main types of models are reviewed – Phillips curve models; Multi-equation models; and Beveridge curve models. The paper begins with a simple review of labour market theory in order to provide some motivation for the empirical approaches that are examined. In the main part of the paper the three modelling approaches are reviewed. For each model the estimation methodology is described, main results on causes of unemployment from that approach are summarised, and an evaluation of the model is made.

## **1. Introduction**

The objective of this paper is to review evidence on the equilibrium rate of unemployment and on causes of unemployment in Australia from empirical modelling of labour market outcomes. Three types of models are reviewed:

- a) Phillips curve studies;
- b) Beveridge curve studies; and
- c) Multi-equation models of the labour market.

A watershed in empirical analysis of unemployment came with the studies of Friedman and Phelps in the late 1960s that applied the notion of equilibrium to the determination of unemployment in a Phillips curve framework (Friedman, 1968, and Phelps, 1968). Since that time the equilibrium approach has dominated empirical research on unemployment. In Australia the first application of the equilibrium approach was by Parkin (1973). That paper assumed the existence of a unique and constant equilibrium rate of unemployment. Subsequent Phillips curve studies have moved from the assumption of a unique and constant equilibrium rate of unemployment to allow for hysteresis and a time-varying equilibrium rate of unemployment, and for a range of equilibria.

Empirical modelling of the equilibrium rate of unemployment in a Phillips curve framework has been undertaken as a 'stand-alone' exercise, and also as part of multi-equation models of the Australian labour market. In the former type of study the emphasis is solely on estimation of a Phillips curve equation. In the latter type of study the Phillips curve (or a similar wage adjustment equation) is one of a set of equations estimated to characterise labour market outcomes. Other components of multi-equation models include equations for labour demand and labour supply. An important point is therefore that the multi-equation modelling approach uses a Phillips curve methodology to characterise the equilibrium rate of unemployment (and hence changes in the rate over time). The main difference between the Phillips curve and multi-equation modelling approaches is that the multi-equation method provides a richer framework for analysing the causes of changes in the equilibrium rate of unemployment than the Phillips curve approach. Essentially, this is because a multi-equation approach provides

greater scope to model and to statistically identify potential causes of unemployment than a single equation approach.

Beveridge curve modelling can be thought of as complementary to the Phillips curve and multi-equation approaches. It characterises the equilibrium relation between unemployment and vacancies in the labour market, and of particular relevance for this study, it provides a method for assessing the effects of structural change and search efficiency on changes in the equilibrium rate of unemployment. Hence, a Beveridge curve equation has often been incorporated into multi-equation models of the labour market.

This paper begins with a simple review of labour market theory. The purpose of this section is to provide some context for the foundations of the empirical approaches that will be examined. In the following sections each of the three types of modelling approaches is reviewed. For each model we summarise the estimation methodology and the main results on causes of increases in the rate of unemployment, and provide an evaluation of the modelling approach. A concluding section attempts to synthesise the findings from the alternative approaches on the causes of unemployment, and suggests future steps in empirical research on unemployment in Australia.

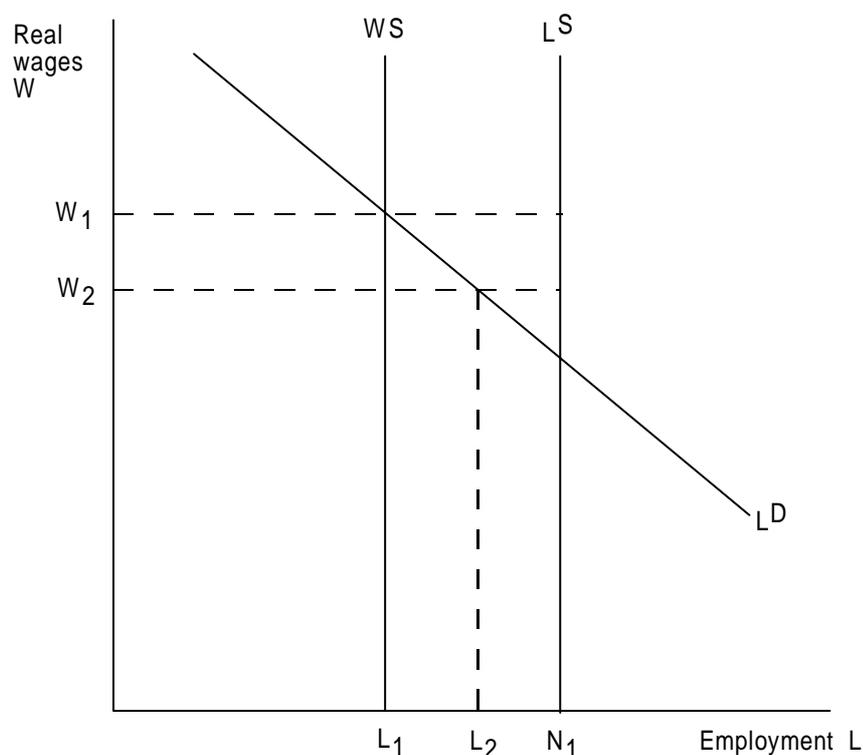
## **2. The contemporary theory of the labour market**

This section presents a brief review of contemporary theoretical modelling of the labour market and determination of the equilibrium rate of unemployment. Estimation of the Phillips curve and multi-equation models of the labour market is motivated directly from this theoretical framework. The Beveridge curve can be considered as a supplementary component to the model, through which the demand for labour is divided between jobs and vacancies.

The contemporary theory of the labour market on which we focus is based on the theory of wage bargaining where trade unions have bargaining power. In these settings involuntary unemployment will arise. This seems particularly relevant for Australia where trade unions and arbitration commissions are influential in labour market outcomes. (For other recent accounts of the contemporary theory of the labour market, see for example, Layard et al., 1991 and Bean, 1994).

A summary of the labour market model is shown in Figure 1. There are three basic components of the model: a labour demand curve ( $L^D$ ), a labour supply curve ( $L^S$ ) and a wage setting curve (WS).<sup>1</sup> Multi-equation models estimate the three structural equations,  $L^D$  (sometimes called the price setting equation), WS and  $L^S$ . The Phillips curve approach, since the Friedman/Phelps revolution of 1968, estimates a disequilibrium equation in which the rate of change of wages (or prices) relative to expected wages (or expected prices) depends on the difference between the actual rate of unemployment and the equilibrium rate of unemployment. The latter is determined as the reduced form of the system of equations described above.

*Figure 1*



The main theoretical novelties lie in the WS curve and so we concentrate our explanation on that aspect of the model.<sup>2</sup> The WS curve is derived from the theory of

<sup>1</sup> The precedent to the contemporary theory is the search approach developed especially in several papers in Phelps(1970). In the search approach the wage setting curve is based on the search behaviour of the unemployed. In those models unemployment is voluntary.

<sup>2</sup> The wage in the following analysis,  $W$ , is the real wage. The labour demand curve is in real terms.

wage bargaining. (In models of efficiency wages such as Shapiro and Siglitz, 1984 a similar curve is called the “non-shirking constraint”). From the theory of wage bargaining, the bargained wage emerges as a markup on the reservation wage.<sup>3</sup> This can be written

$$W = k W^R \quad (1)$$

where  $k$  = wage markup and  $W^R$  = reservation wage.

The markup is determined by trade union power and the elasticity of firms’ revenue with respect to employment. The latter captures the role of product market competition. Because it is hard to argue that there are any clear cut effects from the level of activity to this elasticity or to union power (as defined in the model - the idea being that the latter is determined by institutional and other factors which are invariant to the cycle), it is reasonable to adopt the benchmark that over the cycle the wage markup is fixed. However the reservation wage is subject to cyclical influence. This influence has a major impact on the shape and position of the WS curve.

To understand the cyclical influence on the reservation wage, and thus the WS curve of the level of activity, it is necessary to begin by defining the reservation wage for workers at a representative firm. Summarily, the reservation wage can be written as a weighted average of alternative wages and unemployment benefits, as:

$$W^R = (1-\rho)W^A + \rho B \quad (2)$$

where  $W^A$  = alternative wage and  $B$  = unemployment benefits.  $\rho$  is the weight attached to unemployment benefits. An interesting special case emerges from setting  $\rho$  equal to the rate of unemployment,  $u$ . In this case the reservation wage is thought of as the probability of getting an alternative job times the wage from that job plus the probability of not getting a job times the unemployment benefit. For this special case it can be shown that the equilibrium rate of unemployment depends on the wage markup and the ratio of unemployment benefits to wages,  $B/W = b$ . To see this, set  $\rho = u$ ,  $b = B/W$  and then from (2), assuming  $W^A = W$ , the equilibrium rate of unemployment is determined by

$$u = (k-1)/[k(1-b)] \quad (3)$$

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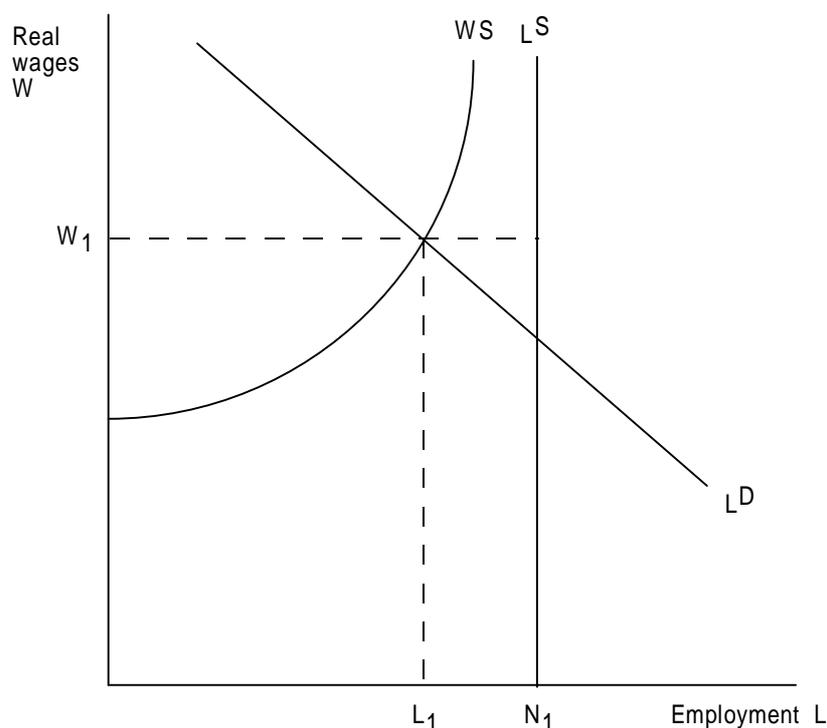
<sup>3</sup> Creedy and McDonald (1990) show this result for a variety of wage bargaining models.

( $W=W^A$  follows from assuming that the entire economy is composed of many identical union-firm pairs setting wages according to the wage markup formula above so that the alternative wage is the same as the wage from any union-firm bargain). For a particular value of  $b$  there will be a unique equilibrium rate of unemployment. The WS curve for this case is shown in Figure 1.

