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State & Territory Beveridge Curves and the National Equilibrium Unemployment Rate

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Abstract

Shifts in the 'national' equilibrium rate of unemployment relevant for determining national economic policy settings, we contend, are those shifts which are 'common across states & territories'. One way to identify these is to identify the common shifts in state and territory Beveridge curves in Australia over time. When we do this we recover a national equilibrium unemployment rate series which is similar to, but at the same time different enough from, other measures to make it interesting. In our view it is this, or some other "national" equilibrium rate series, a series which 'by construction' will capture national (nation-wide) factors based on common shocks or common trends across states and territories, that should be the basis for policy and not an 'aggregate series' which does not do this. We estimate the value of the equilibrium unemployment rate for 2006 to be 3.7%, which may be compared with the actual unemployment rate for that year of 4.8%, indicating that even as recently as 2006 the actual rate was at least 1 percentage point above the equilibrium rate.

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I Introduction

Although regional Beveridge Curves have been examined for a number of other countries (for example Jones &Manning (1992) and Wall & Zoega (2002) for the UK; Borsch-Supan (1991) for Germany; Samson (1994) for Canada;), so far as we are aware there has been no attempt to estimate state and territory Beveridge Curves for Australia. This is odd for a number of reasons. First, the performance of regional (state & territory in our case) labour markets are of interest in their own right. Second, and in our view more importantly, even if one was solely interested in variations in national labour market performance over time – and it is this which has dominated Australian research on equilibrium unemployment[1] – an understanding of the size and timing and effects of common shifts in the Beveridge Curves across the states & territories is of interest because it allows a different approach to identifying the direction and the timing of the shifts in the 'national' Beveridge Curve. It is this argument and the presentation of a new set of estimates for the time path of the equilibrium rate of unemployment in Australia which is our primary concern. The connection between state & territory Beveridge Curves on the one hand and the provision of new estimates of the equilibrium rate of unemployment in Australia, by which we mean a series appropriate for *national* macroeconomic policy, is that we define 'national' to be 'that which is common across states & territories'. Thus movements in the 'national' equilibrium rate of unemployment relevant for determining national economic policy settings, we contend, are those movements which are 'common across states & territories'. This series can be recovered once we pool state & territory unemployment and vacancy rates.

This paper unfolds as follows. In the next section we motivate our estimating equation relying on Hansen's (1970) model of the labour market. In sections III and IV we discuss the results concentrating initially on differences between states & territories in their relative distance from the origin of the Beveridge Curve. In sections V and VI we present our estimates of the common shift in the state and territory Beveridge Curves for each year and generate estimates of the implied state & territory and 'national' equilibrium rate of unemployment. We compare our estimates of the 'national' equilibrium rate of unemployment with those by other authors. In section VII we examine differences between

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[1] See for example Crosby & Olekalns (1998), Debelle & Vickery (1998a and b), Gruen, Pagan & Thompson (1999) Groenewold (2003), and Lye et al (2001). All of these have in common that they (implicitly) regard 'national' as 'aggregate' whereas we are interested in exploring the consequences of regarding national as 'that which is common across states & territories'.

states & territories in the slope (the elasticity) of the Beveridge Curves. The final section concludes.

II The Labour Market and the Beveridge Curve

A Beveridge Curve shows the relationship between the level of vacancies (*V*) or the vacancy rate (*v* – defined as the ratio of vacancies to the labour force) and the level of unemployment (*U*) or the unemployment rate (*u* – defined as the ratio of unemployment to the labour force).[2] Its primary role in policy analysis is to provide guidance on the timing, direction and extent of shifts in the equilibrium unemployment rate.

There are a number of ways to derive the *u*-*v* relationship from accepted micro-foundations. We will follow the approach to the labour market developed by Hansen (1970).

The rule that markets ‘operate on the short side’ when trading is voluntary implies that, in the event of dis-equilibrium, the quantity transacted (the number employed in the case of the labour market) will be determined by the demand or supply ‘curve’ which is nearest the ‘price’ axis. In real-world labour markets informational imperfections, search & relocation costs and mismatch are responsible for some parts of supply and demand to remain ineffective. “In terms of ordinary supply and demand theory, this means that actual employment is never *on* the supply curve (if the wage is below equilibrium) or the demand curve (when above equilibrium), but to the left of both the demand and supply curve” (Hansen, 1970, p 7). The curve *EE* in Figure 1 shows actual employment at various wage rates given the demand curve *DD* and the supply curve SS. The shape of the EE curve “results from the assumption that matching becomes better when the pressure of excess demand or excess supply increases” (Borsch-Supan, 1991, p 281). Note that the horizontal distance between *EE* and *DD* for any wage measures the number of vacant jobs (*V*), while the horizontal distance between *EE* and *SS* measures the number unemployed (*U*). Now, consider the relative levels of unemployment and vacancies associated with different levels of the real wage. If the real wage is at the equilibrium level, unemployment will equal vacancies. If the real wage is above the equilibrium level, unemployment will exceed vacancies and if the real wage is below the equilibrium level, vacancies will exceed

[2] A concise introduction to the Beveridge Curve and related theoretical constructs may be found in Cahuc and Zylberberg (2004, Ch 9).

unemployment. This implies that there will be an inverse relationship between vacancies and unemployment, as depicted in Figure 2 (disregard the 45^{o} line momentarily). Equilibrium unemployment is that which is associated with $U = V$. In other words it is the level of U (or the unemployment rate) at which the Beveridge Curve crosses the 45 degree line (as indicated in the diagram). Shifts in or out of the Beveridge Curve reflect changes in the equilibrium rate of unemployment. "Conceptually, shifts in the UV Curve are a function of how competently the unemployed search for work, how well suited employers believe the unemployed are for the available vacancies, and the degree of mismatch between the skills of the unemployed and the requirements of employers" (Fahrer and Pease, 1993, p 45).

[FIGURES 1 AND 2 NEAR HERE]

III Estimation of the Common Shifts in the Beveridge Curve(s)

In our empirical work we will follow other authors and relate the logarithm of the unemployment rate to the logarithm of the vacancy rate (inter alia).[3] We use a panel approach in the estimation of the model. The panel approach endows regression analysis with both a spatial and temporal dimension. In our specific application the spatial dimension pertains to the eight states and territories while the temporal dimension pertains to periodic observations of the unemployment and vacancy rates characterizing these regions over a particular time span. The most common models in panel data analysis are a fixed effects model (dummy variable approach) and a random effects model. We prefer the fixed effects model to the random effects model. "While the latter is efficient if there is no correlation between the time varying and time invariant unobservables, the former is robust if this assumption does not hold, which appears quite likely [in this case]" (Borsch-Supan, 1991, p 296). Our approach is to pool data for each of the states while allowing for state specific fixed effects and time dependent common shifts. The main advantage is that, by so doing, we gain sufficient degrees of freedom to estimate the direction and size of any common component in shifts in the Beveridge Curve for each year (or group of years) for which we have data.[4] This allows us to avoid the assumption that any common shifts are once-and-for-

[3] An alternative would be to relate the unemployment rate to the inverse of the vacancy rate.

[4] As mentioned in the Introduction our primary aim is to use state and territory data to recover the common shifts and thus a 'national' equilibrium rate. For this reason we do not look at states and territories (and their dynamics) separately. One way to view the model we estimate is that it assumes time-dependent state and

all or that they follow a particular and smooth function. This is important given our aim of using the state and territory information to obtain an estimate of how the national equilibrium unemployment rate has evolved over time.

