EQUILIBRIUM UNEMPLOYMENT IN AUSTRALIA: CONCEPTS AND MEASUREMENT

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EQUILIBRIUM UNEMPLOYMENT IN AUSTRALIA: CONCEPTS AND MEASUREMENT

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ABSTRACT

It has been customary in applied macroeconomics to distinguish between frictional, structural and cyclical unemployment. The first task of this paper is to clarify this distinction and discuss its usefulness for the purposes of studying unemployment empirically. A subsequent task is to discuss a number of definitions of "equilibrium" unemployment.

Two leading ways in which the term "equilibrium unemployment" is used refer to, respectively, the rate of unemployment that would prevail in a stationary state and the rate of unemployment that would prevail given short-run rigidity of the real wages rate. If labour market always cleared, possibly with lags of adjustment, then the first concept of equilibrium would be the most relevant one. Such an equilibrium rate would correspond to either pure "frictional" unemployment or "frictional-structural" unemployment and the level of such unemployment would depend upon the imperfections of the labour market. If, however, labour market typically does not clear, possibly because of the rigidity of the real wages in face of excess supply, the relevant equilibrium rate of unemployment is that to which the labour market tends, given the real wage rate. In this paper we provide estimates of equilibrium unemployment rate defined in either manner. Moreover, it is shown exactly why and how the equilibrium rate, however defined, varies over time.

Three theoretical approaches, respectively labelled the neo-Keynesian rationing approach, the search-turnover approach and the natural rate approach, are considered. In a clearing
labour market, the second and third approaches would attribute most of the cyclical variation in unemployment to errors in anticipating wages and prices. The empirical analysis of the paper shows that such constructs do not adequately explain the data. Rather, all formulations in which a non-clearing labour market is postulated and the effects of an exogenous real-wage or job-availability factors are incorporated explain the behaviour of unemployment in Australia much better.

The empirical analysis of the paper suggests that whereas the equilibrium unemployment rate corresponding frictional-structural unemployment is only of the order of 2%, the unemployment rate which the economic system would generate and maintain, say, if the conditions of 1980-81 fiscal year were to be held fixed (in a hypothetical experiment) is much higher. Several estimates are given, all in excess of 6% and approaching 7%. The principal contributory factors to this high level are the real wage rate and capacity utilisation, in that order. We find no evidence that a significant proportion of the increase in the unemployment rate in Australia during the 1970s is due to "increasing structural imbalance" or an increase in frictional unemployment.
I. Introduction

Theoretical and policy oriented discussions about unemployment use either explicit or implicit notions of socially optimal or efficient rates of unemployment. Examples of such discussions are Phelps (1972), Prescott (1975) and Tobin (1972). A number of such discussions employ the concept of an "equilibrium" rate of unemployment, but the meaning of the term "equilibrium" is not always intended to be the same. In some discussions the "equilibrium" level is also socially efficient or optimal, in other discussions it means simply a position of rest without any welfare connotations. Furthermore, some definitions are essentially rooted in a general equilibrium viewpoint, some are based explicitly on a notion of trade-off between unemployment and inflation and yet others are based on the notion of an equilibrium that is constrained by slow adjustment processes, especially in respect of wages and prices, and non-market clearing. Each definition of equilibrium is typically embedded in a particular conceptual framework and, moreover, based on a particular model of the unemployment phenomenon. The objective of this paper is to elucidate four different equilibrium unemployment definitions and to provide econometric estimates either in the form of arithmetic quantities or in the form of functions of measurable variables. To achieve this objective it becomes necessary to compare and evaluate the performance of different models of unemployment in the light of actual unemployment experience in Australia. It does not seem desirable to attach a great deal of credibility to a particular
estimate of equilibrium unemployment if that estimate is derived from a model which fails to satisfactorily account for the observed experience. Consequently the paper has the dual objective of comparing and assessing different models of aggregate unemployment and of providing estimates of equilibrium unemployment. Four definitions of equilibrium unemployment are discussed in the paper and the four Sections IV to VII inclusive are devoted to elucidation, amplification and measurement of the corresponding model of unemployment and to the examination of its implications. A further section brings together the principal conclusions from each of these and compares them. It is an integral part of an exercise such as this to provide an explanation of the variations in measured unemployment in Australia in the 1960s and 1970s. Since this is a subject on which much has been written already, we have devoted Section II to providing a brief survey of this literature. The main reason for doing so is to provide a backdrop to our own work in modelling unemployment and to permit the reader to assess the coherence of our results with previous findings. This brief survey also points out a number of limitations of existing empirical work which need to be overcome where possible.

We shall now provide a brief outline of our general approach to modelling unemployment which is based in part on a time-worn distinction in macroeconomics between frictional, seasonal, structural and cyclical unemployment. Without aiming at great precision we shall first attempt source of frictional unemployment lies in imperfect mobility and imperfect to explain how we exploit this taxonomy.
It might be said that the source of frictional unemployment lies in imperfect mobility and imperfect information on the part of the labour market participants that preclude a perfect match between demand and supply of labour. "Frictions" refers collectively to all such imperfections. Given such imperfections in the labour market, many of which stem from heterogeneity of skills, zero unemployment is not feasible. For a given state of information technology, a given distribution of skills and characteristics of the working population, a given level and distribution of demand, there will be (it is asserted) a positive level of unemployment which is due to the said frictions and which constitutes an irreducible minimum to the level of unemployment. For this reason one may as well regard it as the level that corresponds to full employment, or the level that would obtain in a stationary state. Tobin (1972) even suggests that various definitions of full employment would coincide with this frictional unemployment in stationary state and would only differ in disequilibrium states.

Structural unemployment, as usually considered, has its source in the shocks to tastes and technology, or to demand and supply, which cause displacement of labour and hence unemployment. To the extent that such unemployment cannot arise in the true stationary state it can be distinguished from frictional unemployment; on the other hand, out of stationary state, the extent of displacement and unemployment resulting from the aforementioned shocks may depend upon the nature and type of frictions and this may obscure the distinction between frictional and structural unemployment.
Finally, we come to cyclical unemployment, a component which will be zero in a labour market macroequilibrium, and which will be non-zero in disequilibrium, by definition. The term "cyclical" usually suggests a sinusoidal deviation from some equilibrium level. The U.S. literature on business cycles is especially concerned with such phenomena. See, for example, Gordon (1982). The term cyclical unemployment is used in this paper in a looser sense to refer to deviations from the long-run equilibrium position. Cyclical unemployment is almost residually defined and subsumes unemployment due to deficient demand or inadequate capacity or any inappropriate combination of wage rate and aggregate demand. Cyclical unemployment is included in Keynes' concept of involuntary unemployment; it is the component which is dealt with in almost all discussions of growth and business cycle fluctuations. It is, in brief, what concerns macroeconomists most in their discussions of aggregate unemployment.

Generations of economists have commented on the fact that this traditional taxonomy of unemployment is not watertight and that once one leaves the abstraction of a stationary state components of unemployment may well be interdependent. Frictions may increase or decrease with the level of activity, structural change may be faster or slower in times of boom or depression, seasonal fluctuations may be amplified or attenuated by booms, and so forth. Many plausible interactions can be constructed.
Figure 1

CES UNEMPLOYMENT RATE (%) - 1949(1) TO 1979(3)

Figure 2

ABS UNEMPLOYMENT RATE (%) - 1964(1) TO 1981(4)
A practical consequence of this is that any attempt to empirically identify individual components is vitiated. To explain this clearly let us decompose unemployment rate as follows:

\[ u = u^f + u^s + u^c + u^{fs} + u^{sc} + u^{cf} \]

where the superscripts \( f, s \) and \( c \) denote, respectively, frictional, structural and cyclical components, and \( fs, sc \) and \( cf \) denote interactions. In a stationary equilibrium \( u^f > 0 \) and all other terms will be zero. In a stochastic steady state \( u^f > 0, u^s, u^{fs} > 0 \) and all other terms will be zero. Note that if changes in the composition of demand do not generate any new frictions then strictly speaking \( u^s = 0 \) and \( u^{fs} > 0 \) even in a stochastic steady state. However, since many structural shocks reflect changes in tastes and technology, it seems reasonable to assume that they will in turn generate new frictions, thereby validating the notion of a positive level of \( u^s \). A practical difficulty about the identification of the components of \( u \) arises because there is no unique way in which one can partition \( u \). Thus the term \( u^{sc} \) may be combined with either \( u^s \) or \( u^c \) and \( u^{fs} \) may be combined with either \( u^s \) or \( u^f \). Depending upon the variables that one uses to represent the frictional, structural and cyclical influences one would arrive at different estimates of the components. The problem of identification would be less serious if it could be validly assumed that the interaction effects were negligible.
Notwithstanding these dissatisfactions, the traditional taxonomy is a useful one for several reasons. Firstly, several strands in modern macroeconomics of unemployment can be directly associated with the explanation of one or the other of these components. For example, a large part of search and labour turnover theory is an explanation of the level and dynamics of frictional unemployment. It provides us with insights into factors determining the level of frictional unemployment and how it may change over time. Another example is provided by the modern equilibrium business cycle theories and modern neo-Keynesian macroeconomics which are concerned almost exclusively with cyclical unemployment (in the sense that they deal with serially correlated departures from long run equilibrium). The policy oriented applied work in Australia is largely concerned with cyclical unemployment. However, no one has seriously suggested that frictional and structural components of unemployment have remained unchanged over time. Indeed, we know very little about them. The most conspicuous feature of measured unemployment in Australia (see Figures 1 and 2) since the mid-sixties is not cyclical fluctuations but a rising trend. The longer Commonwealth Employment Service unemployment series in Figure 1 displays both cyclical and trend-like movements. It is reasonable then to try and explain not only the changes in, but also the level of, aggregate unemployment. Only time will tell whether what currently appears to be a local trend is in fact a part of a cyclical movement with a long periodicity. Furthermore, it seems to us that if we are to exploit the insights of theoretical macroeconomics, it is a reasonable
starting point to begin with the traditional taxonomy. The fact that the taxonomy is not watertight seems to us to matter less than the fact that the different components may be approximately identifiable. Therefore, we have adopted the following approach. All the models we work with have a common component to explain the existence and variations in seasonal-frictional-structural unemployment. That is, the models differ only in the treatment of the cyclical component. In a stationary state, therefore, all models would collapse to an expression which measures frictional unemployment. For this reason our specification of frictional-structural unemployment is developed in Section III, prior to the treatment of the disequilibrium component which is discussed in Sections IV-VII. A full specification of any unemployment equation is obtained by combining the two parts. This approach reflects our judgement that the specification of the frictional-structural component is relatively uncontentious and that those investigators who have neglected its specification in the past have done so for reasons of convenience only.
II A Brief Survey

Of all the issues relating to unemployment in Australia during the 1970s, there are two which are of direct relevance to the present paper, viz. the possibility that frictional-structural unemployment in Australia may have risen and that real wage changes have contributed to the increase in aggregate unemployment.

The notion that structural maladjustment may have contributed significantly to the increasing level of unemployment during the 1970s may be regarded as the recurrence of a familiar theme in the post-war discussions of unemployment in Australia. In a world in which technological innovations and changes in tastes are continually occurring it would be easy to lose a sense of perspective and to overstate the importance of particular shocks as sources of unemployment. The particular shocks whose influence on frictional unemployment have been examined in the past include the increases in the real value of unemployment benefits in 1973, changes in the number of assisted migrant workers in the workforce, changes in other social security benefits and so forth. See Hancock (1963), Hughes (1975), Gruen (1978), Paterson (1979), Harper (1980), Bowden (1980), Warren (1981), McMahon and Robinson (1981) amongst others. Some econometric evidence has been produced which suggests that measured unemployment as reflected in the Commonwealth Employment Service (CES) and Department of Social Security (DSS) unemployment data did increase significantly in response to the increase in unemployment benefits. Evidence on the same from
studies which use other measures of unemployment, such as the
Australian Bureau of Statistics (ABS) survey unemployment series,
is much weaker. With respect to the question of an increased
maladjustment in the labour market as a consequence of an
imbalance between skills demanded and skills supplied, the
evidence is somewhat muted, having been based on observed shifts
in the u-v locus, shifts which are consistent with such an
imbalance. Finally, we are aware of no systematic investigations
which link changes in unemployment to changes in the composition
of aggregate demand.