In Figure 1, the labour supply curve is assumed vertical. The labour demand curve is downward sloping. The WS curve is drawn assuming  $b$  is fixed. It lies to the left of the  $L^S$  curve, the distance being determined by the rate of unemployment that satisfies the equation determining the equilibrium rate of unemployment, equation (3). The uniqueness of the equilibrium rate of unemployment and the verticality of the  $L^S$  curve implies that the WS curve is vertical. The verticality of the WS curve shows the extreme cyclical responsiveness of the wage in this special case of  $\rho=u$  and  $b$  fixed. The equilibrium outcome is  $\{W_1, L_1, N_1\}$ . Note that the unemployment at this equilibrium outcome is involuntary in the sense that there are  $N_1 - L_1$  people who would like to work at the market wage of  $W_1$  but are unable to find jobs.

In many representations the WS curve is drawn as convex from above, approaching the horizontal as employment approaches zero, see Figure 2. One way to derive a convex from above WS curve is to assume that the real level of unemployment benefits,  $B$ , is fixed. This makes  $b$  variable. At lower levels of employment the lower real wage implies a higher value of  $b$ . One way of putting these two assumptions in a single framework is to assume that fixed  $B$  captures cyclical activity and fixed  $b$  captures long run outcomes. However one might question the importance that the model places on the setting of unemployment benefits.

*Figure 2*



Bearing in mind that the model here is based on trade union wage bargaining, several points deserve emphasis. First, if contractionary aggregate demand policy forces unemployment above the equilibrium rate then the inflation process operates in reverse, causing a downward spiral in the rate of inflation. Second, if  $b$  is fixed then the equilibrium rate of unemployment is unique and independent of the level of real aggregate demand. Third, if  $b$  is fixed then changes in real aggregate demand, which would shift the  $L^D$  curve, will not affect the equilibrium rate of unemployment. But if  $B$  is fixed then changes in real aggregate demand will affect the equilibrium rate of unemployment. One source of changes in  $L^D$  is changes in the capital stock or in total factor productivity (which change the marginal product of labour). The absence of a historical trend in the rate of unemployment in the face of large increases in the capital stock and technical knowledge supports the idea noted above that  $b$  fixed is a good long run assumption. Another source of changes in  $L^D$  is changes in the ratio of producer prices to consumer prices (workers are concerned with real wages in consumer purchasing power and firms with real wages in terms of the prices they receive for their output.) The latter may be caused by changes in the terms of trade or by changes in retail/producer price markups. These sources are short term or cyclical phenomena

which are usually thought to influence the rate of unemployment. If  $B$  is fixed then the model suggests that they would. However, as also noted above, the role of the setting of unemployment benefits, ie whether  $b$  or  $B$  is fixed, is playing a greater role in the behaviour of unemployment than seems reasonable.

One might think of the “long run” assumption of a fixed  $b$  as the most robust specification of the model. With  $b$  fixed, the following factors will affect the equilibrium rate of unemployment:

The rate of unemployment benefits relative to the wage. An increase in this replacement ratio will shift the WS curve to the left, increasing the equilibrium rate of unemployment.

An increase in union power will shift the WS curve to the left, increasing the equilibrium rate of unemployment.

An increase in search efficiency will reduce the probability of workers not getting a job (that is reduce  $\rho$ ). This will raise income of casual workers and lead to an increase in the equilibrium rate of unemployment.<sup>4</sup> Training programs and other subsidies to the unemployed will also on this logic raise the equilibrium rate of unemployment. (Below it is shown that allowing for heterogeneity in the labour force can reverse the result. An inverse relation between search efficiency and the equilibrium rate of unemployment is also emphasised in the later section on the Beveridge curve.)

An increase in the rate of tax on wages with no tax levied on unemployment benefits will raise the equilibrium rate of unemployment. By contrast, an increase in the proportional rate of tax levied on wages and unemployment benefits will not change the equilibrium rate of unemployment.

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<sup>4</sup> Mortensen (1970, p. 207-8) noted that in the search model of unemployment an increase in the search efficiency of the unemployed may increase the equilibrium rate of unemployment if it attracts extra employed people into unemployment to search for jobs. This perverse effect is clearly apparent in theory in the efficiency wage model of Shapiro and Stiglitz.).

Institutional factors can influence the equilibrium rate of unemployment through their effect on the union power parameter,  $k$ . For example outlawing secondary picketing, in as far as it reduces  $k$ , will reduce the equilibrium rate of unemployment.

The labour market model described thus far can be extended to allow for multiple equilibria, such as hysteresis or a range of equilibria. This can be done through a variety of mechanisms which extend the basic model – deskilling; the role of insiders in wage-setting; or loss aversion on the part of economic agents.

Deskilling implies that persons unemployed for longer periods lose their skills, or some of their skills, relative to recently employed people. In this situation the reservation wage for the employed is not adversely affected, at least not very much, by an increase in the numbers of long term unemployed. This breaks the proportionality between the rate of unemployment and  $\rho$ . To capture this in the model, specify the determination of  $\rho$  by

$$\rho = \rho(u, x) \text{ with } \rho_u > 0, \rho_x < 0 \quad (4)$$

where  $x$  represents the proportion of long term unemployed in total unemployment.

Thus an increase in  $u$  and  $x$  can leave  $\rho$  unchanged. Then using this in (3), for a given value of  $x$  there is a unique equilibrium rate of unemployment. But higher values of  $x$  support higher equilibrium rates of unemployment. This is shown in Figure 3 for a decrease in real aggregate demand. Starting at  $\{W_1, L_1\}$  a decrease in aggregate demand causes unemployment to increase. This increases long term unemployment, shifting the WS curve to the left. The final equilibrium is at  $\{W_1, L_2\}$ . Thus the equilibrium rate of unemployment has increased.

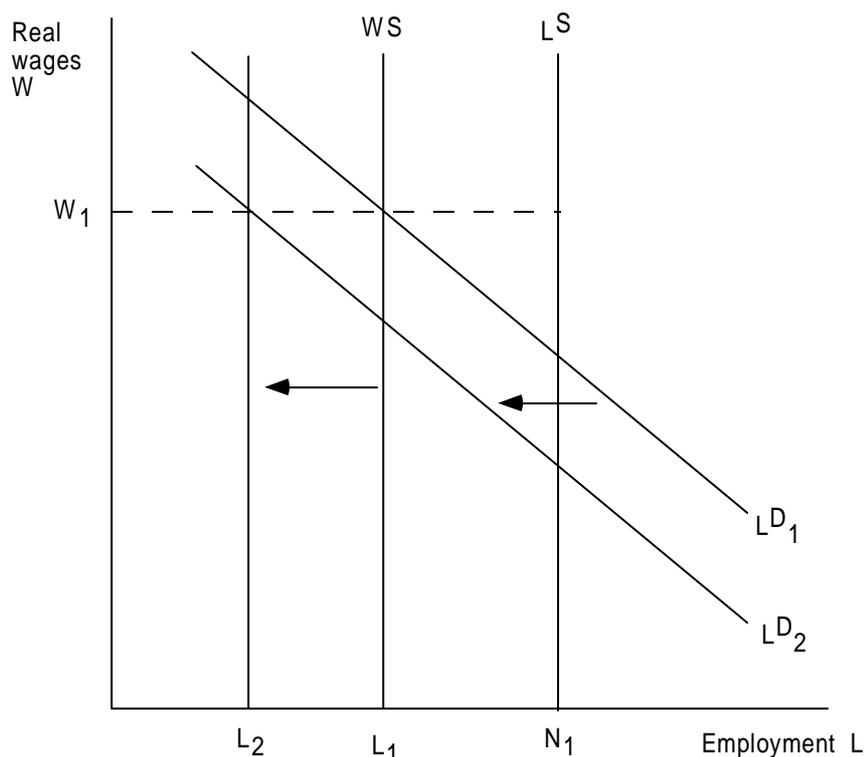
Under certain circumstances it has been shown that insiders in wage-setting can create hysteresis.<sup>5</sup> In the Blanchard and Summers (1986) model union membership adjusts towards the actual level of employment. Because the union is assumed to place a zero weight on the interests of non-members, the union's indifference curves have what McDonald and Solow (1984) had earlier called a "travelling kink", which moves with the level of employment. As a result, if employment contracts those workers laid off

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<sup>5</sup> A more simple account of the Blanchard and Summers model is in Blanchard and Fischer (1989, pp.447-51).

lose their influence in wage setting. The real wage adjusts up the labour demand curve. If demand subsequently expands the employed workers, by resisting any reduction in their real wage prevent employment from increasing. Hence, over the long-run the effect of insiders is to introduce an asymmetry into movement of the equilibrium rate of unemployment – it rises during contractions, but remains unchanged during expansions.

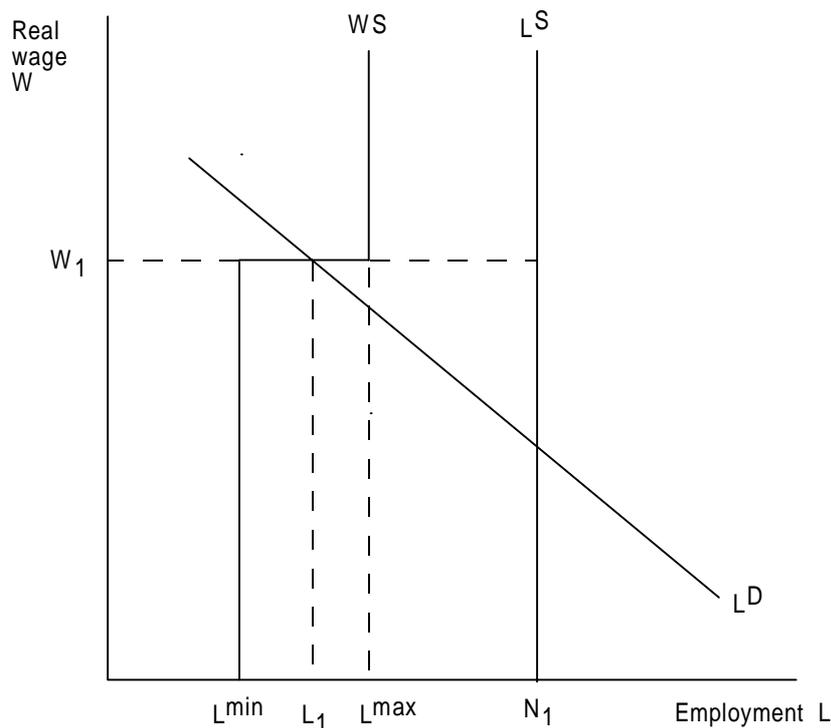
*Figure 3*



Loss aversion describes a discontinuity in the valuation of losses relative to gains in an economic agent's objective function. Relative to some reference level of consumption, the loss in utility from a reduction in consumption exceeds the gain in utility from an increase in consumption. Thus marginal utility has a jump at the reference level of consumption. For wage bargaining it seems particularly appropriate to think of the reference level of "consumption" as the wage earned by some reference group of workers, eg workers of similar skill levels. The effect of this discontinuity is to put a horizontal section in the WS curve, as shown in Figure 4. The horizontal section is determined by the reference wage. Only if unemployment gets very high (that is the level of employment gets below  $L^{\min}$ ) and thus the income if on strike gets very low, will workers be prepared to accept wage reductions. The range of equilibrium outcomes,

and thus the range of equilibrium rates of unemployment, is determined by the flat section of the WS curve. At any level of activity within this range, the rate of inflation will tend to be constant. There will be no disequilibrium forces causing the rate of inflation to change. But to attempt to force employment above  $L_1$  or below  $L_2$  would cause inflation to increase/decrease for as long as this force was exerted (McDonald and Sibly, 2000).