Following Borsch-Supan (1991) and (especially) Wall & Zoega (2002), the equation we estimate is:

$$\ln\left(u_{it}\right) = \sum_i \alpha_i SD_i + \sum_i \beta_i SD_i \ln(v_{it-1}) + \sum_t \tau_t TD_t + \varepsilon_{it} \tag{1}$$

where *ln* indicates the natural logarithm of the variable concerned; u_{it} is the unemployment rate (this is the ratio of unemployment to the labour force) in state *i* at time *t*; α_i is a state-specific fixed effect; SD_i is a state dummy variable; β_t is the elasticity of unemployment with respect to vacancies in state *i* (assumed constant over time), v_{it-1} is the vacancy rate (this is the ratio of vacancies to the labour force) in state *i* at time *t-1*; τ_t is a coefficient on a time dummy; TD_t is a time dummy variable; and e_{it} is the error term for state *i* at time *t*.

Both unemployment and vacancy levels are deflated by the same variable (the labour force) and so, as is common in other Beveridge curve studies, we use the lagged vacancy rate as the instrument to avoid simultaneity bias. We follow this practice (although it is the volatility in the two numerators which dominate each series). The data for vacancies, unemployment and the labour force by state has been obtained from the DX database. The Vacancies data is from the DX ABS Time Series data base Labour ABS 6354.0 Job Vacancies Table 6354-1A LVLQ.UNVLE*TZZ which measures "Total job vacancies: Private & public: States '000". This data is taken from the ABS publications 6231.0 and 6354.0. The data series we use is for private & public sector vacancies combined. For each State & Territory this is very highly correlated with the job vacancies for the Private sector alone and overcomes the problem of numerous missing observations for "private" alone in the raw data for some states and territories. This data is only available from the December quarter of 1983.[5] Unemployment and labour force data is taken from the DX ABS Labour

territory specific items are uncorrelated with the common component – but then we see that as a natural definition of state and territory specific items.

[5] A small number of observations for WA in early 1984 were missing in the file downloaded from DX. These were interpolated using data from the Australian Bureau of Statistics publication *Job Vacancies: Australia*, ABS Cat No 6231 for 1984. Also, from 17 March 1998, changes in public service regulations have meant that most Australian Public Service vacancies, previously only available to current public service employees, are open to all Australian citizens. Commencing in May 1998 these vacancies fell within the scope of the Job Vacancies and Overtime survey. This change produced an increase in the number of Australian Public Service

Force Statistics data base series LUHM.UN* and LLHM.UN*. The unemployment and labour force data series we use is for persons to match the Vacancies data.

Set out in Table 1 is the result of estimating equation (1) for annual data over the period 1985 – 2006 for the eight states and territories of Australia.[6,7] To avoid collinearity the time dummy for 1985 was excluded and so the estimated coefficients on the time dummies show the position of the Beveridge Curve relative to that of 1985.

[TABLE 1 NEAR HERE]

The standard F-test for comparing restricted and unrestricted models rejects the restrictions (separately and in combination) that: (a) there have been no shifts over time, (b) that the shifts have been the same in each period, (c) that the state and territory intercepts are the same, and (d) that the state and territory slopes are the same - all at the 1% level.

In the following sections we examine estimates of the (average) position of the Beveridge Curve for each of the states and territories and then look at (common) shifts in the Beveridge Curve over time. We also use our results to generate an implied national equilibrium unemployment rate and compare it with the estimates of the equilibrium rate of unemployment arrived at by other researchers.

IV The position of the Beveridge Curve for the different states.

Given the set-up of our model, the estimated coefficients on the state and territory dummies allows us to identify the relative distance of the Beveridge Curve from the origin for each of the states and territories. Our results imply that the Beveridge Curves for the ACT, VIC, WA and NSW lie closest to the origin, then SA, followed by QLD and with the Beveridge Curves for the NT and TAS lying furthermost from the origin. These results

vacancies being reported. However, leaving aside the ACT, the effect on the time series for total (public plus private) vacancies seems to have been quite small.

[6] We use annual data to reduce the complications associated with short-run dynamics in the time series.

[7] Our results are essentially unchanged if we drop TAS and NT, indeed the results - ie the final national equilibrium rate series - are surprisingly robust to methods of estimation and to states and territories included and to restrictions imposed. For this reason we prefer to keep TAS and NT in and use the point estimates of their slope coefficients, even though they are not well determined. Fortunately, their 'weight' in forming the aggregate equilibrium unemployment rate is small and so it makes little difference to that series whether they are included or not. Also, essentially the same results are obtained if we use the current vacancy rate instead of the lagged vacancy rate. In the Appendix we report a differential coefficients model. Using the differential coefficients approach results in significant slope coefficients for the NT and TAS but other than that nothing is gained except to simplify the model considerably.

roughly correspond to the ranking of the average levels of the unemployment rate in each of the states over our sample period, which were (in order of lowest to highest) ACT, NT, WA, NSW, VIC, QLD, SA and TAS, but there are some interesting differences in the rankings. First, while the average actual unemployment rate for WA lies below that for VIC, the Beveridge Curve results suggest that the equilibrium rate for VIC is likely below that for WA. Second, whereas the average unemployment rate for SA lies above that for QLD the Beveridge Curve results suggest that the equilibrium rate for SA is below that for QLD. Third, while the Beveridge Curve results suggest that the equilibrium rate for NT is relatively high, the observed unemployment rate for the NT is relatively low.[8] Taken together these results imply that there may be some important disequilibrium component of the unemployment rate in WA, SA and the NT over the period (perhaps related to industry structure or the rate of economic growth) which, on average, was keeping the actual rate lower in WA and the NT and higher in SA than it would otherwise be.

V The time path of the common (national) shifts and the implied state and territory equilibrium unemployment rates

Of most interest is the evidence we have of (common) shifts in the Beveridge Curve over time as determined by the variations in the size of the estimated coefficients on the time dummies (these show the position of the Beveridge Curve relative to that of 1985). The reader will recall that for us the macroeconomic (in the sense of 'national') policy significance of these results is that we define 'national' in a policy context to be 'that which is common across states & territories'. Shifts in the 'national' equilibrium rate of unemployment are those shifts which are 'common across states & territories'. Figure 3 shows the proportional change in the unemployment rate which would result from the shifts. For each date we show $e^{\tau}-1$, rather than the coefficient on the dummy (τ) - although in practice it really makes little difference given that the coefficient is 'small'.[9,10]

[8] Alternative formulations of the model, such as that reported in the Appendix imply that the intercept for the NT is lower (and that for TAS is higher) than those for other states.

[9] There has been considerable discussion in the econometrics literature of the most appropriate measure of the proportional change in the dependent variable that implied by the coefficient on as shift dummy when the dependent variable is in logarithms (see for example Kennedy (1981) and Derrick (1984)).

[FIGURE 3 NEAR HERE]

We can use our results to recover the evolution of an implied 'equilibrium unemployment rate' for each state over time. (This is the first step in the computation of a national equilibrium rate series.)

Given the set-up of our model, the implied equilibrium rate for state *i* in period *t*, will be:[11]

$$u_{it}^* = EXP\left(\frac{\alpha_i + \tau_t}{1-\beta_i}\right) \tag{2}$$

where α_i and β_i are the state or territory intercept and slope respectively and τ_t is the coefficient on the time dummy for period *t*.