Much greater emphasis in empirical work has been given to
the contribution to unemployment of real wage movements and
aggregate demand. With the exception of the McMahon and Robinson
(1981) study almost all contributions to this debate focus on the
cyclical component, to the total exclusion of frictional-structural unemployment, with special attention being paid to the role of real labour costs in generating and
maintaining unemployment. Contributions to this debate include
those by Corden (1979), Hughes (1981), Johnston, Campbell and
Simes (1976), McMahon and Robinson (1981), Pitchford (1981),
Sheehan (1973), Snape (1979, 1980, 1981), Stammer (1978) and a
number of papers and comments in the special issue of the
Australian Economic Review 1979. The evidence adduced in
support of the thesis that real wage rates, or, in some cases, an
increase in real wage costs in excess of trend labour
productivity, have contributed substantially to the growth in
unemployment since 1974 is somewhat varied. To substantiate this
position Johnston, Campbell and Simes (1978), Pitchford (1981)
and McMahon and Robinson (1981) rely principally on an econometric analysis of unemployment data (and, in the first case, labour force participation data) whereas Snape (1981, p.33) argues less formally when he writes that "the strongest support for saying that there is (or has been) a significant degree of classical unemployment in Australia comes from the fact that increased real labour costs and the development of the 'overhang' preceded the emergence of substantial unemployment in 1974, and that the high real labour costs were to a significant extent locked in by the wage indexation system". Yet another group of contributors rely either on a priori reasoning alone, or on somewhat selective pieces of evidence to argue that real wages don't matter or that they do, see, for example, Fisher et al. (1978). Since a good deal of the discussion of the role of real wages falls in this last category, we appear not to have available a solid body of evidence for or against the contribution of real wages to unemployment, especially evidence regarding the channels through which the real wage effects worked, if they did. The only clear quantitative statements about the contribution of real wages to unemployment growth since 1974 come from Johnston, Campbell and Simes (1978), who attributed a 2-2.5 percentage point increase in unemployment to the so-called real wages overhang, and from Pitchford (1981) who provides a graph showing the contribution of real wage changes to changes in unemployment since 1969 and points out that "...[f]or
conclusions about the importance of the real wage in raising the unemployment rate in Australia do depend quite significantly on the experience of 1974.5
III A simple specification of frictional-structural unemployment

In specifying the mechanism that generates frictional-structural unemployment we rely mainly on models of job search. A major problem in specifying the sources of frictional-structural component is that the number of candidate variables can be very large even though each one individually might contribute rather little. See, for example, Nickell (1982). It is, therefore, inevitable that certain factors will be neglected.

In a simple job search model, based on the assumption of a stationary economic environment, optimal duration of search is determined by the equality of marginal cost and benefit of a further period of search. It is an implication of such a model that unemployed workers in receipt of unemployment benefit will set higher reservation wages than those who do not receive such compensation. Furthermore, any factor which increases the benefit or reduces the cost of job search, such as an increase in the unemployment benefit, will increase the duration of job search and reservation wage. An increase in the mean duration of job search will in turn lead to an increase in the unemployment rate. The real unemployment benefit, denoted RUB, will be taken as a determinant of frictional unemployment.

The importance of RUB as a determinant of measured unemployment will depend in part on the measure of unemployment that we choose to explain. Since registration with the CES is a precondition for the receipt of unemployment benefit for those eligible for it, we should expect a priori greater sensitivity of
that measure to variation in unemployment benefit than for the
ABS unemployment measure which includes those not eligible for
unemployment benefit. Various social security payments,
especially those available to aged workers, may influence
unemployment duration in the same way as RUB. The
McMahon-Robinson study has examined this hypothesis but failed to
find statistically significant effects.

A second factor contributing to a positive level of
frictional-structural unemployment is the shifts in demand and
supply in a multisectoral economy. If there exist many distinct
markets with imperfect and costly labour mobility between them,
fluctuations in demand and supply will lead to an increase in the
number of accessions of new workers and separations of displaced
workers. Such demand and supply shocks may arise from changes in
taste and technology, from product and process innovation and
from regional shifts in location of industry and labour, all of
which at least in the short-run lead to an imbalance between
skills demanded and supplied. A stationary equilibrium, such as
the one considered by Lucas and Prescott (1974), is characterised
by market specific demand fluctuations with a constant variance
and hence yields a constant equilibrium unemployment rate. In
empirical work it seems desirable to relax this assumption by
allowing for a nonuniform growth in demand. For a given degree
of labour mobility, a less uniform distribution over sectors of
changes in total demand would be associated with a higher level
of frictional-structural unemployment.
To test this hypothesis we require a measure of the shift in the sectoral composition of demand. The term "sector" should be defined broadly to encompass regional as well as industrial variations and a measure based on a fine disaggregation would be preferred to that based on a coarse disaggregation. Two measures of demand dispersion were considered, one due to Stoikov (1966) and another due to Lilien (1992). Stoikov's measure of shift in the composition of the demand for labour consists of the sum of all positive shifts in the demand of the individual labour markets. He proposes the index

$$S_t = \sum_{i=1}^{n} \left| \hat{E}_{it} - \bar{E}_t \right| \left( \frac{E_{it}}{E_t} \right)^{\tau}$$

where $E_t$ denotes the total employment in $n$ industries in year $t$. $E_{it}$ employment in industry $i$ in year $t$, the dot denotes the proportionate rate of change and $\bar{E}_t$ denotes the weighted average time rate of change of employment for all industries defined as

$$\sum_{i} \frac{\hat{E}_{it}(E_{it}/E_t)}{i}$$

The index $S_t$ "is a measure of employment dispersion that occurs from year to year. If there were no relative shifts in demand for labour between industries, then individual deviations from the all-industry average rate of change of employment would be zero (and the index $[S_t]$ would read zero). The greater the relative shifts of demand, the larger the index $[S_t]$. The individual deviations from the average rate of change are
Figure 4

DISPERSION OF DEMAND 1964(X) - 1982(Y)

YEARS (Q)
weighted by the relative employment of the industry in question in order to take account of industries with different employment volumes"; Stoikov (1966, p.541). Note that if total employment is constant then $S_t$ reduces to the total number of hirings and separations in the economy.

The available data only permitted us to construct the index $S_t$ on a quarterly basis for an eleven industry ASIC classification. This disaggregation is coarser than we would like. Furthermore, changes in definitions prevented us from constructing a single consistent series and the index constructed has a discontinuity at 1972(4). See Figure 3. Because of the resultant jump in the level of the series, we have treated the index as two separate variables, $S_1$ and $S_2$, defined to be non-zero for periods 1964(2)-(4) and 1973(1):1981(2), respectively.

The index of sectoral shifts suggested by Lilien (1982) is a weighted variance measure defined by

$$v_t = \left( \sum_{i=1}^{n} \frac{E_{it}}{E_t} (\Delta \ln E_{it} - \Delta \ln E_t)^2 \right)^{1/2}$$

which is somewhat different from $S_t$ (and also harder to interpret), but like it, is also intended to measure nonuniformity in employment growth. This index was constructed for the same period as the $S$ index and like the latter is subject to a discontinuity at 1972(4). See Figure 4.
Finally consider the possibility that there may exist demographic influences on the unemployment rate. In a hypothetical state with a constant composition population and labour force this effect will be absent. Over sufficiently short periods of time also the contribution from this source will be minor, but over the sample period under consideration here it is hard to make prior judgements. As there is no obvious labour force composition measure, we have experimented with two or three, viz. the proportionate rate of change in the working population (PW), the proportion of females and juniors in the labour force (LFJ), the proportion of juniors and married females in the labour force (LFWJ). None of these measures had a consistent performance so we have employed them less than systematically.

Summarising this section, the frictional-structural component of unemployment in our specification depends upon a constant, real unemployment benefits and the composition of demand index B or V. To reiterate, such a specification allows one to specify a moving (changing) equilibrium level of employment. This source of unemployment reflects a part of normal turnover of the labour force. Unemployment from this source would increase if there are unusual obstacles to mobility or if changes are occurring so rapidly that the labour market cannot adapt or adjust to them.
IV. Equilibrium unemployment: a neo-Keynesian rationing approach

In this section we put forward a definition of equilibrium unemployment based on modern reinterpretations of Keynes, specify an econometric equation for unemployment based on it, present our estimates and discuss the properties and implications of our results. This process is repeated for other definitions in the next three sections.

Keynes' definition of full employment, the level which corresponds to zero involuntary unemployment, has been often taken to be ambiguous and unsatisfactory. We shall substitute "cyclical" for "involuntary" so that full employment corresponds to zero cyclical unemployment. This definition then leaves us with the (not insubstantial) task of specifying the source of cyclical deviation in unemployment from the full employment level. In the taxonomy used in neo-Keynesian macroeconomic theory, for example in Malinvaud (1977), excess supply in the labour market (job rationing) can arise in a classical or a Keynesian rationing equilibrium. In the former case unemployment may be caused by an excessively high real wage, which reduces profitability and desired productive capacity, and in the latter by deficiency in aggregate demand. In these cases, therefore, unemployment is accompanied by a disequilibrium in the real wage and in aggregate demand. The source of the disequilibrium lies in the sluggish response of nominal wages and prices to excess supply. Whether one treats these disequilibria as symptoms or causes of unemployment is debatable and has a bearing on how one models unemployment. In what follows we treat observed
disequilibria as proximate causes but, of course, the real causes are factors which themselves induce stickiness in wages and prices. See, for example, Akerlof (1980), and Gordon (1981). Some economists emphasize that the disequilibria in question are persistent, that wages and prices respond slowly to excess demand and supply, especially the latter. Whereas in an economy with rapid price adjustments it is not meaningful to ask what unemployment rate the economy will tend to in response to a given disequilibrium in the goods market or in real wage, such a question becomes meaningful in a rationing model where such disequilibria can persist or can be assumed to persist. The equilibrium rate of unemployment in a rationing model may be defined as the rate that the economy will tend to if certain given disequilibria persist long enough (in a relative sense) for the unemployment rate to adjust to them. If wages and prices are exogenous, then this may be a plausible scenario, but since they cannot be so except in the short run the "set-up" is controversial. For example, Fitoussi and Georgescu-Roegen (1980) have observed that the "...The disequilibrium theorists have been so concerned with explaining how an economic system can live with a given disequilibrium that they have ended up with a theory which implies that any given disequilibrium must continue forever". This criticism can also be levelled against the specification of the unemployment equation in the rationing equilibrium framework which is considered below. Our response to it is the standard one, viz. that provided wages and prices respond gradually to persistent disequilibria such a specification is of interest.
Specification of the unemployment equation in a rationing model:

We wish to specify an unemployment equation capable of accounting for classical and Keynesian unemployment. Beginning with a Walrasian (unconstrained) equilibrium, classical unemployment can arise through a disturbance, such as an exogenous increase in the real wage, which reduces profitability or an exogenous supply shock which reduces labour productivity thereby creating an imbalance between the wage rate and average labour productivity.