*Figure 4*



This review suggests a wide range of potential causes of increases in the rate of unemployment. Changes in aggregate demand can cause cyclical variations in unemployment, while movements in a range of supply-side factors such as unemployment benefits, union power, or taxes may cause permanent changes in unemployment. Where hysteresis effects exist (due to deskilling, insider effects, or loss aversion) then increases in unemployment due to cyclical movements in aggregate demand may also become permanent.

### 3. Phillips curve

#### a. Model description

In general the Phillips curve is written

$$\text{inflation} = a_1 + a_2 (\text{unemployment level effect}) + a_3 (\text{speed limit effect}) + b (\text{expected inflation effect}) \quad (5)$$

In most Phillips curve studies inflation is the rate of change of wages – however, some studies focus on the rate of change of prices. The unemployment level effect has, since the work of Friedman (1968) and Phelps (1968), been specified as the deviation of the actual rate of unemployment from the equilibrium rate of unemployment. The equilibrium rate of unemployment is sometimes known as the natural rate of unemployment or NAIRU. The speed limit effect is the effect of changes in the level of activity on the rate of inflation. In the original Phillips article the existence of this effect was inferred from the cyclical behaviour of data on inflation and unemployment; that is the data followed loops around the Phillips curve. These became known as Phillips loops. Compared with the theoretical work on the equilibrium rate of unemployment, there has been little work on the theory underlying the speed limit effect. The expected inflation effect was introduced in the Friedman/Phelps revolution. It is not unusual in wage inflation Phillips curves to use the expected rate of price inflation to capture inflation expectations. Theory suggests that it is the expected rate of wage inflation that should influence the actual rate of wage inflation. If the expected rate of price inflation is used then there is good reason to include the expected rate of growth of labour productivity as an explanatory variable.

Researchers have, since Friedman/Phelps in 1968, regarded errors in forecasting inflation as the major source of disequilibrium causing the rate of inflation to change. The corollary of this is to define the equilibrium rate of unemployment as the rate of unemployment that arises when the expected rate of inflation is equal to the actual rate of inflation. For economic policy, the importance of the equilibrium rate of unemployment is that lower rates of unemployment are unsustainable. This is because to try to achieve them would cause persistently increasing inflation. This will eventually cause unemployment to increase when policy makers, to avoid high or even

hyperinflation, will give up forcing unemployment to low levels and contract aggregate demand (for example, Australia in 1974-75.)

## **b. Main findings**

Studies of the Phillips curve can be classified by their treatment of the behaviour of the equilibrium rate of unemployment. The earliest studies based on the equilibrium rate of unemployment assumed that the equilibrium rate of unemployment was constant. These studies appeared in the 1970's. However by the 1980's a number of researchers were questioning the constancy of the equilibrium rate of unemployment and undertaking studies in which the equilibrium unemployment varied due to hysteresis mechanisms or by a unit root process. Finally, at the end of the 1990's one study that allowed for a range of equilibrium rates of unemployment appeared.

### *i. Constant equilibrium rate of unemployment*

The study by Parkin (1973) was the first Australian study based on the concept of the equilibrium rate of unemployment. Parkin estimated the following Phillips curve equation in which the rate of unemployment appears in reciprocal form, thus yielding a convex short run Phillips curve, that is

$$p = a_1 + (a_2/u) + bp^e \quad (6)$$

Throughout we write  $p$  for the rate of inflation,  $p^e$  for the expected rate of inflation and  $u$  for the rate of unemployment. In the Parkin equation, as in most studies reported here, the rate of inflation is the rate of change of earnings. Using unemployment in reciprocal form yields a non-linear short run Phillips curve in which the downward effect on inflation of the excess supply of labour is muted at high levels of unemployment.<sup>6</sup> The original estimate by Phillips (1958) specified unemployment in reciprocal form. Parkin's estimates yielded  $b$  insignificantly different from 1, from which he concluded (p.138) that "there is probably no long-run trade off". If  $b=1$ , then defining the equilibrium rate of unemployment as the rate of unemployment which sets  $p=p^e$ , the equilibrium rate of unemployment is determined by:

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<sup>6</sup> Parkin also estimates a linear form for the unemployment level effect but his comments on the size of the equilibrium rate of unemployment are based on the estimates using reciprocal form.

$$un^{eq} = -a_2/a_1 \quad (7)$$

However in trying to calculate the equilibrium rate of unemployment, Parkin pointed out that the estimates of  $a_1$  and  $a_2$  being both positive gives a meaningless, ie negative, estimate of the equilibrium rate of unemployment. (They are also both insignificant.) Setting  $a_1$  at the value given by the lower bound of the confidence limit implies the equilibrium rate of unemployment equals 1.5%. Higher values of  $a_1$  give higher values of the equilibrium rate of unemployment.  $a_1 = -0.02$  is the highest acceptable value of  $a_1$  because higher values imply that the equilibrium rate of unemployment is greater than 100%! So these estimates imply that the equilibrium rate of unemployment lies between 1.5% and 100%. Parkin then turned to a scatter-chart of inflation and unemployment data to argue that the equilibrium rate of unemployment for Australia appeared to be about 1.75% for the period from 1966 to 1973 but appeared to be as high as 2.5% for the period 1961 to 1963.<sup>7</sup> One of Parkin's conclusions (p.142) was that the effect on the equilibrium rate of unemployment of "controllable variables such as unemployment benefits and labour market institutions need investigation".

Parkin's study found a strong expectations effect and a weak activity effect. This finding appears to be the characteristic of the subsequent literature on estimating the Phillips curve in Australia. In the literature, especially the earlier literature, authors often infer from a measured coefficient on inflation expectations that is not significantly different from one, that the data supports the accelerationist hypothesis. The quoted sentence from Parkin above is an example of this. But this is not a valid inference. The idea that aggregate demand can have no more than temporary effects on the rate of unemployment requires that the equilibrium rate of unemployment is independent of aggregate demand. This in turn requires that  $b=1$  **and** that there is a well-defined activity effect.

Assuming a constant equilibrium rate of unemployment, Challen and Hagger (1975) estimated the equilibrium rate of unemployment from 1964/4 to 1974/1 as 1% but with large confidence interval from which they concluded that the only safe conclusion was a

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<sup>7</sup> Note that Parkin's inferred equilibrium rate of unemployment tends to be influenced by the actual rate of unemployment. For example, in the period when the actual rate of unemployment was high. 1961 to 1963, Parkin infers a high equilibrium rate of unemployment.

completely agnostic one. Parkin revisited the Australian Phillips curve in Parkin (1976) and on the basis of charts (but no new regressions) concluded that “the natural rate of unemployment must have increased during 1972-73 ... to around 2 ½ per cent”, Parkin (1976, p.139). He resisted the implication of the charts that the equilibrium rate of unemployment had in fact increased to 3.5% by appealing to lags in the inflation process. Rao (1977), using data for 1968/1 to 1974/4, estimated the equilibrium rate of unemployment at 2.0%. Rao also found a structural break in 1967 for the Metal Trades Decision. For the period before this structural break, 1961/3 to 1967/4 Rao (p.283) found that an estimate of the equilibrium rate of unemployment “is not possible since the intercept term is poorly determined”. Kirby (1981), using data up to 1978 estimated the equilibrium rate of unemployment as 2.2%.

Following the 1970's there have been a number of estimates of the equilibrium rate of unemployment assuming a constant equilibrium rate of unemployment. These estimates of the equilibrium rate of unemployment have been much higher than the earlier ones. For example OECD (1990), using data from 1966 to 1987, estimate the equilibrium rate of unemployment as 4.9%. Powell and Murphy (1995), using data from 1976/1 to 1991/4 estimate the equilibrium rate of unemployment at 7.1%. Crosby and Olekalns (1998), using data from 1959 to 1995 estimated the equilibrium rate of unemployment as 6.2%. There is also a tendency for the later data which covers periods when the rate of unemployment was higher to yield higher estimates of the equilibrium rate of unemployment. Thus OECD (1990) separately estimate the equilibrium rate of unemployment from the last 8 years of the 1966 to 1987 period equal to 7.7% (1980-1987) compared with 4.9% for the entire data period. In their second edition, Powell and Murphy's (1997) estimate of the equilibrium rate of unemployment was revised up to 7.6 % (based on an unspecified data period but presumably one that ends later). Crosby and Olekalns (1998) divided the period 1959 to 1997 into 3 sub-periods from which they recover the following estimates of the equilibrium rate of unemployment: 2.3% (1959-1973), 5.0% (1974-1984), 9.2% (1984-1997).

The tendency for later data to yield higher estimates of the equilibrium rate of unemployment and thus to suggest that the long run Phillips curve, if it exists, was shifting to the right, is illustrated in the Phillips curve regressions in Gregory (1986).

Gregory finds from estimating a Phillips curve with data from 1966/4 to 1982/4 that a time trend is positive and significant. This suggests that the Phillips curve was shifting to the right over time. Furthermore, only with the time trend included is the rate of unemployment significant. From these results Gregory argued that unemployment was not a good measure of the market pressure that affects wages.<sup>8</sup>

His conclusion that the rate of unemployment was not a good measure of the market pressures that affect wages suggested to Gregory (1986) that the unemployed are not close substitutes to the employed and in consequence it is the economic conditions within a firm rather than conditions in the external market that affect wage claims. From this he suggested that overtime, a measure of the economic conditions within the firm, was a better measure of the relevant labour market conditions than unemployment. Regressing changes in wages on overtime confirmed this view. From this Gregory showed that, using the normal rate of overtime as the defining benchmark for equilibrium, the equilibrium rate of unemployment increased from 1.7% in 1970 to 2.4% for 1970-74 and to 5.8% for 1979-82.

Gregory (1986) also noted a problem of asymmetry that is of relevance for answering the policy question of how to reduce the rate of unemployment. He commented (p.S67) that “(t)he loosely formulated model explains the shift to the right in the relationship but does not offer any mechanism-short of government intervention to directly affect the relationship between unemployment and wage changes between the firm and its employees-to shift wage negotiations back to the left”.