The implied equilibrium rates for each state and territory over the period 1985-2006 are graphed in Figure 4 (to make it easier to view we have broken the states and territories up into two groups – the four highest and the four lowest but we have used the same vertical scales for each group). The reader is most likely interested in the relative levels of each of the states and territories on average (we have already addressed this in the previous section) and in the most recent estimates of the equilibrium rate. For 2006 the estimated equilibrium rates are: NSW 3.6%, VIC 3.4%, QLD 4.3%, SA 4.0%, WA 3.4%, TAS 5.9%, NT 4.7% and ACT 2.9%. These figures may be compared with the actual rates for 2006 of NSW 5.1%, VIC 5.0%, QLD 4.5%, SA 4.9%, WA 3.6%, TAS 6.4%, NT 4.7% and ACT 3.1% - suggesting that, the rates for NSW, VIC and SA at least (and perhaps also QLD), whilst they are the lowest we have seen since the just prior to the start of the last recession, are still (well) above those consistent with labour market equilibrium.[12]

[FIGURE 4 NEAR HERE]

We now turn to the matter which is the central focus of our paper, the series for the national equilibrium rate of unemployment.

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[10] In an Appendix we show the consequences of dropping all time dummies whose coefficient is not significantly different from zero and also grouping dummies into 'epochs'. It will be seen that none of our conclusions about the implied 'national' equilibrium unemployment rate are altered in any essential way.

[11] This is arrived at by solving (1) for each state and territory, imposing the condition that vacancies equal the number unemployed. Note that while this 'equilibrium rate' takes into account the state specific intercept and slope, it only includes common shift components. This is because our primary interest is not in the state and territory equilibrium rates per se, but the information they yield on the national equilibrium rate.

[12] Or, at least, they were in 2006.

VI The time path of the implied national equilibrium unemployment rate

We are now in a position to recover the implied national equilibrium unemployment rate for each year as the weighted average of the state and territory equilibrium rates, that is, the (implied) national equilibrium rate in period *t*, will be

$$u_t^* = \sum_i \left(\frac{L_{it}}{L_t} \right) \left(u_{it}^* \right) \quad (3)$$

where L_{it} is the labour force in the state or territory in period t and L_t is the aggregate (national) labour force in the same period.

The resultant series is displayed in Figure 5. Not surprisingly, given the approach we have taken, its evolution over time follows the same pattern as the time dummies in our estimated equation (shown in Figure 3). Readers may be interested in seeing how our implied national equilibrium rate of unemployment compares with the actual national rate of unemployment over the period 1985- 2006. This is shown in Figure 6. We estimate the value of the equilibrium rate for 2006 to be 3.7%, which may be compared with the actual unemployment rate for that year of 4.8%, indicating that even as recently as 2006 the actual rate was at least 1 percentage point above the equilibrium rate.[13]

[FIGURES 5 & 6 NEAR HERE]

(i) Comparisons with other national equilibrium rate series

Figures 5 shows that our series for the (national) equilibrium rate of unemployment has not been constant over the period. In this respect our view of the behaviour of the equilibrium rate is markedly different from many researchers who have seen the equilibrium unemployment rate as having been constant, at least over the first half of our sample period.[14] Crosby and Olekalns (1998), using data for the period 1959 - 1997 estimate a constant NAIRU value for the whole of the period where their sample period overlaps with ours, i.e. 1985 – 1997. Debelle and Vickery (1998a) estimate a Beveridge curve for Australia over the period 1979-1997. They find “that the Beveridge curve has not shifted [outwards] since the early 1980s” indicating that “the natural rate has not changed greatly over the past 15 years”

[13] The ‘parsimonious model’ given in the Appendix yields an estimate of 3.8% for the national equilibrium rate in 2006.

[14] In fairness we should point out that the other studies we refer to (with the exception of Kennedy (2007) and McDonald (2007)) are using data which finishes only half way through our sample period at best.

(p 238f). Downes and Bernie (1999) estimate the NAIRU over the period 1971 – 1999 and find that it is constant over the period we are interested in, i.e. 1985 – 1999. They also estimate an equilibrium rate using a Beveridge curve with data for the period 1967 – 1999 and find that this also is constant over the period 1985 – 1999.[15]

As well as indicating that the (national) equilibrium rate of unemployment has not been constant over the period 1985 - 2006 our estimates suggest that it has varied in a particular fashion over that time. Specifically, our (national) equilibrium rate rises (the Beveridge curve shifts out) between 1985 and 1987, it falls (the Beveridge curve shifts in) over the period 1987 and 1989, it rises over the period 1989 to 1991, then slowly falls over the period 1991 to 2000, it jumps up a little in 2001 but then resumes its downward path (albeit at a decreasing rate) from 2001 through to the end of our sample period (2006).

Other Australian researchers have estimated a time varying aggregate NAIRU or frictional rate of unemployment.[16] Debelle and Vickery (1998b, p 391) using data for the period 1959 - 1996,[17] estimate that the NAIRU[18] fell from 1985/86 to 1989/90 and then rose steadily from 1989/90 to 1995 while Gruen, Pagan and Thompson (1999), using data for the period 1965 – 1997, estimate a NAIRU which rises more or less steadily from 1985/86 to 1997.[19] Groenewold (2003) takes an aggregate Beveridge curve approach. Using data for the period 1966 – 1998[20] he estimates that equilibrium unemployment[21] fell steadily from 1985 to 1989/90 and then rose to 1994, falling sharply between 1994 and 1996 then rising slightly between 1996 and 1998. While all of the estimates behave similarly in the 1980s the time path for the equilibrium rate we report in Figure 3 is unlike that reported by these authors over the 1990s. We have the equilibrium rate falling from 1991 on while others have it rising, but the difference in this period may reflect different data sets being used and especially the different time periods used for estimation. As noted above none of these studies cover more than the first-half of our sample period.

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[15] Downes & Stacey (1996) also find no evidence of shifts in the Aggregate Beveridge Curve in the 80s or 90s.
[16] Most of the estimates given in the text which follows are based on interpolations from figures given in the papers being referred to.
[17] We write 1996 but strictly speaking their last data point is for the first quarter of 1997.
[18] We are using the two-sided NAIRU estimates from their Non-linear model (which seems to be their preferred model).
[19] We are using the two-sided NAIRU estimates from the W-curve (which seems to be their preferred model).
[20] We write 1998 but strictly speaking his last data point is for the first quarter of 1999.
[21] See the figure on p 79 of Groenewold (2003).

The most recent study of the equilibrium unemployment rate in Australia is that by Kennedy (2007) who (inter alia) updates Gruen et al's estimates of the time-varying NAIRU to mid 2007. His series for the NAIRU (see Kennedy 2007, p 8) shows the equilibrium rate falling between 1985 and 1989 then rising until 2001 and then falling between 2001 and 2006. Our series behaves in a similar fashion to Kennedy's NAIRU before 1991 and after 2001 but again we show the equilibrium rate falling during the 1990s while Kennedy's NAIRU is rising during that period. In his paper Kennedy also updates Groenewold's (2003) equilibrium ('frictional') unemployment estimates.[22] This yields an (strongly cyclical) equilibrium rate which is roughly steady between 1985 and 1988, it then falls between 1988 and 1990, then rising sharply peaking in 1993, then falling until 1996, rising until 1998, then falling sharply until 2001 and then continuing to fall (but more slowly) until 2006. It is only this second series reported by Kennedy which is the most like ours, but even then there are marked differences in the timing of turning points in our series compared with that reported by Kennedy. However, it is also the case that our series, and both of the series reported by Kennedy, have been falling since 2001, if not earlier.

An alternative explanation of equilibrium unemployment is the 'range of equilibrium rates of unemployment' estimated for Australia by Lye et al (2001) and 'updated' in McDonald (2007). For our time period their estimate of the lower bound for equilibrium unemployment (given in Figure 1 of McDonald (2007)) rises from just under 5% in 1985 to a peak of 6% in 1988 and then steadily trends downwards to a value of 2.5% in 2006. By contrast our equilibrium rate (see Figure 5) is lower in 1988 than it was in 1985 and rises (not falls) between 1989 and 1991. Our series commences its decline in 1991, not 1988 and the fall in our series is interrupted in 2001, unlike the series in McDonald (2007) which falls steadily without interruption throughout the whole of the period from 1988 through to 2006. One final area of difference is that we estimate the equilibrium rate in 2006 to be 3.7% whereas McDonald (2007, p 84) proposes a figure of 2.5% (for the lower bound to the equilibrium rate).