It has been frequently alleged that the unemployment in Australia that arose in 1974 and subsequently is of this classical type (see Snape (1981)). According to this argument, a relevant determinant of unemployment is the excess of real labour costs over trend labour productivity. Keynesian unemployment, by contrast, will be modelled in terms of demand deficiency. On the basis of these arguments cyclical unemployment, $u^C$, may be specified as follows:

$$u^C = f(RW/y, Y/YCAP)$$

where RW denotes the real wage rate, the trend level of average productivity, $Y$ the actual level of output and YCAP the given level of full capacity output. Following Malinvaud (1988) let

$$Y = \min(\text{aggregate demand, profit maximising output, output that can be produced given supply of inputs}) \leq YCAP.$$
In Walrasian equilibrium,

\[ Y = \text{aggregate demand} = \text{profit-maximising output} = \text{factor-constrained output} = \text{YCAP}. \]

Out of Walrasian equilibrium, \( Y < \text{YCAP} \), and \( Y/\text{YCAP} \) or \( (Y-\text{YCAP}) \) may be taken as a measure of disequilibrium arising from one or more sources. Note that \( Y/\text{YCAP} \) will measure demand deficiency in a Keynesian regime, but will proxy the cost-influences on unemployment in a classical regime. Thus \( Y/\text{YCAP} \) need not be thought to be independent of the real wage. If, for instance, variations in \( Y/\text{YCAP} \) are induced by variations in the real wage, then only the latter variable can be regarded as an independent influence on unemployment. Assuming constant trend productivity an increase in the real wage will increase unemployment and an increase in capacity utilisation will decrease it. We shall say that the real wage rate and aggregate output are in an appropriate combination if they lead to zero \( u^c \). This formulation is not well suited to distinguishing between classical and Keynesian unemployment because it does not distinguish between reductions in output that result from an exogenous fall in aggregate demand and those which come about as a result of profit-maximising firms reducing their output in response to, say, an earlier increase in \( \text{NM/r} \). Both will cause \( Y/\text{YCAP} \) to fall leading to an increase in \( u^c \). However, this is not a serious limitation, since the main purpose of this paper is not to distinguish empirically between classical and Keynesian sources of unemployment in Australia. It may be noted also that
in a multi-sectoral open economy coexistence of classical and Keynesian types of unemployment is possible so that a formulation such as (1), which allows for both, has some merits.

**Econometric estimation:** The basic specification of the unemployment equation in this section is

\[
\begin{align*}
\text{u} &= \text{u(RW/4, Y/YCAP, RUB, S or V)}^+ \quad \text{ plausible } \quad \text{(2)} \\
& \quad \text{(+) (-) (+) (+)}
\end{align*}
\]

where the expected signs of the partial derivatives are shown in parentheses. The specification actually fitted to the data is an elaboration of this basic form in that (i) it includes seasonal dummy variables, (ii) it allows for lags of adjustment and/or expectation in the response of unemployment to the explanatory variables in (2) and (iii) it allows for alternative definitions of variables such as the real wage.

The unemployment equation finally fitted using quarterly seasonally unadjusted data has semi-logarithmic functional form, uses the ABS survey definition of unemployment, excludes the trend productivity variable allowing its effects to be absorbed in the coefficient and incorporates either the variable GUT (from the Australian Treasury model NIF-10) or the CES vacancy rate, VR, or a survey measure of capacity utilisation, denoted PSAT. That is, the equation has the form

\[
\begin{align*}
\ln u_t &= \beta_0 + \beta_1 RW_{t-1} + \beta_2 \frac{RW_{t-3} - RW_{t-1}}{RW_{t-1}} + \beta_3 \text{GUT}_t + \beta_4 \text{RUB}_t \\
& \quad + \beta_5 S_1 + \beta_6 S_2 + \beta_7 \ln u_{t-1} + \text{seasonals} \\
\end{align*}
\]

The semi-logarithmic formulation was preferred to the double
logarithmic formulation both because it is less restrictive in its elasticity implication and because it produced a better fit to the data (and it was also preferred to the linear formulation because it proved to be more stable as judged by CUSUM and CUSUMSQ tests) and because the linear version had heteroscedastic residuals while the semi-logarithmic version did not. The trend productivity variable was excluded because it is difficult to construct a long time series for it without making too many compromises and GUT was used as the measure of capacity utilisation because its conceptual basis is consistent with the model.

A major problem with the variable GUT arises from the fact that YCAP, which is intended to be a measure of potential output, is proxied by a trend value calculated by peak-to-peak interpolation. The method is widely thought to have become unreliable, especially since 1975. An alternative is provided by the Confederation of Australian Industry and Bank of New South Wales Survey of Industrial Trends which provides estimates of the proportion of manufacturing firms that regard their current level of capacity utilisation as satisfactory. These data are available from 1960 onwards. The survey weights all establishments equally, does not use an objective measure of a "satisfactory" level of capacity utilisation, and is restricted to manufacturing only - all of which are limitations. However, for the want of better data, we assumed that the 'true' index of capacity utilisation was a monotonic function of the reported proportion with "satisfactory" capacity utilisation, PSAT. We restricted attention to a linear and logarithmic transformation
of PSAT though other transformations may be considered also. Logarithmic transformation appears preferable on a priori grounds.

**Properties of the estimates:** How well does the model fit the data? To answer this question reasonably fully, one has to examine the specification of the model in several dimensions. In terms of \( R^2 \), significance of the economic variables, absence of serial correlation in the residuals and consistency with underlying economic theory the equation seems satisfactory. There was some evidence from the estimated ACF that the residuals exhibited fourth and fifth order moving average serial correlation which, we think, is probably due to the inability of the linear shift seasonal dummy variables to account fully for seasonality in the unemployment series. But statistically this was not significant so the results reported in Table 1 do not correct for it. Estimates obtained subsequent to such a correction differed only negligibly from the reported results. We also used CUSUM and CUSUMSQ tests to check the stability of the equations,\(^{13}\) but because of the discontinuity of our index \( S \) could apply the tests only separately to two subsamples leaving the specification of the model intact. Subsequently we omitted \( S_1 \) and \( S_2 \) altogether from the equation and ran the stability test on this variant. Notwithstanding the ambiguity which results from exclusion of what we believe to be a relevant and significant variable in the equation, we report that the CUSUM test indicated a stable regression whereas the CUSUMSQ test produced only slight evidence of instability around the period 1970(2-3). See Figures 5a and 5b. Table 1 provides the
coefficients for the two sub-samples. The impression conveyed by
the sub-sample estimates is one of lack of statistical stability.
In particular, the explanatory power of both the real wage and
the capacity utilisation variable derives predominantly from
post-1972 observations. Interpretation of the evidence of
variation in coefficient estimates poses a problem. One the one
hand, switches of regimes, say from Keynesian to classical ought
to be reflected in parameter variation, even though aggregation
will probably cause such switches to be smooth rather than
abrupt. Therefore, parameter variation is not difficult to
accommodate theoretically. On the other hand, irrespective of
the reason for parameter variation, estimation and inference will
be affected if it is not taken into account. To throw further
light on this issue we used the residuals from equation 3, Table
1, to compute the LM test statistic in Breusch and Pagan (1979,
p.1293) setting n=13, the length of the first sub-sample. This
yielded a value of only 0.14. This is rather small compared with
the critical value of 3.84, contradicting the casual
impression one has of parameter variation. Another possible
interpretation of the results in Table 1 could be that
insufficient variation in the real wage variable over the period
1964-72 makes it difficult to identify its coefficient but that
sizeable variation in the second sub-sample does lead to
identification. Thus what we may be witnessing may be not a
situation of parameter variation but one in which the first
sub-sample does not contain enough sample variation to identify
the coefficients or the real wage variable.
The estimation of equations including the variable PSAT, or log(PSAT), in the place of GUT was carried out by least squares as well as the instrumental variables method. It seems desirable to use the latter (preferably in its generalised version) especially as one suspects that measures of capacity utilisation will not be stochastically independent of unemployment. Misleading results may be obtained if the extent of simultaneity between the two is substantial. In applying the instrumental variable procedure \((\log \text{PSAT})_{t-1}\) was used as an instrument for \((\log \text{PSAT})\). Sample-split estimates were also obtained for periods 64:3 to 72:4 and 73:1 to 81:2. The main features of resulting estimates are as follows. The coefficients of the real wage variables \(\text{RW}_{t-1}\) and \(\ln \text{RW}_{t-2}\) are positive and highly significant for the full sample period as well as for the period 73:1 to 81:2 but statistically insignificant for the period 64:3 to 72:4. This is the case with both the least squares and instrumental variable estimates. In other words the inclusion of post-1972 observations is critical to the conclusion that real wage movements have contributed to unemployment. The capacity variable \(\log(\text{PSAT})\) was found to be a very important determinant of unemployment in the first sub-sample according to both the instrumental variable and the least squares estimates. It was found to be a statistically insignificant influence on unemployment in the second sub-sample, this feature being relatively more outstanding for the instrumental variable estimates. We have therefore a conflict between the results based on the two measures of capacity utilisation, both of which are imperfect proxies, and whereas the use of one (GUT) leads to
### Table 3: Unemployment Equation - Neo-Keynesian Rationing Approach

Dependent Variable: ln \( u_t \)

| Equation | Constant | \( \sigma_1 \) | \( \sigma_2 \) | \( \sigma_3 \) | \( \sigma_4 \) | \( \Delta \sigma_{1-1} \) | \( \ln \sigma_{1-1} \) | \( \sigma_{2-1} \) | \( \Delta \sigma_{2-1} \) | \( \sigma_{3-1} \) | \( \Delta \sigma_{3-1} \) | \( \sigma_{4-1} \) | \( \Delta \sigma_{4-1} \) | \( \text{R}^2 \) | Durbin h | LM | \( \sigma^2 \) | Time Period |
|----------|----------|--------------|--------------|-------------|-------------|----------------|----------------|--------------|----------------|-------------|----------------|-------------|----------------|--------|--------|----------|----------|
| (3)(1)   | 0.4605   | 0.2761       | -0.5461      | -0.1651     | 0.2493      | 0.2952         | 0.1167         | 0.2493       | 0.0987         | 0.2037      | 0.0277         | 0.0987      | 0.2493         | 0.1167 | 0.2037 | 0.0277   | 0.0078   | 64:03 to 72:3 |
| (3)(11)  | 1.6591   | 0.2851       | -0.3433      | -0.2911     | 0.3505      | 0.2458         | 1.2559         | 2.2982       | 0.6381         | 1.2559      | 0.3505         | 0.2458      | 1.2559         | 2.2982 | 0.6381 | 1.2559   | 0.0043   | 73:1 to 81:2 |
| 1        | 1.4064   | 0.2055       | -0.0942      | -0.0694     | 0.2349      | 0.0360         | 1.1562         | 0.6584       | 0.1835         | 0.0360      | 0.2349         | 0.0360      | 1.1562         | 0.6584 | 0.1835 | 0.0360   | 0.0006   | 64:3 to 81:2 |
| Ln\( \Delta \) | 0.4689   | 0.0308       | -0.0226      | -0.0158     | 0.09420.2458 | 0.0360        | 1.1562         | 0.6584       | 0.1835         | 0.0360      | 0.2349         | 0.0360      | 1.1562         | 0.6584 | 0.1835 | 0.0360   | 0.0006   | 64:3 to 81:2 |
| Ln\( \Delta \) | 0.6576   | 0.1973       | -0.3289      | -0.3171     | 0.0843      | 0.2458         | 0.0360         | 1.1562       | 0.6584         | 0.1835      | 0.0360         | 0.2458      | 0.0360         | 1.1562 | 0.6584 | 0.1835   | 0.0007   | 64:3 to 81:2 |

Notes: 1. \( \sigma_1 \) (1-2,3) quarter dummy variable.
2. \( \sigma_2 \) (1-2,3) stock index for period 1.
3. \( \Delta \sigma \) real wages: deflated by CPI and GDP deflator.
4. \( \sigma \) capacity utilisation index.
5. \( u \) - RBS Unemployment Rate.
6. \( \Delta \sigma \) unemployment benefit CPI.
7. \( \text{ACT} u \) fourth order MA coefficient.
8. \( \text{LM} \) is the Lagrange multiplier test statistic for testing the significance of 1st order MA coefficient.
9. \( \sigma^2 \) is residual variance.
10. \( \text{R}^2 \) is the coefficient of determination.
11. \( \text{Durbin} h \) is the Durbin h statistic.
12. **Corrected for serial correlation.
Neo-Keynesian Rationing Equation (3) - Stability Tests at 5% Significance Level

CUSUM of Squares of Recursive Residuals

CUSUM of Recursive Residuals

Figure 5a.