Following on and refining Gregory’s approach, Dawkins and Wooden (1985) show that the overtime result is not robust and that DEV=deviations from trend in average weekly hours worked outperforms overtime as an explanatory variable for wage inflation. From this they conclude that DEV is a better measure of economic conditions within a firm than overtime.

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<sup>8</sup> From a cross country study, Layard, Nickell and Jackman (1991, Table 14, p.436) report for Australia the equilibrium rate of unemployment is 2.35 % (1960 to 1968), 4.01% (1969 to 1979) and 6.10% (1980 to 1988). Note the tendency for the estimate of the equilibrium rate of unemployment to increase over time as the actual rate of unemployment increases.

In contrast to replacing the level of unemployment with a measure of hours worked, Simes and Richardson (1987) include both the level of unemployment and overtime in a Phillips curve equation. They specified an asymmetric measure of overtime, ROTD, which was detrended overtime with negative values set to zero. They found both the level of unemployment and ROTD significant.

These results of Gregory (1986), Dawkins and Wooden (1985) and Simes and Richardson (1987) are consistent with the idea of hysteresis. This is because they show that the rate of inflation is independent of the rate of unemployment. Thus for example, starting from low unemployment and a normal rate of hours worked, the deflationary effect of an increase in unemployment will die out when hours of work return to normal even if the rate of unemployment remains high. However, of these studies, Simes and Richardson (1987, p.150) most closely considered whether the evidence supports hysteresis and they concluded that "...attempts to incorporate a persistence element into the implied natural rate have not proved entirely successful".

*ii. Hysteresis effects on equilibrium rate of unemployment*

The first study to explicitly address the existence of hysteresis in Australia is Mitchell (1987). Mitchell models a hysteresis process for the equilibrium rate of unemployment, which is

$$un^{eq} = un^{eq}_{-1} + \lambda(un_{-1} - un^{eq}_{-1}) \quad (8)$$

Putting the above equation for the evolution of the equilibrium rate of unemployment into a Phillips curve, Mitchell showed that there was evidence of hysteresis. In this model hysteresis is interpreted as the value of  $\lambda$  which measures the sensitivity of the equilibrium rate of unemployment to the state of activity. Results on data from 1969/3 to 1984/4 using award earnings data support a value of the hysteresis coefficient of 0.5 to 0.6. Actual earnings data supports an even larger hysteresis coefficient of between 0.6 and 0.8 (the precise value is not given). This suggests that an increase in the actual rate of unemployment of 1% will increase the equilibrium rate of unemployment by 0.5% in the following quarter, a large change. Whilst Mitchell's discussion of the causes of hysteresis emphasises the role of skill depletion, the size of this coefficient seems too large to plausibly reflect that process. Even Mitchell is puzzled. He concludes (p.111) "(t)his is a fairly rapid work skill attrition rate which requires more analysis elsewhere".

Mitchell points out that the hysteresis model implies that a decrease in the actual rate of unemployment below the equilibrium rate of unemployment does not imply permanently increasing inflation. This is because the equilibrium rate of unemployment will increase and will eventually catch up with the actual rate of unemployment. At this time the upward pressure on inflation will cease. An implication of this is that the long run Phillips curve is not vertical.

Mitchell (1987) uses his estimates of the hysteresis process to calculate the impact on inflation of a permanent reduction in the actual rate of unemployment to be one percent less than the initial equilibrium rate of unemployment. His calculations are reproduced in Table 1. In period 1 the actual rate of unemployment is pushed one percent below the equilibrium rate of unemployment. Inflation increases by 0.11 percentage point. In the second period hysteresis has reduced the equilibrium rate of unemployment by 0.5 percent points. Inflation increases by a further 0.05 percent to take the total or cumulative increase to 0.16%.<sup>9</sup>

*Table 1 – The effect on inflation of a permanent increase of 1 percentage point in the rate of unemployment*

Period	$u-u^{eq}$	Cumulative p %
1	1.0	0.11
2	0.5	0.16
3	0.25	0.1875
4	0.125	0.2012
5	0.0625	0.2080
6	0.0313	0.2114
7	0.0156	0.2131
8	0.0078	0.2140
9	0.0039	0.2144

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<sup>9</sup> According to our calculations there is a very small error in the Mitchell calculations in Table 1. We get closer to the Mitchell numbers if we assume the unemployment level effect on inflation is 0.1074, although even then we do not replicate Mitchell's numbers exactly. However these differences are of no importance for the argument in the text.

*Table 2: Phillips Curve Studies for Australia with Estimates of the Equilibrium Rate of Unemployment*

	Data period	Dependent variable	Does inflation expectations coefficient =1?	Nature of unemployment level effect	Additional activity effect	Equilibrium rate of unemployment	
						Determining process	Size (per cent)
Parkin (1973)	1960-1 to 1973-2	AWE	yes	convex but insignificant	none	constant	estimated coefficients implied $u^{eq} < 0$ . Visual inspection of the data suggested 2.5 (1961-63) 1.75 (1966-73) and similarly Parkin (1976) suggested 2.5 (1973-74)
Challen and Hagger (1975)	1964-4 to 1974-1	AWE	yes	convex and insignificant	none	constant	1.00 but “must be treated with caution”
Rao (1977)	1968-1 to 1974-4	AWE	yes	convex and significant	none	constant	2.0 “A meaningful estimate ... for the period 1961-3 to 1967-4 is not possible”.
Kirby (1981)	1965-2 to 1978-2	AWE	yes	linear and significant	none	constant	2.2
Gregory (1986)	1966-4 to 1982-4	AWE	no (=0.6)	dropped	overtime	overtime= “normal” rate	1.7(1970), 2.4 (1970-74), 5.8 (1979-82)
Dawkins and Wooden (1986)	1967-1 to 1983-4	AHE	yes	dropped	DEV=deviation from trend in average weekly hours	NAIRLU= non-accelerating inflation rate of labour utilisation	not reported
Simes and Richardson (1987)	1968-1 to 1985-2	AWE	yes	linear and significant	detrended overtime with negative values set to zero	constant	3.6
Mitchell (1987)	1969-3 to 1984-4	award wages	yes	linear and significant (MUG)	none	hysteresal	follows actual rate of unemployment
Powell and Murphy (1997)	1976-4 to 1991-4	average weekly earnings	yes by assumption	convex and almost significant	change in unemployment	constant	7.1 (revised up to 7.6 in second edition)
Crosby and Olekalns (1998)	1959 to 1995	CPI	yes by assumption	linear (significance not reported)	none	constant for sub-periods	2.3 (1959 to 1973), 5.0 (1974 to 1984), 9.2 (1984 to 1997)
Debelle and Vickrey (1998)	1959-3 to 1997-1	underlying CPI	yes by assumption	convex and significant	none	unit root	2.0 (1960's), 6.0 (1974), to 8.0 (1980 to 1997), 6.9 (1997)
Gruen et al (1999)	1965-2 to 1997-4	unit labour costs (ulc) CPI	yes by assumption	convex and significant	change in unemployment	unit root	2.0 (1960's), 6.0 (1990's), For 1997, ulc imply 7.0 and CPI imply 5.5
Lye et al (1999)	1965-2 to 1997-4	unit labour costs	yes by assumption	none in the range linear and significant in the peak	change in unemployment	depends on unemployment benefits/AWE	$u^{min}$ , 2.0 to 3.0 (1960's), 5.0 (1976), 5.5 (1990's)

*iii. Time varying equilibrium rate of unemployment*

Debelle and Vickrey (1998a), Ng (1998) and Gruen et al. (1999) specify the equilibrium rate of unemployment to follow a unit root process:

$$un^{eq} = un^{eq}_{-1} + v \quad (8)$$

Debelle and Vickrey (1998a, p.387) argue that specification allows “the information implicit in movements in the inflation rate to help identify shifts in the NAIRU”. These papers also use a non-linear Phillips curve (viewed as a reflection of the “traditional upward sloping labour supply curve”) and for inflationary expectations a linear combination of backward looking (lagged inflation) and forward looking (Melbourne Institute survey/bond yields) components for expected inflation. In all of these respects these three papers are based closely on Clarke and Laxton (1997) and Debelle and Laxton (1997). Debelle and Vickrey (1998a) use price inflation. Gruen et al. (1999) extends Debelle and Vickrey (1998a) to consider wage inflation (for which they focus on unit labour costs to capture the wedge that increases in labour productivity drive between wage increases and the expected rate of price inflation) and to include additional relevant regressors (lagged terms and, for the price equation, import prices).

Debelle and Vickery (1998a) find the NAIRU was about 2% in the 1960’s and then increased after 1973 to about 6% in the 1990’s. Ng (1998) finds the NAIRU increased from 2.1% in the period 1959 to 1975 to 8.7% in the period 1983 to 1997. Gruen et al. (1999) estimate the NAIRU as increasing from about 2% in the 1960’s to 5.5% or 7% by the end of the 1990’s, depending on whether inflation is defined as the underlying rate of consumer price inflation or the change in unit labour costs. Thus the results from all of these papers is that the equilibrium rate of unemployment tends to follow, broadly speaking, the actual rate of unemployment. This result is consistent with the hysteresis process.<sup>10</sup> Below, we discuss in more detail the NAIRU series calculated by Gruen et al.(1999). The speed limit effects, measured by the change in the rate of unemployment,

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<sup>10</sup> If the equilibrium rate of unemployment is specified to follow a unit root process and in fact the equilibrium rate of unemployment follows a hysteresal process, then if the equilibrium rate of unemployment increases the error term in the unit root will be positive. This implies an increase in the next period in the equilibrium rate of unemployment.

are found to be insignificant in Debelle and Vickery (1998a). However in the extension by Gruen et al. (1999), speed limit effects are significant.

When the short-run Phillips curve is convex, reduced volatility of business cycles can lead to a lower average rate of unemployment (see for example, Clark and Laxton, 1997, or Debelle and Vickrey, 1998). The argument is that for the rate of inflation to average say zero percent, deviations of unemployment below the equilibrium rate of unemployment must be offset by larger deviations of unemployment above the equilibrium rate of unemployment. There is plenty of evidence for a convex short run Phillips curve. The papers using the time varying equilibrium rate of unemployment, that is Debelle and Vickrey (1998a), Ng (1998) and Gruen et al. (1999), specify a convex short run Phillips curve. Many other researchers have found a convex short run Phillips curve fits the data best, most notably Phillips (1958). The short run Phillips curve estimated by Powell and Murphy (1997) is also convex. (Furthermore it is virtually identical with the estimated Phillips curve of Phillips, (1958).) Thus existence of a convex short run Phillips curve suggests an advantage to using countercyclical “leaning against the wind” aggregate demand policy.