To summarise: We have recovered a national equilibrium unemployment rate series which is similar to other measures, but at the same time different enough from them to make it interesting. It is also our view that it is this, or some other "national" equilibrium rate

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[22] Kennedy also uses a slightly different definition of 'equilibrium' to that used by Groenewold (2003).

series, a series constructed on the basis of common shocks or common trends, that should be the basis for policy and not an 'aggregate series' which is not constructed so as to capture national (nation-wide) factors.

(ii) Proximate sources of differences in the equilibrium rate between states and territories

Finally, in relation to the equilibrium rates we can pose the question: To what extent do the differences in the equilibrium unemployment rate between the states and territories reflect differences in α (& τ) and to what extent do they reflect differences in β? The reason why we think this issue is of some importance is that pretty well all of the research effort which has gone into explaining differences in equilibrium rates (either over time for a nation or across regions at a point in time) that we are aware of has been concerned solely with establishing those factors which account for shifts in the curve, that is variations in α (& τ). We are not aware of any previous study that has considered that changes in or differences in slopes (β) may have played an important role. Is it the case that differences in the equilibrium unemployment rate between the states and territories in Australia are due mainly if not entirely to differences in 'intercepts' rather than 'slopes'?

The simplest way to approach this question is to look at differences in the value of $LN\left(u_{it}^{*}\right)$ between states and territories for a given year and ask to what extent these differences are due to there being differences in α and to what extent they are due to differences in β? However there is a catch. Even if we work with $LN\left(u_{it}^{*}\right)$ rather than u_{it}^{*}, we have to recognise that the relationship is inherently non-linear, this is because for each state and territory,

$$LN\left(u_{it}^{*}\right)=\frac{\alpha_i+\tau_t}{1-\beta_i} \qquad (4)$$

To answer our question we need to find an algorithm that will decompose the variance of a ratio into those parts which reflect separately the variance of the terms in the numerator and the denominator. Our reasoning is as follows:

Let $LU_i^{*}=\left(\alpha_i+\tau_t\right)/\left(1-\beta_i\right)$ and $LU_j^{*}=\left(\alpha_j+\tau_t\right)/\left(1-\beta_j\right)$, where *LU* is the logarithm of the equilibrium rate of unemployment and *i* and *j* are two different regions (two different states or territories).

Now, we are interested in examining the extent to which the difference between LU_i^* and LU_j^* is due to differences in $(\alpha+\tau)$ and the extent to which it is due to differences in β. It must be true that:[23]

$$LU_i^* - LU_j^* = \frac{\alpha_i+\tau}{1-\beta_i} - \frac{\alpha_j+\tau}{1-\beta_j} = \frac{(1-\beta_j)(\alpha_i+\tau)-(1-\beta_i)(\alpha_j+\tau)}{(1-\beta_i)(1-\beta_j)}$$

This expression is equivalent to

$$\begin{aligned} LU_i^* - LU_j^* &= \frac{(1-\beta_j)(\alpha_i+\tau)-(1-\beta_i)(\alpha_j+\tau)+(1-\beta_i)(\alpha_i+\tau)-(1-\beta_i)(\alpha_i+\tau)}{(1-\beta_i)(1-\beta_j)} \\ &= \frac{(1-\beta_i)(\alpha_i-\alpha_j)+(\alpha_i+\tau)\left((1-\beta_j)-(1-\beta_i)\right)}{(1-\beta_i)(1-\beta_j)} \\ &= \frac{1}{(1-\beta_j)}(\alpha_i-\alpha_j)+\frac{(\alpha_i+\tau)}{(1-\beta_i)(1-\beta_j)}(\beta_i-\beta_j) \end{aligned}$$

and also to

$$\begin{aligned} LU_i^* - LU_j^* &= \frac{(1-\beta_j)(\alpha_i+\tau)-(1-\beta_i)(\alpha_j+\tau)+(1-\beta_j)(\alpha_j+\tau)-(1-\beta_j)(\alpha_j+\tau)}{(1-\beta_i)(1-\beta_j)} \\ &= \frac{(1-\beta_j)(\alpha_i-\alpha_j)+(\alpha_j+\tau)\left((1-\beta_j)-(1-\beta_i)\right)}{(1-\beta_i)(1-\beta_j)} \\ &= \frac{1}{(1-\beta_i)}(\alpha_i-\alpha_j)+\frac{(\alpha_j+\tau)}{(1-\beta_i)(1-\beta_j)}(\beta_i-\beta_j) \end{aligned}$$

It follows that we may write:

$$LU_{it}^* - LU_{jt}^* = \frac{1}{2}\left(\frac{1}{(1-\beta_i)}+\frac{1}{(1-\beta_j)}\right)(\alpha_i-\alpha_j)+\frac{1}{2}\left(\frac{(\alpha_i+\tau_t)+(\alpha_j+\tau_t)}{(1-\beta_i)(1-\beta_j)}\right)(\beta_i-\beta_j) \qquad (5)$$

Which is to say that differences in the equilibrium rates of unemployment can be resolved into a weighted sum of differences in α and differences in β. This is the same result one would arrive at by differentiation (i.e. a Taylor's series expansion), save only that this approach makes explicit recognition of the discrete nature of the data and uses mean values

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[23] Our approach owes a good deal to Harris (1966).

for the two regions under consideration as the weights.[24] However, since one of the variables on the RHS of (5) has a time subscript (ie τ), the relative contributions of differences in α and β will vary over time even though the (absolute) contribution of differences in α will be the same across time.[25]

There is one further catch. In the equations above the decomposition was presented in the context of making comparisons between any two regions (two states or territories). For ease of computation and analysis it is often preferable to compare the pattern of activity in a region with the corresponding pattern of activity for the nation. Unfortunately, any measure that compares regional indices with an aggregate of which the region is a part suffers from the fact that if a region is 'large' relative to the aggregate then that, by itself, will mean that figures for the region will tend to be close to those for the nation.[26] Because the states and territories in Australia differ markedly in size (two states, New South Wales and Victoria between them account for more than one-half of the national labour force) it is not sensible to compare state and territory figures with a national figure. Instead, in this paper measures for each state and territory have been computed where the benchmark is the relevant figure for NSW (for no reason other than it being the most populous of the states and territories).

Table 2 sets out values for each of the components of equation (5) for three representative years: 1985 when τ is zero, 1993 when τ is positive and 2006 when τ is negative.[27] The differences between years are small and so it is possible to draw conclusions which will apply to all years. A number of features of the results are worth commenting on. First, with the exception of WA where differences in α and β are both 'pushing' the equilibrium rate in the same direction (to make it lower than for NSW), in the other states and territories differences in α and differences in β were working in opposite directions, in other words, one is tending to make the equilibrium unemployment rate lower (higher) than that for NSW while the other is tending to make the equilibrium unemployment rate higher (lower) than that for NSW. Second, we see that the difference in slopes (β) between the ACT and NSW is tending to make the equilibrium unemployment rate higher in the ACT than would otherwise be the case. Third, and more importantly from our point of view, differences in *both* α and β

[24] See also Burt & Finley (1968) and Goldberger (1970).
[25] This means that we can easily compute the relative contributions of differences in α and β.
[26] See Shepherd & Dixon (2002) for further discussion of this issue in the context of econometric work on the 'cyclical sensitivity' of unemployment rates.
[27] Rows may not sum exactly due to rounding.

are important for explaining differences in the equilibrium unemployment rates and not differences in α alone. The contribution of differences in β, while often smaller in absolute magnitude than the contribution of differences in α, are far from negligible. All this suggests that it is desirable to have some explanation of the differences in the slopes of the Beveridge Curve and not to be content to only examine differences (or shifts) in the intercepts.