Figure 5b.
a conclusion that capacity factors have a role in explaining unemployment in the post-1972 period over and above that accounted for by real wage movements, the use of the second proxy does lead one to conclude that the capacity factors do not have any additional role. Those who take the position that reduction in capacity utilisation in the post-1972 period, and especially since 1975, is a response to an earlier increase in real wages will prefer to conclude that capacity factors really do not have an independent role. Others who believe that, in some industries at least, demand factors can and did play a role in reducing capacity utilisation and increasing unemployment will, in view of our less than conclusive results, continue to look for a role for this factor. Given the theoretical possibility that the two variables can vary independently, both should be retained in the specification. But without better data and additional observations, as well as refinements in estimation, resolution of the issues is difficult.

Implications of the results: The estimates suggest:

1. Lagged adjustment of unemployment to changes in its determinants is a very important aspect of unemployment behaviour. Introducing explanatory variables with a few finite lags does not adequately account for the strong serial correlation in the unemployment rate.

2. Lagged real wage rate and two-period lagged rate of change of the real wage, measured as money wages deflated either by the consumer price index (CPI) or by
the GDP deflator, is a significant determinant of the unemployment rate. The short-term elasticity of unemployment with respect to the real wage measured at average 1980-81 level of the real wage is estimated to be 1.2, and the "long-term" elasticity is estimated at 3.6. Our chosen functional form implies a higher elasticity at a higher wage rate. These results are qualitatively consistent with those of Johnston et al. (1978) and Pitchford (1981).

3. The capacity utilisation index GUT provides a significant part of the explanation of changes in the unemployment rate since 1976. The short-run and long-run elasticities with respect to GUT, evaluated at average 1980-81 values are, respectively, -2.08 and -6.11. The importance of GUT as an explanatory variable does not of course contradict the suggestion that classical type of unemployment persists since the observed reductions in capacity utilisation could well be a response to previous changes in wages. From the viewpoint of rationing theory GUT could be interpreted as an index of job availability. An increase in GUT would lead to more jobs and hence a lower rate of unemployment. A variable which is used more conventionally to measure job availability is the vacancy rate. Estimates were also obtained with the CES vacancy rate in place of GUT; see Equation 3b, Table 1. These results are qualitatively similar to those obtained using GUT. We suggest, therefore, that
deficiencies of GUT notwithstanding, it may be a valid proxy for the job availability index.

To partially guard against the valid criticism that the contribution and importance of capacity factors is overstated by GUT especially since 1975 we have used a survey measure of manufacturing capacity utilisation. The results of this analysis give a larger role to the real wage variable and a reduced role to the capacity variable over the 73:1 - 81:2 period relative to the 64:3 - 72:P4 period. Insofar as the results based on PSAT are more reliable than those based on GUT, and this is far from clear, it would appear that the latter probably do somewhat overstate the role of capacity factors in unemployment generation in 1979 and 1988.

4. The composition of demand variables, $S_1$ and $S_2$, appear with statistically significant coefficients and support the hypothesis that statistically significant variations in the level of frictional-structural unemployment occur continuously. We can find no evidence, however, that a large part of measured unemployment rate is a result of "accelerating pace of change". Quite to the contrary, we find that on average this type of structural unemployment probably accounts for only about 1 to 1.1 percentage points of unemployment and variations in its level are of the order of 0.3 to 0.5 percentage points. Thus this particular source simply cannot account for the measured
increase in unemployment in the 1970s. Finally, the unemployment benefit variable, RUB, is not significant. This once again confirms previous results including that of McMahon and Robinson (1981).

There is an alternative way of drawing out the implications of our estimates that is appealing. Take as given observed disequilibria reflected in the real wage rate and capacity utilisation over some historical periods, say 1972-73 and 1980-81, and also historical values of other variables such as $S_1$ and $S_2$. Conditional on these, what rate of unemployment would the system settle down to? Such a rate, a temporary rest point of the system, can be interpreted as a rationing equilibrium unemployment rate. Calculations based on Equations (3) and (3a) in Table 1 lead to the following estimates:

<table>
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<tr>
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<th>1972-73</th>
<th>1980-81</th>
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</tr>
<tr>
<td>Equation (3a)</td>
<td>3.06</td>
<td>7.25</td>
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</table>

Two points are worth noting about these plausible estimates. First, most, if not all, of the change in the equilibrium rate from about 3 percent in 1972-73 to around 7 percent in 1980-81 is accounted for by cyclical factors, viz. real wage and capacity utilisation. Second, since 1980-81 there has almost certainly been a further decline in capacity utilisation and an increase in real wages. This suggests that the 1982 “equilibrium”
unemployment rate is highly likely to exceed the 7 percent reported above. Calculations based on equation 33(ii) lead to a lower estimate of 5.3% in 1980-81. Precise numerical results such as these should be treated with caution because there is some difficulty in deciding which equation, if any, is most suitable for such calculations.
V. Equilibrium unemployment: zero excess demand definition and the u-v model.

Zero excess demand definition: Dow and Dicks-Mireaux (1958) defined equilibrium in the labour market as corresponding to the level of unemployment at which aggregate unemployment and vacancies rates are equal, i.e. \( u=v \). \( u>v \) corresponds to excess supply and \( u<v \) to excess demand for labour. The definition is motivated by policy considerations. \( u>v \) can be interpreted as indicating the desirability of an expansion in aggregate demand, \( u<v \) can be interpreted as indicating the opposite and \( u=v \) indicating that a reduction in unemployment can be achieved by policies that improve the match between jobs and workers. Critics of this definition, such as Mincer (1966), have pointed out that this definition of full employment pays no attention to the objective of zero or constant inflation rate, and, specifically, a low (constant) inflation rate.

The technique of u-v analysis is concerned with modelling the general inverse relationship between the aggregate unemployment rate and the vacancy rate. The static u-v locus is distinguished from the dynamic relationship between \( u \) and \( v \). The static u-v locus is an inverse relation between \( u \) and \( v \) derived from a model of a competitive labour market with a given labour force and given productivity. In such a labour market wages adjust solely in response to appearance of excess demand or excess supply. Figure 6 summarises an argument along these lines. SS and DD represent supply and demand curves for labour respectively, EE represents actual employment at various wage
rates, vacancies measure the difference between demand and employment and unemployment the difference between supply and employment. Above the equilibrium wage rate $W^*$, $u>v$ and below the equilibrium wage rate $u=v$. Figure 6b is derived from Figure 6a and shows the inverse relationship between $u$ and $v$. The region above the $v=u$ line represents excess demand and a rising wage rate, the region below it excess supply and a falling wage rate. The distance of the $u-v$ locus from the origin along the $45^\circ$ ray was taken by Dow and Dicks-Mireaux to be a measure of labour market "maladjustment" in the sense that the distance would be zero in a homogeneous frictionless labour market with perfect information and perfect mobility. Given the $u-v$ locus $f(u,v)=c(z)$ and the equilibrium condition $u=v=u^*$, where $c(z)$ is a function of exogenous variables $z$, an expression for $u^*$, the equilibrium unemployment rate, is obtained in terms of $z$. This is the approach followed by, for example, Harper (1980). Once again, however, it should be noted that this is the equilibrium rate only under the very restrictive assumptions under which the wage responds only to excess demand or supply.

A major practical problem in modelling the $u-v$ locus arises from the need to take account of the possibility, explained in theoretical models of both Phelps (1970) and Hansen (1970) and further exposit by Harper (1980), that movements in $u$ and $v$ induced by exogenous cyclical changes in aggregate demand, take place not along the $u-v$ locus but in counterclockwise loops around that locus. The theory of these loops closely mirrors the theory of loops around the short-run Phillips curve (which is of course closely related to the $u-v$ curve). To explain how these
loops may be generated Hansen proceeds as follows, see Hansen (1970, Section VI). First a lagged employment mechanism is postulated according to which the change in the employment rate depends upon the gap between desired employment, which is a function of demand, and actual employment adjusted to take account of quits. This implies that the rate of employment will mirror the cyclical pattern of demand. Since the unemployment rate is one minus the employment rate, it will also in turn move cyclically in response to a cyclical movement in demand. The vacancy rate depends directly upon the difference between demand and employment and on the time taken to fill a vacancy, which is hypothesized to depend inversely on the rate of unemployment. The vacancy rate also will display a cyclical response to cyclical fluctuation in demand. In short, the loops around the u-v locus are generated primarily by the nature of the response of the employment rate to (assumed) exogenous demand fluctuations.

Conventionally, in modelling the u-v relationship within the framework of single equation u is taken to be the dependent variable and v is taken to be pre-determined. The preceding discussion has suggested that both variables should be taken as determined by demand in a dynamic model framework. However, if v responds rapidly (relative to the unemployment rate) to variations in aggregate demand, then it can be taken to be a proxy for the latter in modelling unemployment. This point has also been emphasized by Phelps (1970).
Empirical exploitation of these ideas requires specification of (a) a steady-state \( u-v \) locus, and (b) a dynamic model capable of depicting the anticlockwise loops mentioned while at the same time possessing a steady-state form consistent with theory. For concreteness let the steady-state \( u-v \) locus have the form

\[ u^* = c(\cdot), \quad \alpha, \beta > 0, \]  

(4)

where \( c(\cdot) \) is a positive-valued function of a vector of variables which jointly determine the level of frictional-structural unemployment. At zero excess demand, \( u=v=0 \) which in conjunction with (4) yields

\[ \bar{u} = c(\cdot)^{1/(\alpha+\beta)} \]  

(5)

as the equilibrium unemployment rate. If \( c(\cdot) = c(z_t) \) where \( z_t \) is a vector of variables which vary over time, then the equilibrium rate \( u \) will also vary over time.

Both Phelps and Hansen include time rates of change in their theoretical specification. In a discrete time empirical model these will be replaced by lagged values of both the unemployment rate and the vacancy rate in a manner which is plainly empirical. For illustrative purposes, consider the dynamic specification

\[ \left( u_t^2 / u_{t-1}^2 \right) \left( u_t / u_{t-1} \right) \left( v_t / v_{t-1} \right)^{\alpha} \left( v_t / v_{t-1} \right)^{\beta} = c(z_t) \]  

(6)

which may also be written (after log transformation) as

\[ [(a+\gamma)-(\gamma-\delta)L-\delta L^2] \ln u_t + [(\theta+\beta)-\delta L] \ln v_t = \ln c(z_t) \]  

(7)
where L is the lag operator. The real-state locus corresponding to (6) is still (4), but the nature of the time path followed between any two points on the locus is determined by the roots of the polynomial \[((\alpha + \gamma) - (\alpha - \delta))L - \delta L^2\].

If the variable v is treated as a proxy for aggregate demand then one may interpret (7) as a dynamic equation with forcing variables \((v, z)\). Rewriting (7) in the form

\[
\ln u_t = \left[\frac{\gamma - \delta}{\alpha + \gamma}\right] \ln u_{t-1} + \frac{\delta}{\alpha + \gamma} \ln v_{t-1} + \frac{\delta + \beta}{\alpha + \gamma} \ln v_t + \frac{\delta}{\alpha + \gamma} \ln v_{t-1} + \ln \frac{c_{t-1}}{\alpha + \gamma}
\]

serves to emphasise the role of v as a determinant of u. Note that although the lag structure of (8) is arbitrary, having been chosen for illustrative purposes, it is still general enough to generate the anticlockwise loops which appear in Figure 6c.