#### *iv. Evaluation of hysteresis and time varying studies*

The evidence in Mitchell (1987) in favour of hysteresis is very strong. However it is not clear what factors or processes cause hysteresis. Researchers have emphasised three alternative hypotheses: deskilling of the unemployed, insider power and loss aversion. However because the evidence for hysteresis is based on the performance of the lagged unemployment term, it is not possible to use it to choose between these hypotheses. What is needed is independent micro based evidence. For example, if a variable that directly measures deskilling was shown to be statistically related to the hysteresis process then one would be far more confident in accepting the deskilling hypothesis. Furthermore, moving from evidence to theory, if deskilling is important then why do not workers take this into account when bargaining for wages and thereby accept more downward flexibility in wages to avoid the layoffs that may lead to deskilling? The difficulty with insider power as an explanation, as was discussed earlier, is that it does not necessarily lead to hysteresis. Instead, special assumptions, in particular that insiders are equal to employment, see above, are needed to generate hysteresis. If

insiders are instead a subset of employees who have no serious concerns about being laid off then insider power does not generate hysteresis.

From a policy perspective, the main limitation of both the hysteresis approach and the time varying approach is that no limits are estimated on how low the equilibrium rate of unemployment can be pushed. Consider hysteresis. Reducing the rate of unemployment below the equilibrium rate will reduce the equilibrium rate. But at what equilibrium rate of unemployment does it become impossible for it to be lowered any further? This is an important question for policy makers. But the econometric approach used in hysteresis and time varying models does not offer an answer.

#### *v. Range of equilibrium rates of unemployment*

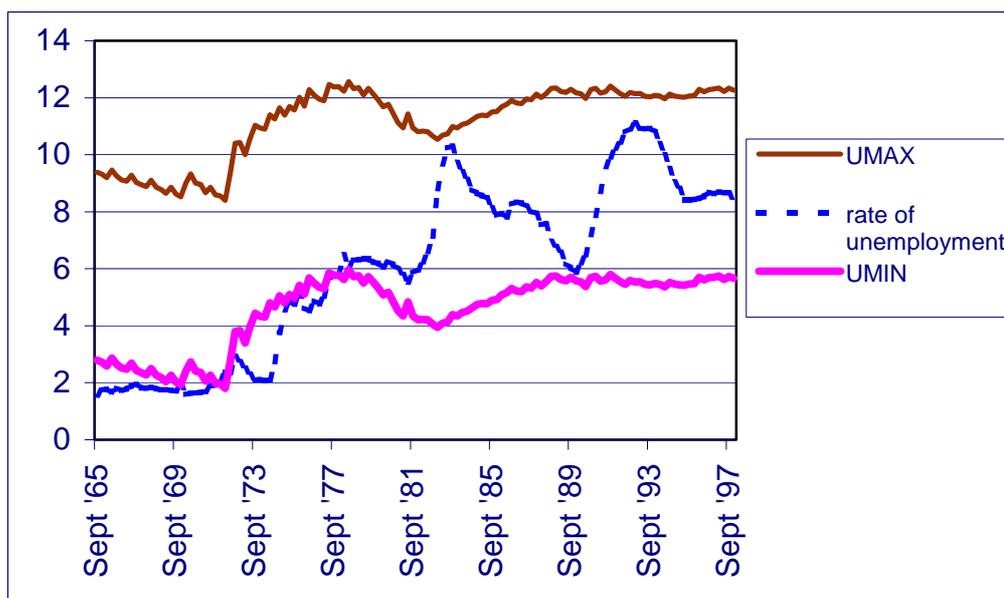
One study, Lye et al. (1999), has estimated a range of equilibrium rates of unemployment for Australia. According to this approach the equilibrium rate of unemployment can lie between limits, denoted  $u^{\min}$  and  $u^{\max}$ . Within these limits, the unemployment level effect is absent. Speed limit effects may influence inflation within the range or outside it. The lower limit to the range,  $u^{\min}$ , is determined by supply-side factors – in Lye et al. (1999) only one supply side factor is specified, that is unemployment benefits as a ratio of average weekly earnings.  $u^{\min}$  is the supply-side constraint on the rate of unemployment, in that to try to push the rate of unemployment below  $u^{\min}$ , by expansionary aggregate demand policy, would cause the rate of inflation to be increasing for as long as unemployment was kept below  $u^{\min}$ . However within the range the rate of unemployment can be reduced by increases in aggregate demand without causing a persistently increasing rate of inflation.

Chart 1 shows the estimated range of equilibria for Australia for the period 1965/3 to 1997/4.  $u^{\min}$  is influenced positively by the ratio of unemployment benefits to average weekly earnings. The graph of  $u^{\min}$  tracks the unemployment benefit replacement ratio, reflecting the positive and significant impact of unemployment benefit replacement ratio on  $u^{\min}$ .  $u^{\min}$  is generally between 2 and 3 percent in the late 1960's. It jumps sharply from 1.8 % in the first quarter of 1972 to 3.8 % in the third quarter of 1972. This reflects the large rise in unemployment benefits at that time. By 1976  $u^{\min}$  has reached

5%.  $u^{\min}$  decreases slightly to 4.2% by 1981:4, and then increases to about 5.5 % in the late 1980's, around which level it roughly remains for the rest of the period, to 1997.

As shown in Chart 1 the actual rate of unemployment is around or less than  $u^{\min}$  for most of the period from 1965/3 to 1977/3. Following 1977/3 the actual rate of unemployment is within the range. The economy has not been in the peak since 1977/2. An implication is that in the boom of the late 1980's, when the minimum value for the rate of unemployment was around 5-6%, the economy was in the range. Thus the estimates suggest that the rates of unemployment in the late 1980's boom were sustainable. The economy had not moved to a disequilibrium region of excess demand, which would have implied persistently increasing inflation had the economy remained there.

*Chart 1 The Range of Equilibria, Australia, 1965 to 1997*



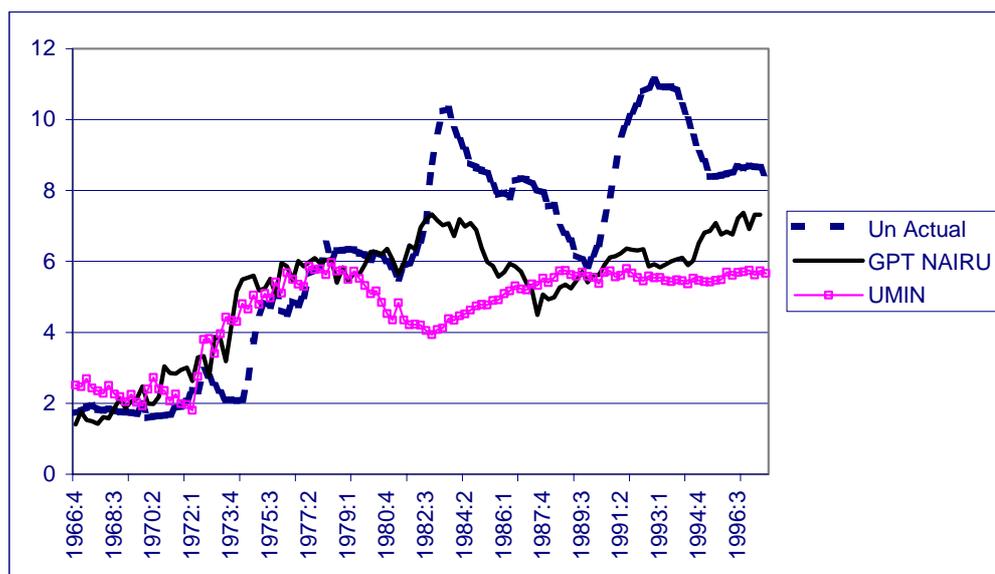
By separating out the influence on the rate of unemployment of supply from demand factors, the range estimates can shed light on the quantitative size of factors that affect the rate of unemployment. Compare the final quarter of the estimation period, 1997/4, with the first period, 1965/3. Over this time the rate of unemployment increased by 6.8 percentage points. Of this increase, 1.2 percentage points is due to adjustment to

equilibrium, 2.9 percentage points is due to the increase in unemployment benefits and 2.7 percentage points is due to a low level of aggregate demand.

Simulation of the estimated range equations suggests that most of the decrease in the rate of inflation from 1977 to 1997 is due to the influence of the lagged variables. The contribution of the forward-looking component of inflation expectations, the unemployment-level effect and the speed limit effect, is minor.

In Chart 2 the estimate of  $u^{\min}$  is compared with the NAIRU estimates of Gruen et al.(1999) using the one-sided estimates of NAIRU. It can be seen from Chart 2 that the Gruen et al. (1999) NAIRU estimates are close to the  $u^{\min}$  estimates up to 1978 but thereafter there is a significant divergence in the 1980's and the 1990's. It can also be seen that the Gruen et al. (1999) NAIRU estimate tends to follow the actual rate of unemployment. This is what hysteresis would be expected to generate. In the 1982 recession the Gruen et al. (1999) NAIRU estimate increases whilst the  $u^{\min}$  estimate decreases. In the recovery in the latter part of the 1980's the NAIRU estimate falls, driven by the fall in actual rate of unemployment whilst the  $u^{\min}$  estimate increases. In the 1990's the NAIRU estimate increases, dragged up it would appear by the higher actual rate of unemployment, whilst the  $u^{\min}$  estimate is constant.

*Chart 2: Comparison of GPT NAIRU and UMIN*



In the initial specification by Friedman (1968), the natural rate of unemployment, the precursor of the NAIRU, was seen as a supply side phenomenon. This is how  $u^{\min}$  should be seen. However by introducing the unit root process, or hysteresal process, the demand side influence can become strong. Indeed, the contrast between the pattern of the NAIRU and  $u^{\min}$  in Chart 2 shows that the demand side influence dominates the NAIRU. This is reinforced by the attempt of Gruen et al. (1999) to include an influence of unemployment benefits, on the NAIRU in their framework. They find no influence, a result they describe as disappointing. As noted above, for  $u^{\min}$ , unemployment benefits have a strong influence. The conclusion is that the range model, by not confounding demand and supply effects, embodies a more appropriate specification of the influence of unemployment benefits, that is that their level will not have a discernable effect on the inflation process when the economy is in the range.

In comparing the estimate of  $u^{\min}$  with other estimates of the equilibrium rate of unemployment, the following points can be made. First, the most striking contrast is that for the late 1990's the estimate of  $u^{\min}$  (5.5%) is less than any of the estimates of NAIRU. Those estimates are 7.6% (Powell and Murphy, 1997), 9.2% (Crosby and Olekalns, 1998), 7% (Debelle and Vickery, 1998a), and 7% (Gruen et al., 1999)<sup>11</sup>. Second, the estimate of  $u^{\min}$  suggests that the rate of unemployment benefits plays an important role. By contrast, in none of the papers cited above do unemployment benefits play an important role; in Gruen et al. (1999) an explicit test finds no importance for unemployment benefits.<sup>12</sup>

#### *v. Evaluation of equilibrium range study*

Taken literally, the estimates of  $u^{\min}$  suggest that were the rate of unemployment benefits to be reduced to the levels of the late 1960's then  $u^{\min}$  would be reduced to about 2%. However this should be interpreted with care. Lye et al. (1999) deliberately

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<sup>11</sup> Gruen et al. (1999) estimate the NAIRU at the end of their sample (1997) as 5.5% when they use the underlying rate of inflation as the dependent variable. Their estimate of 7% comes from using unit labour costs as the dependent variable, the same data used for the  $u^{\min}$  estimates. Using a different methodology, Groenewold and Hagger (1998) find the natural rate of unemployment for Australia for 1997 at 11 percent and on a rising trend.