[TABLE 2 NEAR HERE]

VII The slope of the Beveridge Curve

In the previous section we saw that it is important to look at the slope of the curve as well as its intercept. The estimated elasticity of the Beveridge Curve is 'highest' in the ACT, VIC, NSW and WA (-.35, -.26, -.24 and -.23 respectively) the elasticity is lower in SA and QLD (-.18 and -.15 respectively) and it is lowest in TAS and the NT (point estimates of -0.03 and 0.05 respectively, neither of which are significantly different from zero).[28] How can we account for these differences and what do they signify? These questions may best be approached by noticing the connection between the size of the elasticity in the Beveridge Curve and one of the key parameters (which is also an elasticity) in the Matching Function. We may see this as follows:

The Matching Model views the number of hires (*M*) over any period as related to the number unemployed (U), the number of vacancies (V) and the efficiency of matching (*m*), such that the number of matches is increasing in both *U* and *V*. Empirical studies of the matching function yield the "stylized fact … that there is a stable aggregate matching function of a few variables that satisfies the Cobb-Douglas restrictions with constant returns to scale in vacancies and unemployment" (Petrongolo and Pissarides, 2001, p 396f).[29]

Standardising for the size of the labour force (and assuming constant returns to scale), the matching function may be written as:

$$\frac{M}{LF} = m\left(\frac{U}{LF}\right)^{\gamma}\left(\frac{V}{LF}\right)^{1-\gamma} \tag{6}$$

[28] The 'parsimonious model' presented in the Appendix yields elasticities of -0.2 for TAS and -0.23 for the NT.
[29] An empirical foundation for the Matching Model is the observed relationship between the hazard rate (*M/U*) that an unemployed person finds a job in any period and labour market tightness measured by the ratio of number of vacancies to the number unemployed (*V/U*), such that $(M/U) = m(V/U)^{1-\gamma}$.

where 'm' reflects the efficiency of matching and $0 \le \gamma \le 1$.

The Matching Function and the Beveridge Curve are related. Letting *M/LF* = *g* and rearranging (2) as an expression for *U/LF* in terms of *g*, *m* and *V/LF* gives the Beveridge Curve:

$$\left(\frac{U}{LF}\right) = \left(\frac{g}{m}\right)^{\left(\frac{1}{\gamma}\right)} \left(\frac{V}{LF}\right)^{-\left(\frac{1-\gamma}{\gamma}\right)} \quad (7)$$

For given values of *m* and *g*, this yields an inverse relationship between the vacancy rate and the unemployment rate. Specifically, the elasticity of the unemployment rate with respect to the vacancy rate (our β in equation (1)) and the elasticity of matches with respect to the number unemployed (γ in equation (2)), are related such that

$$\beta = 1 - \frac{1}{\gamma} \quad (8)$$

Given the estimates of β reported in Table 1, the implied values of γ are NSW 0.81, VIC 0.79, WA 0.81, SA 0.85, QLD 0.87, TAS 0.97, NT 1.05 and ACT 0.74.[30] So the question we posed earlier about differences between States in the value of β, becomes: How can we account for these differences in the estimated value of γ and what do they signify?

The parameter γ is the elasticity of the number of matches with respect to the number unemployed (see equation (6) above). It is usual in the literature on matching and search to see the size of the elasticity as (inversely) related to the severity of congestion externalities in the labour market.[31] If γ = 0 there is complete congestion while if γ = 1 there is no congestion. A 'congestion externality' arises because as the number searching (*U*) increases, the chance of someone else competing and matching with any one unemployed person's potential employer increases. Another way to put this would be to say that, in relation to equation (2), we would not expect the number of matches to rise at the same rate as the number unemployed because as the number searching increases there will not only be a greater number of competitors for each post, but a higher number of applications to be processed, interviews to be held etc, for a given vacancy and thus an increasing marginal cost

[30] Using 1996 labour force weights the state and territory values yield an implied national value for γ of 0.82.
[31] See Pissarides (2000), Petrongolo & Pissarides (2001), Shimer & Smith (2001) and Cahuc & Zylberberg (2004) for a discussion of this.

of hires or lengthening of the appointment process resulting in a less than proportionate increase in matches. As result, we would expect γ, while positive, to lie between 0 and 1. The closer γ is to 1 the less must be the degree of congestion (and other negative) externalities (Petrongolo and Pissarides (2001, p 392)).

The nature of our model is such that we are only able to recover six estimated values for the size of γ and so we are unable to test any hypotheses about the determinants of its size. However it is possible to speculate on why we find the values that we have, in other words, why we have found the values for β (the Beveridge Curve elasticity) that we have. A natural way to think of congestion in this context is that of multiple applications (given the number unemployed) for the same number of vacancies. What might enhance this? Suppose we define a job/worker in terms of place and skill/occupation. Given this, one imagines that (inter alia) the degree of congestion will be related to how concentrated geographically the labour market is in each state or territory, the diversity of the labour force, the ability of 'outsiders' to compete with 'insiders', the number of employed who are seeking job-job moves, the number not in the labour force who are in fact job seekers and the average education or skill level of the labour force, on the assumption that anyone at a certain skill level could compete not only for jobs at that skill level but also at any skill level below it, and so the higher the average level of human capital the more potential competitors there are for each vacancy. But, as already mentioned, we have too few measures of slopes to be able to test more specific conjectures.

VIII Concluding Remarks

We have shown that the method we have followed is capable of yielding a national equilibrium unemployment rate series which is similar to, but at the same time different enough from, other measures to make it interesting. In our view it is this, or some other "national" equilibrium rate series, a series based on common shocks or common trends, that should be the basis for policy and not an 'aggregate series' which is not constructed so as to capture national (nation-wide) factors.

In Australia we have extant a number of possible series for the behaviour of the equilibrium rate over time – and this is one area where riches are an embarrassment. While it is the case that those studies with a time-varying equilibrium rate are all predicting the same direction of movement at present, this does not by itself negate our argument that on the one hand there are ‘aggregate series’ and on the other our ‘national – common shifts – series’ and macro-policy makers who claim to be pursuing the ‘national interest’ have to stand up and be counted – they have to declare exactly which series, and which concept they are going to adopt.

There are three areas for further work. First, research needs to be undertaken to explain why the common shifts, and thus the national equilibrium rate, have the profile which they have. We conjecture that it has a lot to do with reforms in both labour and product markets which have made them both ‘more competitive’ and more flexible, with changes over time in eligibility criteria for social security (and especially the disability pension) and also with changes in the degree of labour mobility. Second, we have shown that differences in slopes of the Beveridge Curve matter and these should be explored further – it is not wise to focus solely on causes of shifts in intercepts.[32] Third, the ‘robustness’ of our results needs to be explored, as it is possible to accept our ‘philosophy’ but generate an equilibrium series using different data sets to ours and different econometric techniques.

[32] Also, it will be noticed that our series, in common with all other ‘time-varying’ estimates of the equilibrium rate exhibit to a greater or lesser degree the same cyclicality as the unemployment rate itself. It would be nice to find an equilibrium rate series that does not reflect the business cycle. One attempt to do this may be found in Dixon et al (2006).

REFERENCES

Australian Bureau of Statistics, *Job Vacancies: Australia*, ABS Cat No 6231. Canberra.

Australian Bureau of Statistics, *Job Vacancies and Overtime: Australia*, ABS Cat No 6354. Canberra.