**Econometric estimation:** At the preliminary stage we conducted tests of causality, in the sense of Granger (1969) closely following the approach of Hsiao (1979). The objective was to discover whether such an analysis would support the implicit or explicit presumption in such previous empirical work on u-v locus that v "causes" u but u does not "cause" v. If so, then modelling the u-v relationship in the conventional manner may be justified. This exercise was carried out using the CEG data on u and v for the time periods 1949(1)-1979(3). To save space we do not provide details here (see however Appendix 8) but note that the results indicate that v "causes" u in the sense of Granger. Henceforth in this section we have therefore modelled u
conditionally on \( v \) and lagged values of \( v \) and \( u \).

The specification of the dynamic \( u-v \) equation that was reached after some experimentation with lags is the following:

\[
\ln u_t = \gamma_0 + \gamma_1 \ln u_{t-1} + \gamma_2 \ln u_{t-2} + \delta_1 \ln VR_t + \delta_2 \ln VR_{t-1} + \delta_3 S_{1t} \\
+ \delta_4 S_{2t} + \delta_5 \text{RUB} + \delta_6 \left( \frac{\text{PW}_t - \text{PW}_{t-4}}{\text{PW}_{t-4}} \right) + \text{seasonals} \tag{9}
\]

where \( (\text{PW}_t - \text{PW}_{t-4})/\text{PW}_{t-4} \) is the proportionate rate of change of working age population, has been included to take account of changing working age population — a possibility neglected in the theoretical specification — and \( VR \) is the measured vacancy rate. All other variables have been defined previously.

The specification (9) differs from Harper's only in its inclusion of the Stoikov variables \( S_1 \) and \( S_2 \) and of \( \text{PW} \). Only the first of these is of any consequence. However, there are differences between our respective measures of the labour force and this leads to some differences in estimates of \( u \) and \( VR \) and subsequently to some differences in parameter estimates. Table 2 gives estimates for the full sample period, 1965:1 to 1979:3 and for two subsamples also. The latter have been provided as a part of the discussion of the temporal stability of the estimated relationship.

The main features of the estimates are as follows. First, we note that the demand shift variables \( S_1 \) and \( S_2 \) and the unemployment benefit variable, \( \text{RUB} \), are probably significant determinants of the position of the \( u-v \) locus. However, some uncertainty arises from the fact that the coefficient on \( \text{RUB} \) is
significant only when post 1973:1 observations (which include a
large change in RUB) are included. RUB was, of course, expected
to be a more important determinant of the CES unemployment rate
than of the ABS unemployment rate and the results are broadly in
line with this expectation. The population variable FW is not
found to have a significant coefficient. The estimated
autocorrelation function of the residuals on the equations
suggested the presence of fourth and fifth order moving average
serial correlation. Both the estimates given in Table 2 and the
recursive least squares analysis suggest that this pattern of
serial correlation is associated with an unstable pattern of
seasonality. The equations have been estimated allowing for
fourth and fifth order moving average errors. CUSUM and CUSUMSQ
tests were carried out after omitting $S_1$ and $S_2$ from the
specification. See Figure 7. There is clearly evidence of
temporal instability so the estimates should be treated with
cautions.

From the viewpoint of the present paper, major interest
attaches to estimates of the equilibrium unemployment rate. For
average values of $S_2$, RUB and FW variables that prevailed in
the fiscal year 1980-81, the equilibrium rate of unemployment was
estimated to be 1.79% from equation 9. For the average values of
variables $S_1$, RUB and FW in 1972, the rate was estimated to be
1.21%. Considering the possibility that more accurate estimates
of the equilibrium unemployment rate might be obtained from
sub-sample estimates, we estimated that rate using equation 9(i)
in Table 2, conditional on 1968-69 values of exogenous variables,
and using equation 9(ii), conditional on 1976-77 (approximate
midpoint of the second sub-sample) values of the exogenous variables. These were, respectively 1.02% and 1.60%. Various estimates confirm the hypothesis that the equilibrium (CES) unemployment rate has risen. Thus, according to the Dow and Dicks-Mireaux measure, the "maladjustment" of the labour market has increased.

We believe that most students of the Australian labour market would find our estimates somewhat on the low side. The estimate is obviously affected by numerous factors, not the least important of which is the severe problem of measurement error which afflicts the CES data. Another difficulty arises from apparent instability in the coefficients of the seasonal dummy variables. Finally, there is also the possibility, which we have not taken into account, that significant contemporaneous correlation between \( u \) and \( v \) induces some simultaneous equation bias in our estimates. These issues are left to a future investigation. Another puzzle which might be investigated in the future is just how adequately a flex-price model of the labour market, such as the \( u-v \) model, can accommodate wage rigidities which other formulations incorporate.
### PAGE 2: Unemployment Equation - u-y Approach

**Dependent Variable:** In $q_f$

**t-ratios in parentheses.**

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<thead>
<tr>
<th>Equation</th>
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<th>$s_2$</th>
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<th>InVR f-2</th>
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<th>PW</th>
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<td>(0.19)</td>
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<td>(3.74)</td>
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<td>(2.63)</td>
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<td>(1.03)</td>
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<td>(1.03)</td>
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**Notes:**
1. $O_1$ (1=1,2,3) Quarter i dummy variable
2. $s_1$ (1=1,2,3) Stolkin index for period i
3. $O_2$ CES unemployment rate.
4. $s_2$ CES vacancy rate.
5. WC Unemployment Benefit/CP.
6. PW Working age population.
7. $L_w$ 1 st order MA coefficient.
8. $L_w$ see Table 1.
10. $F$ Residual Variance.
Figure 7b.
VI. Equilibrium unemployment: a search-turnover approach.

In the search-turnover approach, as developed by Holt (1970), Mortensen (1978) and others, equilibrium in the labour market is defined by reference to flows between different labour market states. The labour market is said to be in equilibrium when inflows into and outflows from each state are balanced, and therefore stocks are constant. We shall expand on this definition and turn to the question of how departures from equilibrium may arise.

Let there be three labour market states, employment (E), unemployment (U) and not in the labour force (N). Consider a finite time-interval \([t-1, t]\) during which individuals change their state from \(i\) to \(j\), \(i, j \in \{E, U, N\}\). Let \(\lambda_{ij}\) denote the probability that an individual in origin state \(i\) ends up in destination state \(j\). Let \(A = [\lambda_{ij}]\) be the transition probability matrix:

<table>
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<tr>
<th>Origin State</th>
<th>Destination State</th>
<th>Transition probability matrix</th>
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<tbody>
<tr>
<td>Employment : E</td>
<td>E</td>
<td>(\lambda_{ee})</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>(\lambda_{eu})</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>(\lambda_{en})</td>
</tr>
<tr>
<td>Unemployment: U</td>
<td>E</td>
<td>(\lambda_{ue})</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>(\lambda_{uu})</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>(\lambda_{un})</td>
</tr>
<tr>
<td>Not in the labour force: N</td>
<td>E</td>
<td>(\lambda_{ne})</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>(\lambda_{nu})</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>(\lambda_{nn})</td>
</tr>
</tbody>
</table>

\(\lambda_{ij}\) is not in general symmetric. \(\sum_{j} \lambda_{ij} = 1\). In a stationary state inflows into each state equal outflows from that state. That is,

\[
\begin{align*}
\lambda_{ne} N^* + \lambda_{ue} U^* &= (\lambda_{ee} + \lambda_{en}) E^* \\
\lambda_{ue} E^* + \lambda_{nu} N^* &= (\lambda_{ue} + \lambda_{un}) U^* \\
\lambda_{en} E^* + \lambda_{un} U^* &= (\lambda_{ne} + \lambda_{nu}) N^*
\end{align*}
\]

(10)

where \(E^*, U^*\) and \(N^*\) denote the number of individuals in the three
respective state in equilibrium. Solving for \( E^*, U^* \) and \( N^* \) and defining the equilibrium rate of unemployment as \( u^* = U^*/(E^* + U^*) \), we obtain

\[
u^* = \frac{\lambda \left( \frac{1}{e_u} + \frac{1}{e_n} \right) + \lambda \left( \frac{1}{e_u} \right) + \lambda \frac{1}{e_n}}{\lambda^2 + \lambda + \frac{1}{e_u} \frac{1}{e_u} + \lambda \frac{1}{e_n} \frac{1}{e_n}}
\] (11)

as demonstrated by Kiefer and Neumann (1981) amongst others.

**Behavioural theories of \( u^* \).** To introduce behavioural content into this model it is necessary to specify the determinants of the transition probability. In one approach illustrated by the work of Burdett et al. (1981), which we shall label the **unconstrained labour supply approach**, the transition probabilities are modelled to reflect the behaviour of labour force participants who are not constrained by any factor external to themselves. Specifically, lack of job offers is not a constraint. Some jobs are assumed to be always available. At the level of an individual, the transition probability \( \lambda_{ij}^k \) is taken to depend upon the characteristics of individual \( x \), although some of the characteristics may not be observable. That is,

\[
\lambda_{ij}^k = \lambda_{ij}(x_k), \quad \forall i,j
\] (12)

where \( x \) is a vector of individual characteristics. These characteristics include the reservation wage, age, sex, occupation, skill level, race, country of origin and so forth. The concept of reservation wage, \( w^F \), plays a critical role in the job search literature and it is taken to be the most important economic determinant of transition probability. Since
is not generally directly observed, it is convenient to express it in terms of observable variables. For example, Kiefer and Neumann (1979) chose

\[ W^*_k = g[P(W^*_k), \rho, \sigma] \]  \hspace{1cm} (13)

where \( P(W^*_k) \) denotes the real wage offer distribution which an individual \( k \) sampling job offers expects to obtain, \( \rho \) denotes the individual's subjective discount rate and \( \sigma \) the direct cost of search. For simplicity replace \( P(W^*_k) \) by \( E(W^*_k) = \tilde{W}_k^* \), the mathematical expectation of \( W^*_k \) or the expected wage offer. That is,

\[ W^* = g[\tilde{W}_k^*, \rho, \sigma] \]  \hspace{1cm} (14)

(+) (-) (-)

where the a priori restriction on the partial derivatives are shown in parentheses.

The following a priori restrictions on \( \lambda_{jj} \) seem reasonable:

(1) \( \frac{\partial \lambda_{uu}}{\partial \tilde{W}_k^*} > 0 \), \( \frac{\partial \lambda_{nn}}{\partial \tilde{W}_k^*} > 0 \), (ii) \( \frac{\partial (\lambda_{uu} \lambda_{nn})}{\partial \tilde{W}_k^*} < 0 \) \hspace{1cm} (15)

(iii) \( \frac{\partial \lambda_{en}}{\partial \tilde{W}_k^*} < 0 \), \( \frac{\partial \lambda_{un}}{\partial \tilde{W}_k^*} < 0 \), (iv) \( \frac{\partial (\lambda_{uu} \lambda_{ne})}{\partial \tilde{W}_k^*} > 0 \)
Since higher expected wages increase the inflow into U from N, but also increase the outflow from U to E, the net effect of higher wages on \(1 - \mu_u\) can be either positive or negative. The effect of an increase in unemployment benefit is unambiguous because it reduces the cost of job search and raises the reservation wage. This makes job search while unemployed relatively more desirable and lowers \(\lambda_{ue}\) and \(\lambda_{un}\). Raises \(\lambda_{mu}\) and \(\lambda_{mu}\) and probably leaves \(\lambda_{me}\) and \(\lambda_{en}\) unchanged. From (11) and (15) it can be shown that this would raise unemployment duration and equilibrium unemployment rate \(u^e\). In what follows we shall assume that these a priori restrictions apply also to average transition probabilities. In the average transition probability expression the individual reservation wage will be replaced by the average expected real wage rate, the individual specific search cost variable by average real unemployment benefit and the observed characteristics of an individual by the observed characteristics of labour force such as its age structure, ethnic composition, skill mix and so forth. Finally, structural change of the kind considered in Section III will raise \(u^e\). For any given technology of job search, structural change which manifests itself in greater dispersion of demand across sectors will lower the transition probabilities \(\lambda_{un}\) and \(\lambda_{ue}\) and hence increase the duration of search and \(u^e\). Thus we obtain an expression for equilibrium unemployment such as the following

\[ u^e = f(ERW, RUB, S, \theta) \]

(7) (8) (9)
where $EBW$ denotes average expected real wage and $\phi$ is a vector of characteristics of the labour force.