<sup>12</sup> See for example findings from Beveridge curve studies reviewed later in this paper.

kept to a very simple (linear) relation between  $u^{\min}$  and unemployment benefits as a ratio of average weekly earnings. Thus they did not investigate other factors which may affect  $u^{\min}$ , such as union power. By omitting variables the estimate of the effect of unemployment benefits on  $u^{\min}$  may be biased up. Nor have they investigated other aspects of the unemployment benefit regime, such as changes in eligibility requirements.

A further caveat regarding the estimates of the relation between unemployment benefits and  $u^{\min}$  should also be borne in mind. The estimate of this relation is based mainly on behaviour before 1978. This is because since 1978, the economy has been in the range. Within the range the influence of  $u^{\min}$  is insignificant and so when the economy is within the range there is little information about the relation determining  $U^{\min}$ . In as far as institutional rules such as eligibility requirements have changed since 1978, the current relation determining  $u^{\min}$  may be different from the estimate.

Given that Australia has been in the range since 1977, this raises the question of why did the rate of inflation fall over that period. The significant range estimates suggest that it wasn't the high rates of unemployment that caused inflation to fall. Most of this fall took place in the recession of the early 1990's, which would be consistent with a speed limit effect, although the estimates presented in Lye et al. (1999) do not uncover this. This is a reason for further investigation of the speed limit effect.

### **c. Evaluation of Phillips curve studies for Australia**

The Phillips curve has perhaps been the most applied method for examining movements in the equilibrium rate of unemployment in Australia. This is probably explained by several factors – its relative transparency, that it is fairly simple to implement, and that estimates of the NAIRU can be seen as directly relevant to activities of policy-makers such as the RBA. There are also, however, some problems with application of the Phillips curve methodology that should be noted.

First, many researchers, eg Crosby and Olekalns (1998), Debelle and Vickery (1998a), Gruen et al. (1999), have commented that the estimates of the equilibrium rate of unemployment are poorly determined. Similar comments have been made in overseas studies, see especially Staiger, Stock and Watson (1997).

Second, Phillips curve studies have considered a relatively narrow set of explanatory variables for the equilibrium rate of unemployment. In fact, studies on Australia have not looked beyond the replacement ratio (the rate of unemployment benefits as a ratio to average weekly earnings.) By contrast, other approaches for studying the determinants of unemployment (for example, cross country modelling) consider a much broader range of factors.

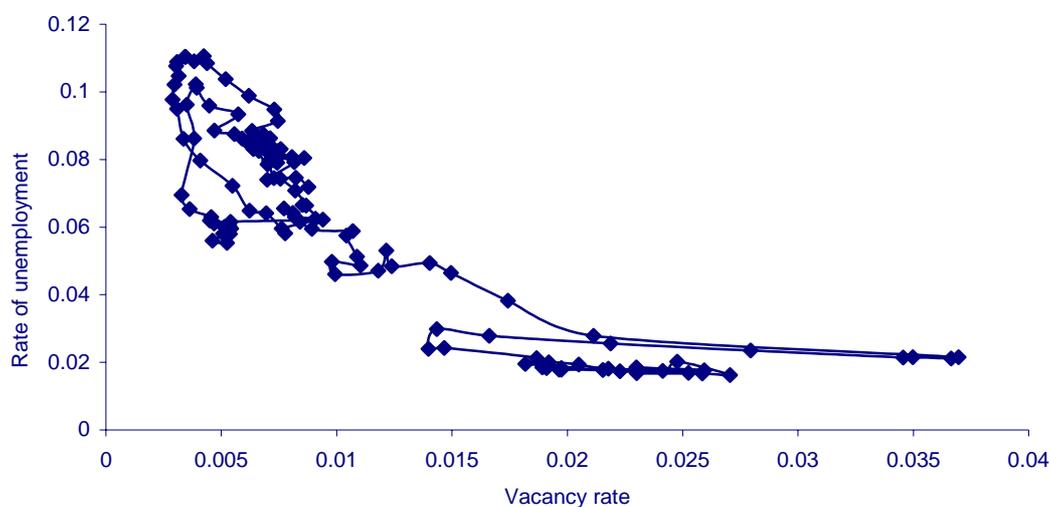
## **4. Beveridge curve studies**

### **a. Model description**

#### *a.i. Theory*

The Beveridge curve describes an empirical relation between unemployment and vacancies (or the rate of unemployment and the vacancy rate) in a labour market. Chart 3 presents data on the Beveridge Curve in Australia for the period between 1966/3 and 1999/3. Estimates of the Beveridge curve relation have been considered useful as a way of identifying the effects on equilibrium unemployment of changes in structural mismatch or in the efficiency of the matching process between jobs and workers. Hence, the Beveridge curve provides one method for understanding about what factors might have caused increases in the equilibrium rate of unemployment in Australia (such as identified by the Phillips curve studies described in the previous section).

Chart 3: Beveridge Curve - Australia - 1966:3 to 1999:3



A standard theoretical framework for deriving the Beveridge curve relation is the Blanchard and Diamond (1989) model. In the Blanchard and Diamond model an increase in the rate of unemployment can result either from a decrease in aggregate demand, from an increase in structural change, or from a decrease in search efficiency. Importantly, when the source of the increase in unemployment is aggregate demand, there will be a corresponding decrease in the vacancy rate; whereas when the source is structural change or search efficiency, there will be a corresponding increase in the vacancy rate. Hence Blanchard and Diamond (1989, p.14) conclude that “...looking at both unemployment and vacancies can shed light on the sources of unemployment movements.”

In the Blanchard and Diamond model the labour force ( $L$ ) is equal to employment ( $E$ ) plus unemployment ( $U$ ); and the number of jobs in the economy ( $K$ ) is defined as the number of jobs that are filled ( $F$ ), jobs that are advertised but not filled ( $V$ ) (ie., vacancies), and ‘idle’ jobs ( $I$ ) (jobs that are unfilled with no vacancy posted). The existence of idle jobs is motivated by an assumption that at any point in time a job may be productive or unproductive; and firms will only seek to fill productive jobs. Hence the set of productive jobs is equal to employment plus vacancies, and the set of unproductive jobs is equal to the number of idle jobs. Finally, a matching function ( $h$ ) that depends on the levels of unemployment and vacancies determines the number of

new hires in each period. It is assumed that the number of new hires, is increasing in the number of persons unemployed, and in the number of job vacancies.

$$L = E + U \quad (9)$$

$$K = F + V + I \quad (10)$$

$$h = \alpha m(U, V) \quad \text{where } m_U > 0, m_V > 0. \quad (11)$$

Flow equations for employment and vacancies in the economy are given as:

$$dE/dt = \alpha m(U, V) - qE - \pi_0 E \quad (12)$$

$$dV/dt = -\alpha m(U, V) + qE - \pi_1 I - \pi_0 V \quad (13)$$

Hence the change in employment is equal to new hires minus workers who quit ( $qE$ ) minus workers who flow from employment to unemployment because their jobs become unproductive ( $\pi_0 E$ ). The change in vacancies is equal to minus new hires plus quits plus the flow of previously unproductive jobs that become productive ( $\pi_1 I$ ), and minus previously posted vacancies that become unproductive ( $\pi_0 V$ ).

From the flow equations for employment and vacancies (equations (12) and (13)) it is possible to derive steady-state equations for employment and vacancies. Both equations are downward-sloping in U-V space, and the intersection point is the labour market steady-state equilibrium. Shifts in the U or V (or both) curves will cause a shift in equilibrium.

In order to analyse the potential sources of changes in the equilibrium rate of unemployment, Blanchard and Diamond undertake three types of comparative statics exercises. First,  $c = \pi_1 / (\pi_0 + \pi_1)$  is interpreted as the level of aggregate demand (that is, the proportion of jobs that are productive). It is shown that a change in  $c$  will shift the equilibrium U-V point along a downward-sloping locus in U-V space. This locus is what is generally referred to as the Beveridge curve. Second,  $s = (\pi_0 \pi_1) K / (\pi_0 + \pi_1)$  represents the instantaneous flow of jobs that change from productive to unproductive, and can be interpreted as a measure of structural change in the labour market. It is shown that a change in  $s$  will shift the equilibrium U-V point along a 45 degree line in U-V space. Finally, the coefficient  $\alpha$  can be interpreted as the degree of search efficiency in the labour market. Changes in search efficiency will also shift the equilibrium U-V point along a 45 degree line.

In the previous section on the Phillips curve it was emphasised that those studies provide some evidence of hysteresis in unemployment. In the Beveridge curve framework, hysteresis might be captured as an outward shift of the curve from a decline in search efficiency, that occurs due to an initial increase in unemployment from a decrease in aggregate demand. This would require modifying the Blanchard and Diamond model to make search efficiency a function of the rate of unemployment or perhaps the proportion of long-term unemployed.

#### *a.ii. Empirical methodology*

The predominant approach to estimation of the Beveridge curve applied in Australian studies has been to estimate a single equation where some function of unemployment or the rate of unemployment is specified to depend on some function of vacancies or the vacancy rate, as well as other explanatory variables such as lagged unemployment and policy variables such as real unemployment benefits or the replacement rate. For example:

$$\log(u)_t = \alpha + \beta(\text{vacancy rate})_t + \delta(\text{Real UE benefits}_t + \phi(u)_{t-1} + \varepsilon_t \quad (14)$$

Two alternative approaches have also been applied. First, Fahrer and Pease (1993) derive an equilibrium relation between unemployment and vacancies by estimating a set of regression equations for inflows to unemployment and outflows from unemployment, and then equating the equations for aggregate inflows and aggregate outflows. Second, Stegman and Stegman (2000) estimate a cointegrating regression between the unemployment rate, vacancy rate, and the proportion of long-term unemployed.

### **b. Main findings**

The main findings from the Beveridge curve studies are summarised in Table 3. Discussion of the main findings of the Beveridge curve studies can be divided into two time periods: the 1970s, and the 1980s/1990s:

- a) For the 1970s all studies find that an outward shift of the Beveridge curve occurred in 1973 to 1974. However, differences exist in estimates of the magnitude of the estimated shift (that is, the increase in the equilibrium rate of unemployment due to the shift). Bean et al. (1986) find that about 2.5 percentage points of the increase in the rate of unemployment during the 1970s can be attributed to a decline in search

efficiency. By contrast, Downes and Bernie estimate the effect at about 0.5 percentage points.<sup>13</sup> (Both studies use generated regressors from Beveridge curve equations to proxy for the effect of search efficiency. However, the specific approach adopted to generating the variable differs.)