Borsch-Supan, A. (1991), 'Panel Data Analysis of the Beveridge Curve: Is There a Macroeconomic Relation between the Rate of Unemployment and the Vacancy Rate?', *Economica*, **58**, 279-97.

Burt, O. and Finley, R. (1968), 'Statistical Analysis of Indentities in Random Variables', *American Journal of Agricultural Economics*, **50**, 734-44.

Cahuc, P. and Zylberberg, A. (2004), *Labor Economics*, Cambridge, Mass, MIT Press.

Crosby, M. and Olekalns, N. (1998), 'Inflation, Unemployment and the NAIRU in Australia', *Australian Economic Review*, **31**, 117-29.

Debelle, G. and Vickery, J. (1998a), 'The Macroeconomics of Australian Unemployment' in Debelle, G. and Borland, J. (eds), *Unemployment and the Australian Labour Market*, Sydney, Reserve Bank of Australia, 235-65.

Debelle, G. and Vickery, J. (1998b), 'Is the Phillips Curve a Curve? Some Evidence and Implications for Australia', *Economic Record*, **74**, 384-98.

Derrick, F. (1984), 'Interpretation of Dummy Variables in Semilogarithmic Equations: Small Sample Implications', *Southern Economic Journal*, **50**, 1185-8.

Dixon, R., Freebairn, J. and Lim, G.C. (2006), *Time-Varying Equilibrium Rates of Unemployment: An Analysis with Australian Data*, Melbourne Institute Working Paper 11/2006, Melbourne, MIAESR.

Downes, P. & Stacey, K. (1996), 'The NAIRU in the Treasury Macroeconomic (TRYM) Model of the Australian Economy: Definition, Measurement and Policy Implications', TYRM Related Paper No. 15, Canberra, Commonwealth Treasury.

Downes, P. & Bernie, K. (1999), 'The Macroeconomics of Unemployment in the Treasury Macroeconomic (TRYM) Model' TYRM Related Paper No. 20, Canberra, Commonwealth Treasury.

Fahrer, J. and Pease, A. (1993), ‘The Unemployment-Vacancy Relationship in Australia’, *Australian Economic Review*, **28**, 43-57.

Goldberger, A. (1970), ‘On the Statistical Analysis of Identities: Comment’, *American Journal of Agricultural Economics*, **52**, 154-56.

Groenewold, N. (2003), ‘Long-Run Shifts of the Beveridge Curve and the Frictional Unemployment Rate in Australia’, *Australian Journal of Labour Economics*, **6**, 65-82.

Gruen, D., Pagan, A. and Thompson, C. (1999), ‘The Phillips curve in Australia’, *Journal of Monetary Economics*, **44**, 223-58.

Hansen, B. (1970), ‘Excess Demand, Unemployment, Vacancies, and Wages’, *Quarterly Journal of Economics*, **84**, 1-23.

Harris, C. (1966), ‘Interregional Variations in the Levels and Rates of Increase of Per Capita Personal Income’, *Yorkshire Bulletin of Economic and Social Research*, **18**, 95-108.

Jones, D. and Manning, D. (1992), ‘Long Term Unemployment, Hysteresis and the Unemployment–Vacancy Relationship: A Regional Analysis’, *Regional Studies*, **26**, 17-29.

Kennedy, P. (1981), ‘Estimation with Correctly Interpreted Dummy Variables in Semilogarithmic Equations’, *American Economic Review*, **71**, 801.

Kennedy, S. (2007) 'Full Employment in Australia and the Implications for Policy' speech to the NSW Economic Society on 11 December 2007. Copy available at http://www.treasury.gov.au/contentitem.asp?NavId=&ContentID=1328

Lye, J., McDonald, I. and Sibly, H. (2001), ‘An Estimate of the Range of Equilibrium Rates of Unemployment for Australia’, *Economic Record*, **77**, 35-50

McDonald, I. (2007) ‘Where is Full Employment?’, *Dialogue*, **26**, 81-92.

Petrongolo, P. and Pissarides, C. (2001), ‘Looking into the Black Box: A Survey of the Matching Function’, *Journal of Economic Literature*, **39**, 390-431.

Pissarides, C. (2000), *Equilibrium Unemployment Theory*, Second edition, Cambridge, Mass, MIT Press.

Samson, L. (1994), 'The Beveridge Curve and Regional Disparities in Canada', *Applied Economics*, **26**, 937-47.

Shepherd, D. and Dixon, R. (2002) 'The Relationship between Regional and National Unemployment', *Regional Studies*, **36**, 469-80.

Shimer, R. and Smith, L. (2001), 'Matching, Search and Heterogeneity', *Advances in Macroeconomics*, **1**, Article 5, 1-16.

Wall, H. and Zoega, G. (2002), 'The British Beveridge Curve: A Tale of Ten Regions', *Oxford Bulletin of Economics and Statistics*, **64**, 257-76.

APPENDIX

A parsimonious estimating equation based on the 'differential coefficients method'.

As mentioned in the text the implied national equilibrium rate appears not to be sensitive to the specification employed. Set out below is the output from the most parsimonious equation we have estimated where we have tested down from the most general to the most specific using the 'differential coefficients method'. The final specification reported in Table A1 was selected using the Akaike criterion (although in this case the Schwarz criterion leads to the same model being selected) subject to the restriction that all slope coefficients be negative.[33] We have also grouped time periods together where the information criterion indicted this was appropriate.

[TABLE A1 NEAR HERE]

Using the procedure described in sections V and VI of the main text it is possible to again recover the implied national equilibrium unemployment rate and this is depicted in Figure A1, together with the actual unemployment rate.

[33] The equation was estimated using the differential coefficients method but for ease of comparison with the results reported in Table 1 we have set this Table out with the implied coefficient values for each state and territory.

FIGURE 1
The Labour Market

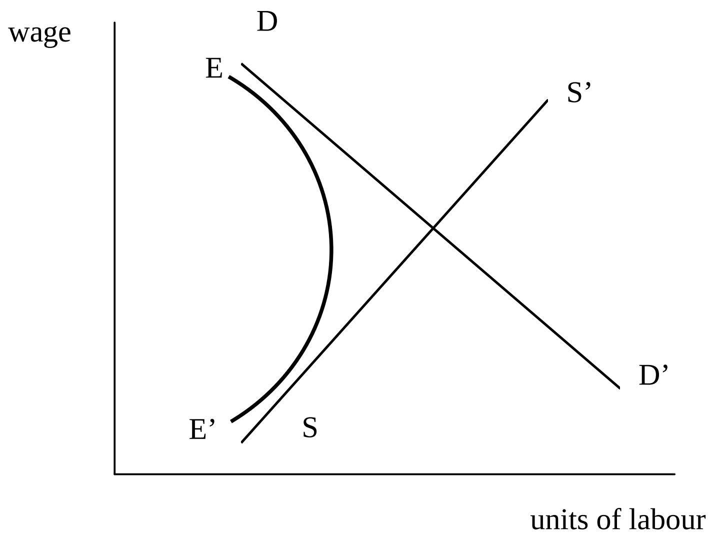


FIGURE 2
The Beveridge Curve.