As stated, this variant of search-turnover theory determines the equilibrium rate of unemployment essentially through labour supply behaviour. If, as is assumed in simple search models, there is a constant probability of receiving a job offer then suppliers of labour are never constrained and the equilibrium unemployment rate simply reflects their choices and hence could be said to be "voluntary". In an alternative version of this theory, applied by Bjorklund and Holmlund (1981) and considered in the next section, this assumption is relaxed.

**Behavioural theory of $u^o$: disequilibrium component.**

Departures from the equilibrium unemployment level are explained in the conventional search-turnover model in terms of intertemporal substitution of labour induced by incorrect wage expectations. If expected future average real wage exceeds its current value, a worker specialising in job search and engaged in intertemporal substitution of labour supply towards future periods will increase search duration and unemployment would increase. If the current wage is higher than its expected future value, then substitution of labour towards the current period will lower current unemployment. As Prescott (1975, p.1229) has succinctly stated, "In the neoclassical speculative labour supply model, unemployment is an intended intertemporal trade of present leisure for an expected improvement in leisure cost of future consumption and future leisure". In brief, departures of unemployment rate from the equilibrium value simply reflect
errors of expectation. Persistent deviation of expected real wages from actual real wages will lead to a persistent deviation of actual from equilibrium unemployment rate. As Solow (1970, p.7) observes, "...people who give the vague impression of being unemployed are actually engaged in voluntary leisure. They are taking it now, planning to substitute extra work later, because they think, rightly or wrongly, that current real wages are unusually low compared with the present value of what the labour market will offer in the future".

The search-turnover theory developed here leads, under the assumption of constant real interest rate, to the following specification of unemployment equation:

\[ u = f(ERW, RUP, S, RW/ERW, \delta) \]

Observe that aggregate demand conditions play a role in the above only indirectly through their effects on actual real wages (RW) relative to expected future real wages. By assumption cyclical variations in job offer probability resulting from corresponding variations in aggregate demand are ruled out. This unsatisfactory feature of the simple search-turnover model has drawn considerable critical comment; see, for example, Tobin (1972). Bjorklund and Holmlund (1981), in an empirical paper, allow for a further disequilibrium component in transition probabilities and by specifying them as functions of both ERW/ERW and the aggregate vacancy rate. An increase in the number of vacancies has a pure availability effect which reduces the average duration of unemployment; it also has a supply
effect, viz. increasing the duration of search by increasing both the expected returns of searching and raising the reservation wage. Under reasonable assumptions, however, the supply effect will be dominated by the job availability effect.\textsuperscript{17} According to this argument, the disequilibrium version of search-turnover theory implies

\[ u = f(ERW, RUB, S, \phi, RW/ERW, JA) \]

where the last two arguments reflect disequilibrium influences and JA is an index of job availability.

Unfortunately, once job rationing considerations are introduced in the search-turnover model it is not clear what, if anything, remains of the concept of equilibrium unemployment, \( u^e \). If job offer probability varies cyclically, then the transition probability functions in a disequilibrium situation are different from those which determine \( u^e \) at (11) with the consequence that the former expression has to be conditioned on JA. Also note that once we adopt the specification (16) the difference between the neo-Keynesian rationing model of Section IV, and the search-turnover model, can be very small because empirically RW and ERW could have very similar coefficients, \( Y/YCAP \) could be an acceptable and valid proxy for JA and, finally, RW/ERW could have a negligible coefficient. Our ability to distinguish between the two models depends critically on RW/ERW being a significant factor in (16) and/or \( Y/YCAP \) or VR being a significant factor in the rationing model.
Econometric estimation: The following specifications were estimated:

(a) \[ u_t = \beta_0 + \beta_1 \text{ERH} + \beta_2 (\text{ERH}/\text{ERH}) + \beta_3 \text{RUB} + \beta_4 \text{LRB} + \beta_5 \text{GUT} + \beta_6 \text{S} + \text{seasonals} \] \hspace{1cm} (17a)

(b) As in (17a) but with in \( u_{t-1} \) added as an additional explanatory variable. \hspace{1cm} (17b)

(c) As in (17b) but with the capacity utilisation variable \( \text{GUT} \) added. \hspace{1cm} (17c)

(d) As in (17b) but with the job availability variable \( \text{vacancy rate, VR} \), added. \hspace{1cm} (17d)

Specification (17a) follows very closely the unconstrained labour supply version. It allows for no lags of adjustment. Specification (17b) does allow for adjustment lags though strictly speaking such lagged adjustment is not readily accommodated in the search-turnover model. Specifications (17c) and (17d) attempt to test whether job availability variables, considered unimportant in the search-turnover theory, do in fact contribute significantly towards explaining unemployment. To the extent that such variables are significant, we must abandon the simple variants in which a constant job offer probability is assumed. In some models, such as Seater (1979), the number of vacancies (employers) contacted is a control variable and hence would appear as an exogenous variable in the unemployment equation. From the job availability viewpoint the vacancy rate is exogenous to an individual. Thus, even though the vacancy rate may be included in either consideration, the interpretation of its role will be quite different in the two cases. In either case the equilibrium unemployment rate must be estimated conditional on the vacancy rate.
To estimate these equations a proxy for the unobserved ERW variable is required. We generated this as the conditional prediction from a regression of actual real wage on its own past values and on current and past values of other variables which are listed in Appendix A. Appendix A also gives additional details regarding this regression. Though consistent estimates of parameters may be obtained by such a two-step procedure, the standard errors obtained at the second stage are not quite "correct". See Pagan (1982). For this reason it would be advisable to be conservative in one's application of the t-test and treat coefficients which are marginally significant or insignificant with particular caution.

Estimates and diagnostic statistics given in Table 3 show that the specification (17a) is very unsatisfactory. $R^2$ is low and serial correlation in the residuals is very serious. Addition of $\ln u_{t-1}$ to (17a) improves the fit of the model considerably and shows that exclusion of $u_{t-1}$ was a serious misspecification; but the coefficient of (RW/ERW) is statistically insignificant so that one of the central predictions of the model, viz. that departures from equilibrium are caused by expectational errors, is contradicted. When either GUT or VR is added to the specification, not only are they highly significant as explanatory variables but the fit of the equations is vastly improved. Correction for fourth order moving average serial correlation is still necessary but, as we suggested in Section IV, this is probably related to a changing seasonal pattern of measured unemployment. The results of this section indicate that the search-turnover model without the vacancy or
### Table 3: Unemployment Equation - Search-Turnover Approach

Dependent Variable: ln u

**t-ratios in parentheses.**

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<th>Constant</th>
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<th>$b_2$</th>
<th>$b_3$</th>
<th>$b_4$</th>
<th>$b_5$</th>
<th>DR</th>
<th>ER</th>
<th>ln DR</th>
<th>ln ER</th>
<th>OUT</th>
<th>VR</th>
<th>$b_6$</th>
<th>$b_7$</th>
<th>$b_8$</th>
<th>Durbin's h</th>
<th>$t_1$</th>
<th>$t_2$</th>
<th>$t_3$</th>
<th>$t_4$</th>
<th>$t_5$</th>
<th>$t_6$</th>
<th>$t_7$</th>
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</table>

**Notes:**
1. $b_1$ (1,3) Quarter i dummy variable.
2. $b_2$ (5-1,2) Stolos index for period i.
3. ER, real wage.
4. DR = Unemployment benefit/GDP.
5. ER = Expected real wage.
6. $u_k$ ABS unemployment rate.
7. $b_6$ Capacity utilisation index.
8. VR = CBS vacancy rate.
9. $b_7$ = Third and fourth order MA coefficients.
10. $b_8$ = See Table 1

11. $t^2$ Residual variance.
   * Durbin's h cannot be calculated.
capacity variable is not quite satisfactory. A possible interpretation is that job rationing constraints are important and should not be neglected. 19

The estimates also suggest that the contribution of unemployment benefits to unemployment is almost certainly negligible. Also the suggestion (common in the Australian empirical literature) that the increase in the unemployment rate in Australia in the mid 1970s occurred more due to labour supply than labour demand behaviour is supported by evidence since the real wage variable we have used and found to be highly significant is an argument in the labour force participation equation. Finally, as in the previous two sections, there is clear evidence that changing composition of aggregate demand, as reflected in variables $S_1$ and $S_2$, has contributed to unemployment, but at no time as much as the variables ERW, GUT or VR.

When the variant (17d) of the search-turnover model is considered, the resulting equation is judged stable by the CUSUM and CUSUMSQ tests. See Figures 8a and 8b. However, this equation is hard to distinguish from Equation 3b of Table 1. Does equation (17d) imply an equilibrium unemployment rate similar to that of the rationing model? Using the estimated equations (17d) and (17c), respectively, equilibrium unemployment rates of 6.07% and 6.13% were computed conditional on the CES vacancy rate of 0.25, ERW=RW and GUT, RUB, RW and $S_2$ set at their average 1980-81 values. The finding that the search-turnover specification implies an equilibrium unemployment
rate slightly lower than the rationing model, and perhaps after taking account of various uncertainties in estimation not all that different, should not be all that surprising. After all, a major possible source of difference could have been the unanticipated wage inflation which was found to be empirically unimportant, and, furthermore, the inclusion of both ERW and VR in the specification made it possible to take account of two important influences on unemployment in a non-clearing labour market. Thus, it must be emphasised, that it is the non-clearing labour market variant of search-turnover theory that is consistent with the data and the equilibrium concept underlying it is rather close to that in rationing models.
VII. Equilibrium unemployment: the natural rate approach.

A relatively recent definition of equilibrium unemployment, one which explicitly takes account of the inflation-unemployment trade-off, equates it to the nonaccelerating inflation rate of unemployment (NAIRU). It is also termed "the natural rate" by Friedman (1968) who defined it thus:

"The natural rate of unemployment is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demand and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility and so on".

This definition is not sufficiently specific for econometric purposes. It is not clear, for example, whether the phrase "structural characteristics of the labour and commodity markets" includes wage and price stickiness and if so whether the resulting concept of equilibrium is any different from that in the rationing models. It may be argued that insofar as institutional features such as unions and the Arbitration and Conciliation Commission are responsible for cushioning wage and price changes from competitive forces, they represent "market imperfections" referred to by Friedman. Therefore, NAIRU should be defined conditionally on these "imperfections". It is
Search-Turnover Equation (17d) - Stability Tests

CUSUM of Recursive Residuals

CUSUM of Squares of Recursive Residuals

Figure 8a.

Figure 8b.
striking to see, however, just how few are the empirical studies of wage inflation that pay adequate attention to this point. We need explicit guidance on how to model the influence of market imperfections on NAIRU. One possibility is to treat wage expectations as the vehicle through which NAIRU changes. Exogenous influences on wage expectations can therefore raise NAIRU. Stated in this way the NAIRU definition does not appear very different from the search-turnover definition but we shall (at least initially) treat it as distinct from the other three. Friedman (1968) pointed out that NAIRU "need not correspond to equality between the number unemployed and the number of job vacancies. For any given structure of the labor market, there will be some equilibrium relation between these two magnitudes, but there is no reason why it should be one of equality". Tobin (1972) has conjectured that NAIRU probably corresponds to higher unemployment than the u-v definition.