An outward shift in the Beveridge curve could be explained – using the theoretical framework described above - by a decrease in search efficiency, or an increase in structural change. The main potential explanations for the decrease in search efficiency that have been considered are a change in the work test for unemployed persons/increase in real unemployment benefits, and a reduction in immigration inflows. Most studies for this period find evidence to support the former explanation (the exception is Downes and Bernie, 1999); but different studies arrive at conflicting conclusions on the role of the latter (for example, Hughes, 1975, argues fairly strongly for a role for immigration, whereas Withers and Pope, 1985 find no evidence of a relation between unemployment and immigration inflows).

It has also been suggested that a decrease in search efficiency might have occurred due to changes in the duration structure of unemployment or in the regional distribution of unemployment. Existing evidence suggests that both factors may have played a role. Analysis of the proportion of long-term unemployed does show that a large increase in the incidence of long duration spells of unemployment occurred in the mid-1970s (Borland, 2000, Figure 3b). As well, research showing a significant increase in dispersion in neighbourhood rates of unemployment in Australia between 1976 and 1981 (for example, Gregory and Hunter, 1995), together with theoretical job search and education investment models showing how increases in regional disparities in rates of unemployment may cause an increase in the aggregate rate of unemployment (for a review see Borland, 1996), suggest that regional factors may have played some role in the decline in search efficiency.

There does not seem to be any work that suggests an increase in structural change in employment can explain the outward shift in the Beveridge curve in the 1970s.

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<sup>13</sup> In the Downes and Bernie study the equilibrium rate of unemployment is calculated by setting the vacancy rate equal to the unemployment rate and solving for the rate of unemployment from the estimated Beveridge Curve equation.

b) For the 1980s and 1990s the consensus appears to be that no permanent or sustained outward shift of the Beveridge curve occurred in the period.<sup>14</sup> This provides support for other studies using alternative modelling approaches (such as the Phillips curve) that do not find large long-term increases in the equilibrium rate of unemployment in the 1980s and 1990s. One feature of recent studies of the Beveridge curve (compared to earlier studies) has been the attempt to incorporate extra explanatory variables into the estimating equation for unemployment. It is worth noting that these attempts reach very different conclusions. For example, Debelle and Vickery (1998b) do not find factors apart from vacancies and lagged unemployment to be significant; whereas Webster (1999) finds a wide range of explanatory factors such as the rate of long-term unemployment, replacement rate, and components of expenditure on labour market programs to be significant.

### **c. Evaluation**

As a first point, it needs to be reiterated that what the Beveridge curve describes is a locus of equilibrium U-V combinations. It does not determine a unique U-V combination consistent with labour market equilibrium. Hence the usefulness of the Beveridge curve as an analytic device for understanding changes in equilibrium unemployment is probably greatest when it is incorporated into a general labour market model. Second, there have been doubts expressed regarding the quality of vacancy data, in particular in the period prior to 1979. Third, there does not appear to be a strong consensus on the appropriate functional form for the Beveridge curve, or on what explanatory variables should be incorporated in estimation of the relation between unemployment and vacancies.

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<sup>14</sup> An exception is Fahrner and Pease (1993) which finds that a decrease in search efficiency of the unemployed caused about a 0.5 percentage point increase in the rate of unemployment in the 1980s, with the increase being mainly concentrated between 1982 and 1985 (assuming a vacancy rate of 0.6).

*Table 3: Beveridge curve studies*

Study	Time period	Method	Main findings
Hughes (1975)	1947-1974 (Annual)	Descriptive	Outward shift in BC in 1972-73. Main potential explanations are: change in work test/increase in UE benefits; shift in composition of UE towards younger age groups; and reductions in immigration intakes.
Harper (1980)	1952:3 to 1978:1 (Quarterly)	Regression model: $\log(u)_t = f(v_t, \text{lagged } U, \text{Seasonal dummies})$	Outward shift and increase in slope of BC at 1973:2. Main potential explanations are: increase in real UE benefits, and reduction in immigration intakes.
Withers and Pope (1985)	1948:3 to 1982:3 (Quarterly)	Regression model: $\log(UE/LF)_t = f((V/LF)_t, \text{lagged } (UE/LF), \text{RUB, Net Migration, Seasonal dummies})$	Real UE benefits significantly related to U/LF. Net migration not significantly related to U/LF.
Fahrer and Pease (1993)	1966:3 to 1992:2 (Quarterly)	a) Regression model: $\log(u)_t = f(v_t, \text{GDPgap, Change in replacement rate, Trend, Seasonal dummies});$ Inflows/Outflows approach: Estimate regression models for inflows to and outflows from unemployment. Derive equilibrium Beveridge curve by setting aggregate inflows equal to aggregate outflows.	a) Outward shift in BC in 1974:3 but not in early 1980s. Increase in gap between potential and actual GDP shifts BC outwards. Positive change in replacement rate shifts BC outwards. b) Small outward shift in BC from 1982 to 1984. (Raises equilibrium rate of unemployment by about 0.5 percentage points.) Main explanation is decrease in average search effectiveness of unemployed.
Debelle and Vickery (1998b)	1979:3 to 1997:4 (Quarterly)	Regression model: $\Delta(u)_t = f(\Delta v_t, \text{lagged } u, \text{lagged } v)$ .	No outward shift in BC in 1980s.
Downes and Bernie (1999)	1967:3 to 1998:3 (Quarterly)	Regression model: $\Delta \log(u)_t = f((V/LF)_t, \Delta (V/LF)_t)$	Outward shift of BC in 1974 which increase equilibrium rate by about 0.5 percentage points. No evidence of outward shift in BC in 1980s or 1990s.
Webster (1999)	1978:1 to 1997:1 (Quarterly)	Regression models: a) $(UE/LF)_t = f((V/LF)_t, \text{Labour market program expenditure, Seasonal dummies, Time trend, Real UE benefits, LTU, Skill composition of employment});$ b) $(V/LF)_t = f((UE/LF)_t, \text{Labour market program expenditure, Seasonal dummies, Time trend, Real UE benefits, LTU, Skill composition of employment});$	Some inward shift in BC over 1980s and 1990s. Main determinants of position of BC: Labour market programs – Increased expenditure on training subsidies, and intensive placement services shifts BC inwards; Increase in rate of LTUE shifts BC outwards; Increase in replacement rate shifts BC outwards; No effect of rate of new immigration, or skill composition of employment.
Stegman and Stegman (2000)	1979:3 to 1997:3	Cointegrating regression between log of unemployment rate, vacancy rate, and rate of long-term unemployment.	Increase in proportion of LTU increases structural mismatch.
Bodman (1999)	1978:1 to 1997:12 (Monthly)	$(\Delta E/E) = f(\text{Structural mismatch, Time trend, Output, Size of Labour Force, Political party in office})$	No trend in efficiency of matching. Increases in output, size of labour force improve matching efficiency.

## 5. Multi-equation studies

### a. Model description

Multi-equation models estimate regression equations for multiple labour market variables such as labour demand and labour supply. Implications for the causes of unemployment are then derived by applying these results to the identity that

$u = (LF-E)/LF$ . The multi-equation models represent attempts to undertake structural empirical analysis of the theoretical framework for labour markets described earlier. (A range of single-equation studies of the determinants of unemployment – apart from the Phillips curve and Beveridge curve approaches – also exist. This approach however has not been common in the 1990s, and for this reason, we confine discussion of those studies to an Appendix.)

Most multi-equation studies for Australia are fairly parsimonious – Bean et al. (1986) estimate equations for employment, real wages and a Beveridge curve relation; Pissarides (1991) estimates equations for labour demand, labour supply, and wages; Debelle and Vickery (1998b) estimate equations for labour demand, labour supply, wages and a Beveridge curve; and Huay and Groenewold (1992) estimate equations for labour demand, wages and prices. Downes and Bernie (1999) (TRYM) is the most detailed model including six equations in the labour market component of their model. The TRYM labour market model is the most comprehensive attempt to estimate a Layard-Nickell-Jackman type model for Australia. Each of the multi-equation modelling approaches tend to be eclectic in the range of explanatory variables included in their regression equations drawing on alternative theoretical models and knowledge of institutional aspects of the Australian labour market.<sup>15</sup>

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<sup>15</sup> Wooden (1996) and Borland (1997) estimate very simple two equation models for the employment/population rate as a function of the change in GDP, and the labour force participation rate as a function of the employment/population rate, from which a predicted rate of unemployment can be derived.

## **b. Main findings**

Most multi-equation studies have focused on seeking to explain the increase in the equilibrium rate of unemployment that occurred in Australia between the early and late 1970s. The findings from these studies are summarised in Table 4. Although the studies each include different sets of explanatory variables, where studies do include the same variables, there is a reasonable degree of consensus about whether a variable was a significant explanatory factor for the increase in unemployment. Where there is somewhat less consensus is over the relative contribution of each significant factor.

First, all studies that incorporate input cost components find that growth in real wages and the increase in the tax wedge between producer and consumption wages had a significant positive effect on the rate of unemployment. As most studies have included these types of variables this seems a robust finding.

Second, studies that include lagged unemployment as an explanatory factor for contemporaneous unemployment find this variable to be strongly significant. This potentially suggests a role for hysteresis type factors, although none of the studies has sought to examine the sources of such effects in detail.

Third, studies that include variables representing the effects of changes to the real level of unemployment benefits in 1973 find this to have been positively related to the increase in unemployment. Some difference however exists between the studies in the magnitude of the estimated effect of unemployment benefits on unemployment. For example, Huay and Groenewold (1992) find that changes in the replacement rate account for about 0.75 percentage points increase in the rate of unemployment in the 1970s, in Pissarides (1991) the effect is about 2.0 percentage points, and Lye et al. (1999) the effect is 2.7 percentage points.

Finally, it is worth noting that there is some evidence that the sensitivity of unemployment to changes in the rate of growth in output increased after the mid-1970s (Nguyen and Siriwardana, 1988, and Downes and Bernie, 1999). This is significant since where there is persistence in unemployment cycles (as in Australia in the 1980s and 1990s) the magnitude of cyclical fluctuations will have an important influence on the average rate of unemployment taken across the cycle.