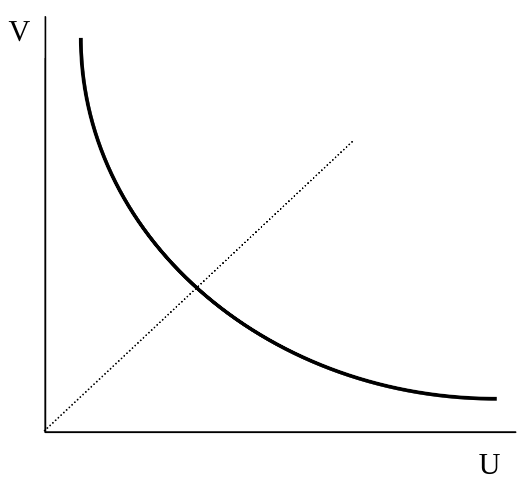


FIGURE 3

The proportional change in the unemployment rate which would result from the common shifts implied by the dummies in Table 1

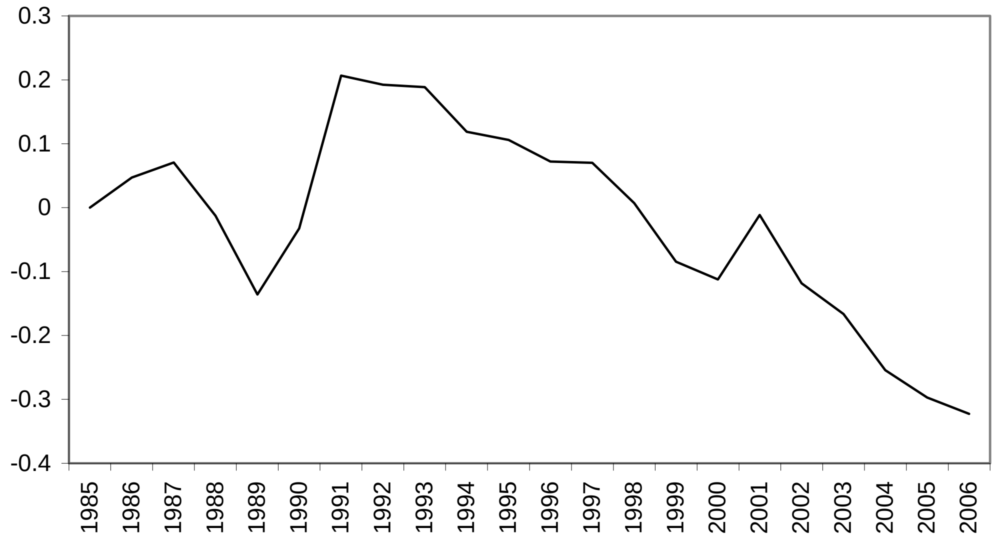
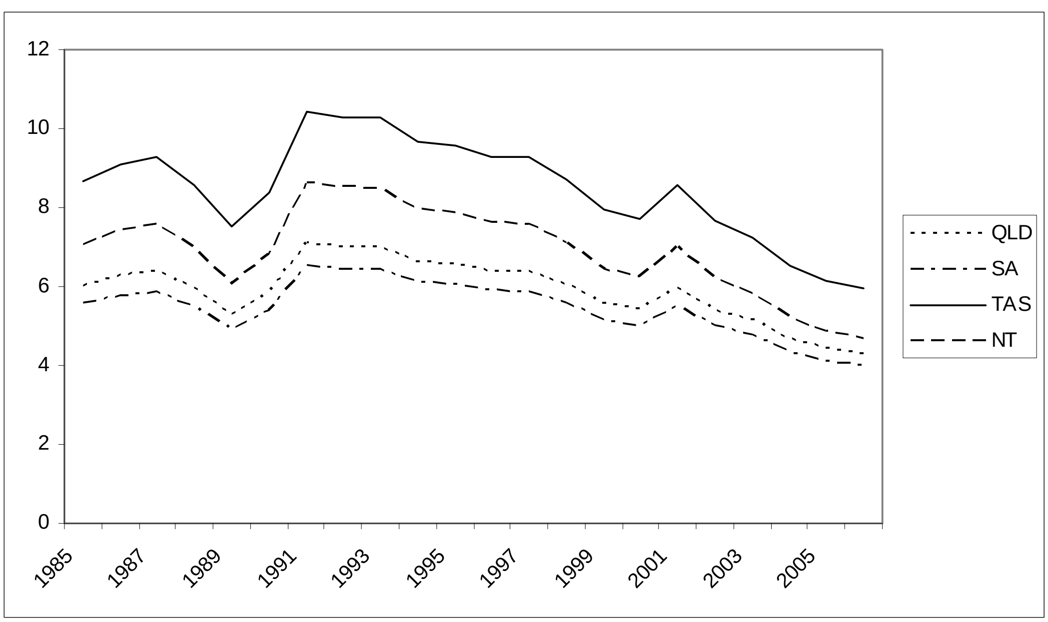


FIGURE 4

The equilibrium rate for each state and territory (%) 1985 – 2006

4A. TAS, NT, QLD and SA (top to bottom)



4B. NSW, WA, VIC and ACT (top to bottom)