Specification of the natural rate model: In a stationary state the natural rate of unemployment would be the rate of frictional unemployment and, as Friedman's definition clearly implies, that would depend upon the costs of job search, variability of demand and supply and other frictions in the labour market. As this aspect has been dealt with in earlier sections, we shall concentrate mainly on the sources of cyclical departures from the equilibrium rate.

In stylised versions of the natural rate models, for example Lucas and Rapping (1969) and Batchelor and Sheriff (1968), the main mechanism generating departures from equilibrium is
intertemporal substitution of labour arising from the deviation of actual from expected wage rates, essentially as in the search-turnover model. Lucas and Rapping put forward a Fisherian two-period work-leisure choice model of a representative household. They summarise their analysis as follows:

"This theory views suppliers of labor as reacting primarily to three variables: an "anticipated" normal or "permanent" real wage rate, which corresponds to the wage rate in the usual one period analysis of the labor-leisure choice and has a negligible effect on labor supply; the deviation of the current real wage from this normal rate, which has a strong positive effect on labor supply; and the deviation of the price level from its perceived "normal" trend which also has a strong positive effect on labor supply.... Measured unemployment (more exactly its nonfrictional component) is then viewed as consisting of persons who regard the wage rates at which they could currently be employed as temporarily low and who therefore choose to wait or search for improved conditions rather than to invest in moving or occupational change".

One of the ways in which Lucas and Rapping test their theory is by estimating an unemployment equation of the following type:
\[ u_t = q_0 + q_1 \bar{s}_t \ln(W^*/W_t) + q_2 \bar{s}_t \ln(P^*/P_t) \]

where \( W^* \) is the expected wage rate, \( W \) the actual wage rate, \( P^* \) the expected price level and \( P \) the actual price level. An auxiliary assumption of their model is that wage and price expectations are formed adaptively, and this leads to the appearance of \( u_{t-1} \) in their estimating equation. In contrast we have chosen to pre-calculate expected wages and expected prices using procedures detailed in Appendix A. Our assumptions about expectations formation are more flexible than the adaptive expectations assumption. In line with the spirit of the rational expectations literature we also allow agents to use much more information in their formation of expectations than is the case with the adaptive expectations model. Our first specification of the natural rate model is

\[
\ln u_t = \beta_0 + \beta_1 \ln(ERW/ERW_t) + \beta_2 \ln(P/PE) + \beta_3 \text{RIR}_t + \beta_4 u_{t-1} + \beta_5 S_{2t} + \text{seasonals} \tag{18a}
\]

where \( P \) and \( PE \) denote, respectively, actual and future expected price levels. Note in particular that \( \ln u_{t-1} \) is not included in this specification. To take account of the possibility that the response of unemployment to unanticipated inflation (expectational errors) is distributed over time the next specification adds \( \ln u_{t-1} \) to (18a), although the additional of such a variable is not in accordance with "pure" versions of equilibrium business cycle models. A further variant "frees up" the lag structure even further by allowing further lags on \( \ln(ERW/ERW) \) and \( \ln(P/PE) \) in addition to including \( u_{t-1} \).
The estimates of these three specifications are given in Table 4 as equations (13a), (13b) and (13c). The first of these has the signs expected a priori on all variables, including the expectational errors, but the fit of the model is poor and serial correlation is pervasive which suggests that at this stage one is probably making incorrect inferences about the role of expectational errors. Introduction of $\ln u_{t-1}$ improves the fit and reduces serial correlation but the expectational errors variables do not have significant coefficients: Their collective contribution to the explanation of movements in the unemployment rate is negligible. To take into account the possibility that the outcome was influenced by our method of generating ERW and PE, we used the survey inflation expectations (see Defris and Williams (1979)) data as an alternative. These data are available from 1971:3. Equation 13aa in Table 4 is based on unanticipated inflation, EPE, calculated from the survey data. This also confirms that unanticipated inflation has a negligible influence on unemployment. We interpret this to mean that a central mechanism for generating unemployment in the equilibrium business cycle model is insufficient to account for observed movements in unemployment. The variable $\ln u_{t-1}$ is simply "picking up" serial correlation. We emphasise that the effects of expectational errors are in the direction that the theory predicts but this source of variation is quite weak, and certainly not strong enough to drive the model.

We next turn to an important issue. Should the observed (or expected) real wage rate appear as a determinant of the natural rate of unemployment? Friedman's definition of the natural rate
appears to make it a function of exogenous variables and this would exclude the real wage rate, at least in an economy with flexible wages and prices. On the other hand, some have argued, in both theoretical and empirical contexts, that the real wage should be treated as a determinant of the equilibrium rate of unemployment. Batchelor and Sheriff’s investigation of equilibrium unemployment in the U.K. includes the real wage as a determinant, the justification being that “real wage resistance” could prevent equilibrium real wage or the natural rate of unemployment being established. A second example is provided by Pitchford (1981a, p.491, see especially footnote 6) who in a theoretical model argues for the inclusion of the real wage rate as a determinant of the natural rate, the main motivation being that the labour market may not clear. It is easy enough to add ERW or RW to the specification of the natural rate model but one must recognize that in doing so the definition of the natural rate of unemployment is seriously compromised since it would no longer refer to frictional unemployment in the stationary state as was intended. Furthermore, if ERW or RW is found to account for a significant amount of, and unanticipated inflation for very little, then another central prediction of the equilibrium business model (see the quotation from Lucas and Rapping on p.43) is contradicted by data. Turning to Equation 18-f-g in Table 4 we observe exactly this. The coefficient on the ERW variable has a positive sign and is highly significant and the inflation anticipation variables contribute very weakly to the explanation of unemployment. Clearly non-market clearing is an important feature of observed experience.
Once we allow for the possibility of non-market clearing, and we have to, we must consider the constraints on job availability as a source of unemployment. As in the last section we do so by introducing into our equation either the capacity utilisation variable GUT or the vacancy rate variable VR. Despite the fact that other "cyclical" variables are already in the model, we find that the equation is much improved by their inclusion. Clearly the job availability factors account for a component of unemployment rate which the natural rate model fails to explain. Also, in view of the relative insignificance of unanticipated inflation variables, it seems that there is nothing in the natural rate model which is not accounted for by the rationing equilibrium model. The latter does encompass the former.

We do not calculate the equilibrium unemployment rate in the natural rate model modified to take account of non-market clearing. The results will not be very different from those already reported in Section VI.
VIII. Summary and conclusions.

In this paper we have examined empirically four stylised formulations of unemployment equations using Australian data. Two of these formulations, those based on the rationing model and the u-v model, emphasise the role of aggregate demand and job availability, whereas the other two, the search-turnover model and the natural rate model, emphasise the role of unanticipated inflation in the generation of cyclical unemployment. The purpose of the paper was to estimate the equilibrium unemployment rate (function) corresponding to each model/concept and to assess how each performed in accounting for the measured unemployment rate in Australia.

The principal conclusion of the paper regarding the theories themselves is that the market clearing versions of search-turnover theory and the natural rate theory are seriously deficient in explaining measured unemployment; specifically, econometric evidence contradicts one of the central predictions of these models, viz. the importance of unanticipated inflation in generating cyclical unemployment and a central premise of the model, viz. market clearing. When these theories are modified to take into account non-market clearing, empirically their explanatory power is much improved but then they are no longer distinguishable from the rationing model.21 The conclusion that the assumption of market clearing is too strong is an empirical validation of the same point made in a number of theoretical papers, e.g. Solow (1979), Buiters (1988), Gordon (1981).
<table>
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<th>$b_3$</th>
<th>$b_4$</th>
<th>$b_5$</th>
<th>$h_2$</th>
<th>$h_3$</th>
<th>$h_4$</th>
<th>$h_5$</th>
<th>$R^2$</th>
<th>Durbin's $h$</th>
<th>$t$ - ratio in parentheses</th>
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Note: 1. $h_q$ = (1-2,3) Quarter 1 dummy variable.  2. $b_{q_1}$ = (14,23) Shiller index for period 1.  3. $b_{q_2}$ = real wages and GDP deflator.  4. $b_{q_3}$ = Unemployment benefit/CE.  5. $b_{q_4}$ = Expected real wage.  6. $b_{q_5}$ = ABS unemployment rate.  7. $R^2$ = residual variance.
The dynamic version of the u-v model also performs quite well, but because the u-v model focuses essentially on the frictional-structural component and because it is fitted using CBS rather than the ABS unemployment data the results for this model stand somewhat apart from the rest. The u-v model is the only one for which we have unambiguous estimates of the equilibrium rate of unemployment. These estimates are of the order of 2%. A clear implication of this is that much, if not most, of the observed increase in unemployment in the 1970s is cyclical.

What are the principal sources of variation in unemployment rate in Australia? All models we have tested support the theoretical proposition that the amount of frictional unemployment varies over time. The consistent performance of demand dispersion as measured by Stoikov's index as a contributor to unemployment rate is a noteworthy new finding. However, it must be said that variations in frictional unemployment are really just a small part of the story. Most, if not all, of the increase in unemployment in the 1970s is explained by real wages and capacity utilisation with the latter variable causing most of the movements in the last five years. This conclusion needs to be qualified since both measures of capacity utilisation are obviously deficient. Furthermore, in an attempt to concentrate on the specification aspects of the unemployment equation, estimation aspects have been somewhat neglected, so econometric refinements are desirable. Our approach is not well suited to answering the question - is it classical or Keynesian unemployment? - mainly because the approach takes as given the
existence of various disequilibria and does not attempt to explain how and why they arose. (This is an important limitation of the reduced form type approach of this paper.) However, the evidence obtained is consistent with the emergence of classical type unemployment since 1974. Whether one can still use that description seems a debatable issue.

At the time of writing this paper (November 1982) aggregate unemployment has approached and passed 8% and has been widely predicted to rapidly rise even further. Though a conjunction of many factors, including some which are absent from our various models, may have contributed to this, the suspected overwhelming importance of wages and demand in this development deserves to be investigated.
Footnotes


[5] Hughes (1981) has emphasised this quite strongly. Regressions of unemployment on the real wage variable also confirm that the measured response is larger when the 1974 and post-1974 observations are included.


[7] Most empirical studies use the ratio benefit-to-income as a determinant of frictional unemployment on the grounds that it reflects the opportunity cost of searching versus working. In our framework we need a measure of the real cost of job search so RUB seems appropriate.


[10] Recall that as these terms are used by Malinvaud (1977) and Muelbauer and Portes (1978) classical unemployment corresponds to a situation where households are on the "short" side but firms are unconstrained whereas in the Keynesian situation households are on the short side in the labour market and firms on the short side in the goods market.

[11] Average labour productivity, \( \pi \), should be interpreted to include external productivity. This elaboration can be important in practice especially
in open economies where RW may change due to external stimuli such as changes in terms of trade, oil price shocks and so forth. The Australian empirical literature on the so-called real wage overhang recognises this point. See, for example, Bonnell (1989).

[12] In theoretical models such as Malinvaud (1960) capacity output corresponds to optimum (profit maximising) level of output. In empirical models capacity output usually corresponds to trend level of output and, capacity utilisation to the ratio of actual to trend output.

[13] Because of the presence of lagged dependent variables in the equation here and elsewhere in the paper such tests are not completely appropriate without an adjustment to the significance level. We take the results in the spirit of data analysis rather than hypothesis testing. See Harvey (1981) for a justification of this approach.

[14] It should be noted that Harper's interest is primarily in detecting shifts in the u-v locus and not in estimating the equilibrium unemployment rate as such.


[16] In principle, all characteristics are observable but when we have to rely on aggregate data, no meaningful or informative aggregate measures of certain characteristics may be available. In such cases it may be appropriate to proceed conditionally on unobserved characteristics.