*Table 4: Multi-equation models*

<b>Study</b>	<b>Time period</b>	<b>Method</b>	<b>Main findings</b>
Bean et al. (1986)	1953 to 1983 (Annual)	3 equation system – Change in log total employment; Change in log real hourly labour costs; Beveridge curve.	Main determinants of increase in rate of unemployment between 1956-66 to 1980-83: * Taxes: +2.56 * Decline in search efficiency: +2.44 (Overall change: +4.98)
Pissarides (1991)	1966:3 to 1986:2 (Quarterly)	3 equation system – Real product wage; Change in person hours employment; Ratio of labour force to working age population.	Main determinants of increase in equilibrium rate of unemployment between 1970-73 to 1976-79: *Hours of work: -3.07 *Wage push: +4.57 (Tax wedge +4.44; Replacement ratio +1.98; Investment -1.85) *Employment shocks +0.64 (Real interest rate +0.52; Competitiveness -1.10; Govt expenditure -0.60; Money supply +1.82) *Participation rate: +0.53. (Overall change: +3.80)
Huay and Groenewold (1992)	1966:3 to 1987:2 (Quarterly)	3 equation system – Real wage; Employment; Prices.	Main determinants of increase in rate of unemployment: a) Between 1967:1-1972:4 to 1973:1-1979:4: Real wages (+2.72); Tax effects (+1.46); Replacement rate (+0.73); and b) Between 1973:1-1979:4 to 1980:1-1986:4 Expected aggregate demand (+1.61); Real wages (+1.50); and Tax effects (+1.12).
Debelle and Vickery (1998b)	1979:3 to 1997:4 (Quarterly)	4 equation system – Change in aggregate hours worked in non-farm economy; Change in male/female participation rates; Phillips curve.	Increase in real unit labour costs of 6.1 per cent between 1973 and 1975 would account for about 3 percentage points increase in natural rate of unemployment.
Downes and Bernie (1999)	Assorted starting points in late 1960s and early 1970s to 1998:3 (Quarterly)	6 equation system for labour market – Log of business employment plus unfilled vacancies; Change in log price of non-commodities; Change in log of average wages per hour worked; Beveridge curve; Adjusted labour force participation rate; Hours worked.	*Increase in responsiveness of employment to GDP shocks with increase in NAIRU. * Increase in responsiveness of employment to real wage movements from mid-1970s onwards.

### **c. Evaluation**

Multiple equation models provide the most detailed structural understanding of the operation of the labour market, and hence of the causes of unemployment, of any of the methodologies reviewed. However, some weaknesses also exist. First, for some of the standard equations in these models there must be doubts regarding robustness of specification. Perhaps the main difficulty with multi-equation models is their reliance on a Phillips curve specification of the wage-setting process in order to derive an equilibrium rate of unemployment. Hence, in characterising the evolution of the equilibrium rate of unemployment, the multi-equation models share the same problems as the Phillips curve models (for example, large confidence intervals). As well, most of the models estimate equations for labour supply or labour force participation. It is well known that time-series analyses of labour supply display a high degree of sensitivity to choice of sample period and the set of explanatory variables included (for example, Dunlop et al., 1984). For this reason more work demonstrating the robustness of equations in the multi-equation models seems necessary. Second, none of the existing models is at present sufficiently rich to allow the effects of all potential causes of unemployment to be studied – for example, there is no way of using these models to study how relative wage movements between high skill and low skill workers impact on unemployment.

Another shortcoming of existing multi-equation studies – that applies more generally to research on the causes of unemployment – is that these studies have tended to focus on the question: What factors explain the increase in the equilibrium rate of unemployment that has occurred since the early 1970s? Hence, the usual type of exercise to describing the causes of high unemployment is to define a base period (such as 1972-74) and an end period (such as 1983-85), and to seek to show what factors explain the rise in the average rate of unemployment between those periods. Such a long-term approach abstracts from the actual path followed by the rate of unemployment – that as well, as a trend increase in the rate of unemployment over time, there has also been considerable cyclical movement. Once it is recognised that the rate of unemployment has followed a cyclical pattern – with sharp increases in the rate of unemployment in a relatively short time period, followed by slow decreases in the rate of unemployment over a more

prolonged period – then it becomes of interest to ask whether the impediments to adjustment that were behind increases in the rate of unemployment during recessions are the same as the impediments to adjustment that prevent the rate of unemployment from declining more rapidly during expansions. (For example, the impediment to adjustment during a recession may be wage rigidity; whereas the main impediment to adjustment during an expansion may be reduced search efficiency of the unemployed.) By examining only long-run changes in the rate of unemployment, existing studies are not able to identify the order or the phase of the cycle where the various causes of unemployment are relevant.

## **6. Conclusion**

This study has sought to provide an overview of findings on how the equilibrium rate of unemployment has changed, and on the causes of those changes, from empirical modelling of the labour market.

Information on how the equilibrium rate of unemployment has changed in Australia comes almost exclusively from Phillips curve equations. The main finding to emerge is that a significant increase in the equilibrium rate of unemployment occurred during the 1970s; since that time there is less evidence of large prolonged shifts in the equilibrium rate.

Analysis of the causes of unemployment has focused primarily on explaining the increase in the equilibrium rate of unemployment during the 1970s, and on the role of hysteresis type influences on unemployment. Increases in real wages and real unit labour costs – that caused decreases in labour demand - are found to be the main explanation for the initial increase in the equilibrium rate of unemployment in the 1970s. Increases in unemployment benefit payments – through the effect on search behaviour - also appear to have played some role. There is strong evidence of hysteresis effects on the equilibrium rate of unemployment – for example, explaining why the increase in the equilibrium rate of unemployment in the 1970s became permanent (despite subsequent falls in real unit labour costs).

The review undertaken in this paper suggests that there remain many ways in which empirical modelling of the labour market might be improved in order to deliver a better

understanding of the causes of unemployment in Australia. Some of these relate to issues that need to be better understood such as the sources of hysteresis, and the role of speed-limit effects in the relation between inflation and unemployment. Other issues relate to the methodologies for labour market modelling. One example is the need for more attention to the robustness of key equations – in particular the Phillips curve. Another would be the scope for a more sophisticated analysis of the causes of changes in the rate of unemployment – to understand the forces that drive the rate of unemployment and the labour market adjustment process during different phases of the business cycle rather than using simple comparisons of the rate of unemployment at (for example) ten year intervals in order to study the causes of unemployment.

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## **Appendix – Single equation models**

Single equation models involve estimation of a regression equation for the determinants of some function of unemployment or the rate of unemployment. Details of these studies, and a summary of main findings, are presented in Table A1.

Sets of explanatory variables for unemployment included in single equation models have been quite varied. Some studies have estimated forms of the Okun's law where unemployment is expressed as a function of the percentage gap between potential and actual output (for example, Nguyen and Siriwardana, 1988). Other studies may be interpreted as reduced forms for particular theoretical models of the causes of unemployment. One study, by Trivedi and Baker (1986), is quite explicit in this way, estimating two regression equations each of which is intended to represent a specific theory for unemployment – first, an equation for unemployment as a function of explanatory variables from a non-market clearing model; and second, an equation as a function of explanatory variables from a search-theoretic model. Other studies are more 'ad-hoc', including a range of explanatory variables motivated by different theoretical models in the same regression model. Most of these studies would as a minimum include a proxy for real labour costs, and for output or aggregate demand.

These types of single equation models can provide a useful summary representation of the main causes of unemployment. However, the methodology also has significant weaknesses. One point relates to the understanding of the causes of unemployment that can be obtained. A structural interpretation (and hence a detailed understanding) of the causes of unemployment cannot be derived from the single equation approach. This has important consequences for policy-making. For example, suppose it is found that union presence has a positive effect on unemployment. This effect might derive either (or both) from a union effect on wage-setting or a direct effect on labour demand due for instance to an effect on labour productivity. Where it is the former the appropriate policy response might be to change wage bargaining institutions to reduce union influence; whereas if it is the latter then award restructuring to alleviate the adverse union effect on productivity would be required. The problem with the single equation approach is that it is not possible to distinguish between the wage-setting and labour demand effects, and hence to decide on the appropriate policy response.

Other shortcomings of the single equation approach involve estimation. First, estimates of the relation between some explanatory variables and unemployment may be affected by simultaneity bias. An example would be the relation between unemployment and real wage growth. Second, problems of multi-collinearity and degrees of freedom will limit the scope for distinguishing between potential explanatory variables for unemployment using the approach.

*Table A1: Single equation models*

Study	Time period	Method	Main findings
Pitchford (1983)	1969:1 to 1980:3 (Quarterly)	Regression model: $\Delta(u)_t = f(\text{Lagged real wages, Lagged real money supply, Seasonal dummies})$ .	Increase in u in 1974 associated with rise in real wage rates and decrease in real money supply. Increase in rue thereafter mainly due to effects of real money supply.
Trivedi and Baker (1985)	1970:1 to 1983:4 (Quarterly)	Regression model: a) Non-market clearing model: $\log(u)_t = f(\text{Stoikov index, Real UE benefits, Lagged real unit labour costs, Lagged change in real unit labour costs, Lagged rue, Seasonal dummies, Lagged rue, Capacity utilisation rate, Vacancy rate, Real price of materials and fuel})$ ; b) Search theoretic model: $\log(u)_t = f(\text{Stoikov index, Real UE benefits, Expected real wage, Lagged rue, Capacity utilisation rate, Vacancy rate, Lagged rue, Expected price level})$ .	a) Increase in u related to increase in real unit labour costs, lagged u, and real UE benefits (prior to 1975), and decrease in rate of capacity utilisation; b) Increase in rue related to increase in expected real wage (labour supply), Lagged u, and decrease in rate of capacity utilisation. [In both models composition of demand (Stoikov index) is significantly related to u but does not explain large fraction of overall increase in u.]
Nguyen and Siriwardana (1988)	1966:3 to 1985:3 (Quarterly)	$UE_t = f(\text{Output Gap, Lagged UE, Dummy variable for 1974:3 onwards})$	Unemployment more sensitive to variation in rate of growth of output post 1974:3.
Watts and Mitchell (1991)	1966:4 to 1989:2 (Quarterly)	$\Delta UE_t = f(\text{Difference in lagged changes in UE, Change in capacity utilisation, Change in potential output growth, Index of structural change in industry composition of employment})$ .	Largest proportion of increase in u between 1966-73 and 1973-89 explained by structural change (about 2.5 percentage points), and fall in capacity utilisation (about 1.5 percentage points).
Valentine (1993)	1965-1992 (Annual)	$\log(u)_t = f(\text{Real unit labour costs, Real output, Time trend, Lagged rue, Percent growth in LF})$ .	Main cause of increase in u is growth in real unit labour costs (accounts for about 4-5 percentage points of increase in rue over sample period).
Dao (1993)	1977:1 to 1993:1 (Quarterly)	$UE_t = f(\text{Lagged UE, Lagged real wage, Capacity utilisation, Change in capacity utilisation, real UE benefits, Structural change})$ .	Increase in unemployment related to increase in real wages, higher lagged UE, real UE benefits and structural change, and inversely related to level of and change in capacity utilisation.
Groenewold and Hagger (1998b)	1979:4 to 1993:4 (Quarterly)	$\Delta(u)_t = f(\text{Lagged } \Delta u, \text{ Inter-industry structural change, GDP/potential GDP, Employment growth/Potential employment growth})$ .	Change in u positively related to change in index of structural change, and inversely related to change in output/employment growth gaps.



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