[18] The real wage rate concept used is the male weighted average minimum weekly wage rate deflated by CPI. Econometric modelling of this variable is somewhat complex due to institutional factors. See Trivedi and Rayner (1978).

[19] The conclusions above depend upon our method of generating ERW. To assess their sensitivity all equations were reestimated under the assumption that ERW could be proxied by one-quarter lagged actual
real wage rate. All conclusions were unaltered.


[21] Lucas and Rapping (1969) did not incorporate aggregate demand variables in their analysis of U.S. unemployment, 1938-65. Rees (1978) has questioned whether their theory succeeds in explaining the labour market behaviour during the period 1929-39. In reply Lucas and Rapping concede that "our hypothesis accounts for much, but not all, of the observed labor market rigidity during this period". (Authors' emphasis).

[22] We have available from the CAI-Bank of NSW Survey of Industrial Trends estimates of the proportions of firms whose production was limited by orders, materials and so forth. We estimated several of the specifications in Section IV omitting the variable P6MAT and including variables PORDERS and PMATERIALS. It was found that whereas both had the a priori correct positive sign only PORDERS was statistically significant. Split-sample tests showed that PORDERS was a significant factor in pre-1973 and post-1972 periods. This could be interpreted as showing the ever-present influence of demand deficiency as a factor in generating unemployment.
References


Bowden, R.J. (undated) "The Relationship Between Unemployment and Unfilled Vacancies in Australia: Some Findings on Secular Change and on the "Natural Rate" of Unemployment", unpublished paper.


Hughes, B. (1981) "Real Wages and Unemployment", in Growth 31 - Inflation and Unemployment, CEDA Study.


Trivedi, P.K. and J. Rayner (1978) "Wage Inertia and Comparison
Effects in Australian Award Wage Determination,

Warren, R.S., Jr. (undated) "The Changing Relationship Between
Unemployment and Job Vacancies in Australia",
unpublished paper.
Appendix A: Data

Data series used were as follows:


Unemployment (ABS) and Labour Force. Australian Bureau of Statistics (ABS) Labour Force Survey unemployment and labour force figures extracted from ABS publications thus:

(ABS Catalogue 6.7)

66:3 to 78:4  *The Labour Force, Australia* 1978 (6204.0).

79:1 to 81:4 Various issues of the monthly *The Labour Force, Australia* (6003.0).

From February 1978, February, May, August and November figures taken as representative of the four quarters.

Labour force figures prior to 64:1 obtained from a series constructed by the then Department of Employment. Units for both: [1'000 persons].

Unemployment and Vacancy Rates. Calculated by dividing the appropriate number of unemployed, or number of vacancies by the labour force, units: [\%].

Period: ABS unemployment rate: 64:1 to 81:4
CSES " 49:1 to 79:3
Vacancy rate (VR): 49:1 to 79:3

Units: [1'000 persons].

Unanticipated Price Inflation (EPE). Calculated as

$PE_t = \left( \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \right) \times 100.0 \%$

where $PE_t$ is the annual percentage increase in consumer prices expected. See DePri and Williams (1979) for the construction of series $PE_t$. $PE_t$ and hence $EPE_t$ available for 73:1 to 82:1.
Unemployment Benefit Rate (UB). Weekly rate of unemployment benefit for married couple. The rate for any quarter taken as that rate applicable during most of the quarter. Source: Department of Social Security Annual Reports. Units: [$]. Period 64:1 to 82:1. Real unemployment benefit (RUB) is UB/CPIT.


Male minimum wage (MW). Weighted average minimum weekly rates payable for a full week's work excluding overtime for adult males. Obtained from various issues of ABS publications on Wage Rates (6313.0, 6312.00, 6313.0, 6314.0). Figures used are the most recently published which varies in only a minor way from the most recently available. For 46:1 to 56:1 and of quarter figures: for 57:1 to 82:1 and of March, June, September and December figures. Units: [$].

Real wages calculated in two ways. Variable MW is male minimum wages divided by the CPI; variable MWG is male minimum wages divided by the gross domestic product deflator.

Stoikov index of demand dispersion $S_1$, $S_2$. Calculated using formula given in text. Period:

- $S_1$: 64:2 to 72:4. 72:4 figure is average of 64:2 to 72:3 figures.
- $S_2$: 73:1 to 82:1.


Unanticipated Wage Inflation. Calculated as the error term from the fitted equation.

\[
\hat{\delta}_1(L) \ln(W_t/W_{t-1}) = 0.0370 - 0.0037Q_{1t} + 0.0131Q_{2t} - 0.0015Q_{3t} + \\
0.60 + 0.49 + 1.79 + (1.13)
\]

\[
\hat{\delta}_2(L) \ln(CPI_t/CPI_{t-1}) + \hat{\delta}_3(L) \ln(GDPP_t/GDPP_{t-1})
\]

where

- $\hat{\delta}_1(L) = 1 - 0.2638L + 0.0449L^2$
  
  \[
  (0.02) (0.37)
  \]

- $\hat{\delta}_2(L) = 0.8868L - 0.4198L^2 + 0.5674L^3$
  
  \[
  (2.69) (1.24) (1.76)
  \]

- $\hat{\delta}_3(L) = -0.0248L + 0.0885L^2 + 0.0876L^3$
  
  \[
  (1.26) (0.46) (0.45)
  \]

and $L$ is the lag operator.
Box-Pierce χ² statistic = 8.82. Compared with χ² 0.05(15) = 25.00.
D.W. = 2.04. R² = 0.182. Period: 60:3 to 81:2. 6² (residual variance) = 0.00005.

This variable is thus ln(Wᵢ₋¹/ₚᵖ) (p = predicted), representing the rate of unanticipated wage inflation.

**Expected Real Wage (ERW).** Calculated as

\[ \text{ERW}_{t-1} + (\ln \frac{W_t}{W_{t-1}} - \ln \frac{\text{CPI}_t}{\text{CPI}_{t-1}}) \]

i.e. \[ \text{ERW}_{t-1} + \ln \left( \frac{\frac{W_t}{\text{CPI}_t}}{\frac{W_{t-1}}{\text{CPI}_{t-1}}} \right) \]

and is thus last period’s real wage adjusted by the expected rate of change of real wage.

\[ \frac{\text{CPI}_t}{\text{CPI}_{t-1}} \] is the prediction from

\[ \hat{\beta}_1 (L) \ln (\frac{\text{CPI}_t}{\text{CPI}_{t-1}}) = 0.0057 - 0.0075q_1 - 0.0084q_2 - 0.0095q_3 \]

\[ (1.86) \quad (1.74) \quad (2.22) \]

\[ + \hat{\beta}_2 (L) \ln (W_{t-1}/W_t) + \hat{\beta}_3 (L) \ln (\text{PM}_{t-1}/\text{PM}_t) \]

where

\[ \hat{\beta}_1 (L) = 1 + 0.0534L + 0.0046L^2 - 0.3891L^3 \]

\[ (0.41) \quad (0.04) \quad (3.69) \]

\[ \hat{\beta}_2 (L) = 0.1305L + 0.0827L^2 + 0.094L^3 \]

\[ (4.03) \quad (2.28) \quad (2.48) \]

\[ \hat{\beta}_3 (L) = 0.1242 + 0.046L - 0.0068L^2 - 0.0665L^3 \]

\[ (2.81) \quad (1.50) \quad (1.54) \]

\[ \hat{\beta}_4 (L) = -0.039L + 0.055L^2 - 0.008L^3 \]

\[ (1.47) \quad (2.04) \quad (0.30) \]

\[ \hat{\beta}_5 (L) = 0.1094L - 0.0305L^2 + 0.0795L^3 \]

\[ (2.56) \quad (0.67) \quad (2.03) \]

and L is the lag operator.

PM and PX are implicit price deflators for imports and exports respectively of goods and services. (Base 1966-57 = 100.0); M₁ is notes, coins and current deposits.

Box-Pierce χ² statistic = 10.09 compared with χ² 0.05(15) = 25.00.
D.W. = 2.34. R² = 0.768. Period: 60:3 to 81:2. 6² (residual variance) = 0.000038.
Note that $\hat{\beta}_1(L)$ is formed on the assumption that import prices are known at time $t-1$ when expectations on $t$ are being formed.

$\ln \frac{W_t}{W_{t-1}}$ is the prediction from the wage equation reported in definition of unanticipated wage inflation.

Quarterly Dummies ($Q_i$, $i=1,2,3,4$). $Q_i = 1$ in quarter $i$; $Q_i = 0$ otherwise.
Appendix B: Causality test for the \((u,v)\) variables.

To test for exogeneity (in the sense of Sims, see Katana (1982)) we followed the procedure outlined in Hallo (1979), first detrending the CES unemployment and vacancy rate series used thus:

\[ u_t = \hat{U}_R - \hat{U} \quad \text{and} \quad v_t = \hat{V}_R - \hat{V} \]

where \( \hat{U}_R = \sum_{i=1}^{T} \hat{a}_i u_{t-i} + \hat{\beta} t \)

and \( \hat{V}_R = \sum_{i=1}^{T} \hat{a}_i v_{t-i} + \hat{\beta} t \)

\( \hat{U}_R \): unemployment rate.

\( \hat{V}_R \): vacancy rate.

\( u,v \): detrended series.

Then for \( u_t \) and \( v_t \) in turn,

(i) fitted \( u_t = \sum_{i=1}^{T} a_i u_{t-i} + \epsilon_t \)

for \( s = 1,2, \ldots, 12 \) and selected the \( n = n^* \) which minimised the Akaike FPE criterion.

\[ \frac{T-s-1}{T-s-1} \sum_{t=1}^{T} (u_t - \hat{u}_t)^2 / T \]

where \( T \) is the sample size (144). The chosen \( n = 9 \).

(ii) fitted for \( n = 1,2, \ldots, 12 \)

\[ u_t = \sum_{i=1}^{n} a_i u_{t-i} + \sum_{i=1}^{n} \beta_i v_{t-i} + \epsilon_t \]

and chose \( n = n^* \) to minimise

\[ \text{FPE} = \frac{T-s+n+1}{T-s-n-1} \sum_{t=1}^{T} (u_t - \hat{u}_t)^2 / T \]

The chosen \( n = 5 \).

(iii) for \( n = 5 \), fitted

\[ u_t = \sum_{i=1}^{n} a_i u_{t-i} + \sum_{i=1}^{n} \beta_i v_{t-i} + \epsilon_t \]

where \( n = 1,2, \ldots, 12 \)
The value $m^* = m$ was chosen to minimise

$$\text{FPE} = \frac{1}{\frac{2m + n^* + 1}{n^* - m - n - 1}} \Sigma (u_t - \hat{u}_t)^2 / T$$

The chosen $m^* = 9$.

(iv) The FPE from (iii) being smaller than for (i) we concluded that $v \Rightarrow u$, i.e. $v$ causes $u$ in the sense of Granger (1969) and that the optimal model for predicting $u_t$ was

$$u_t = \Sigma \alpha_i u_{t-i} + \Sigma \beta_i v_{t-i} + \epsilon_t$$

For $v$, we determined that $s^* = 10$, $n^* = 3$ and $m^* = 10$. The FPE criterion was minimised with

$$v_t = \Sigma \gamma_i v_{t-i} + \epsilon_t$$

and hence we concluded that $u \not\Rightarrow v$ in the sense of Granger.

Hence we have $v \Rightarrow u$, $u \not\Rightarrow v$, which tends to imply we can treat $v$ as a variable exogenous, in the sense of Sims, to any model to explain $u$.

We have not tested for instantaneous causation. If $u \not\Rightarrow v$ instantaneously, then in Hatakena's terminology, we can also treat $v$ as econometrically exogenous in the unemployment equation. If $u \Rightarrow v$ instantaneously, then treating $v$ as exogenous in the unemployment equation is not correct.