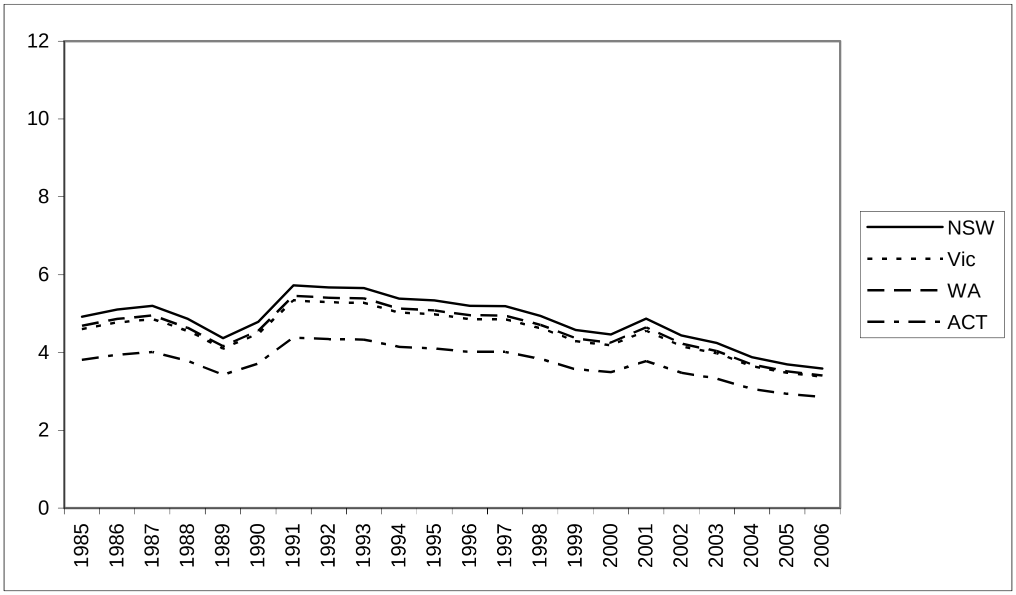


FIGURE 5

The implied national equilibrium rate of unemployment (%) 1985 – 2006

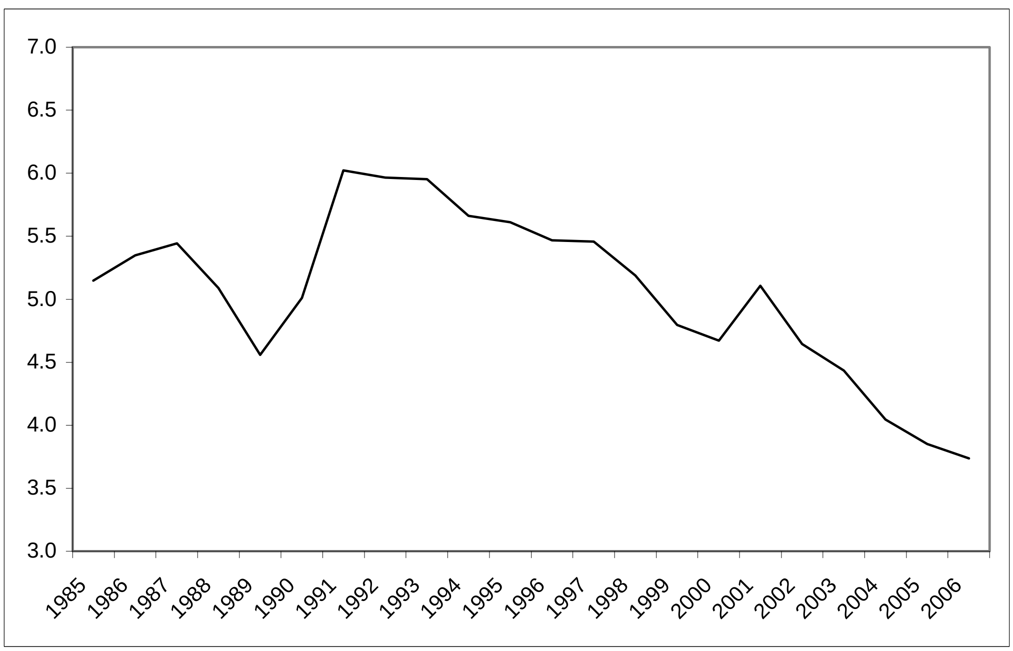


FIGURE 6

The implied national equilibrium rate of unemployment – solid line – and the actual national rate of unemployment – broken line – (%) 1985 – 2006

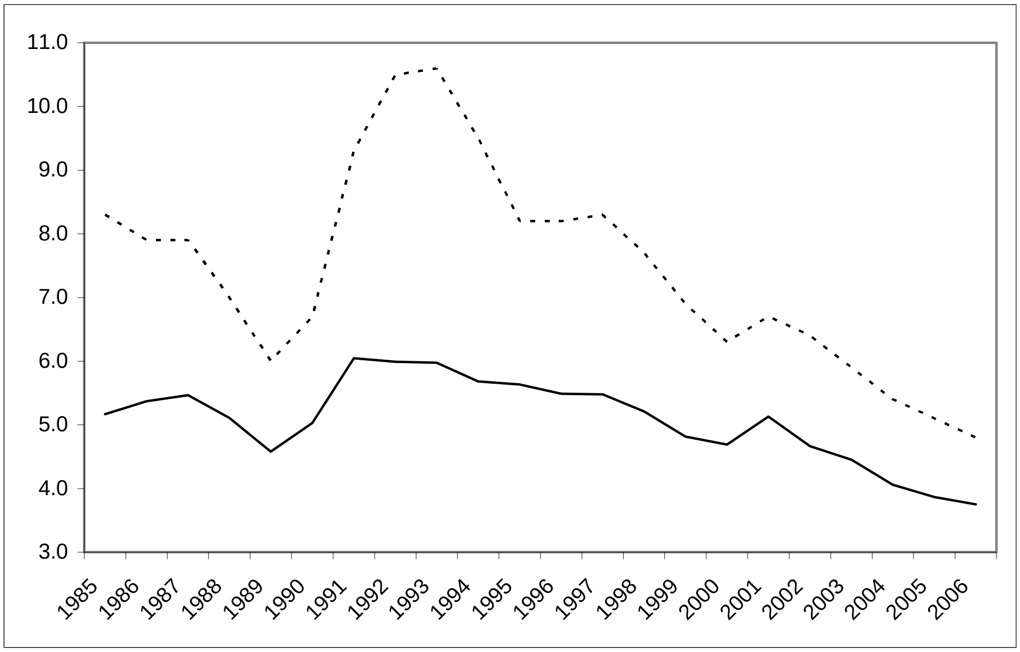


FIGURE A1

The national equilibrium rate of unemployment implied by the estimates in Appendix Table A1 – solid line – and the actual national rate of unemployment – broken line – (%) 1985 – 2006

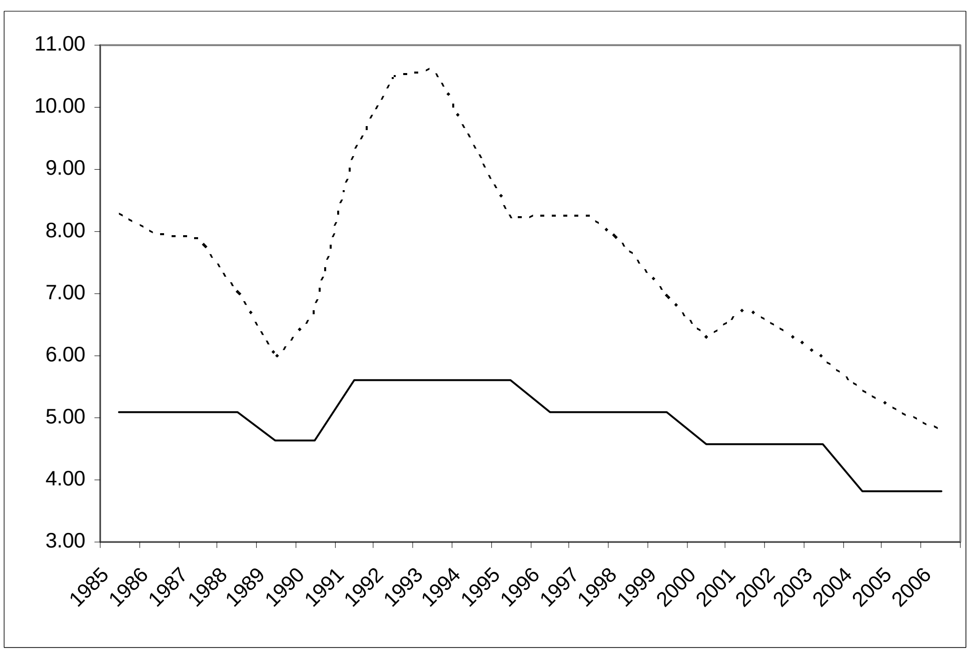


TABLE 1

Regression Results for Equation (1): Dependent Variable is LOG(UR)

Variable	Coefficient	p-value
Intercepts		
NSW	-3.730497	0.0000
VIC	-3.885724	0.0000
QLD	-3.221526	0.0000
SA	-3.413695	0.0000
WA	-3.759805	0.0000
TAS	-2.509217	0.0000
NT	-2.515754	0.0000
ACT	-4.416807	0.0000
Year dummies		
1986	0.046272	0.3939
1987	0.068271	0.2024
1988	-0.012675	0.8113
1989	-0.146268	0.0066
1990	-0.033331	0.5388
1991	0.187884	0.0003
1992	0.176044	0.0013
1993	0.172829	0.0014
1994	0.112211	0.0319
1995	0.100868	0.0572
1996	0.069608	0.1842
1997	0.067845	0.2017
1998	0.006837	0.9000
1999	-0.088201	0.1079
2000	-0.119174	0.0352
2001	-0.011405	0.8426
2002	-0.125838	0.0228
2003	-0.182315	0.0013
2004	-0.293578	0.0000
2005	-0.352855	0.0000
2006	-0.389665	0.0000
Slopes		
NSW	-0.238317	0.0031
VIC	-0.261978	0.0000
QLD	-0.146119	0.0402
SA	-0.180658	0.0219
WA	-0.228295	0.0007
TAS	-0.026311	0.7043
NT	0.050531	0.5021
ACT	-0.352158	0.0000
Observations	176	
Adjusted R^2	0.864	
Log-likelihood	173.8353	

TABLE 2

Contribution of differences in α and β to differences in the logarithm of the Equilibrium Unemployment Rates relative to NSW

1985	Difference in LU^*	Contribution of differences in α	Contribution of differences in β
NSW	0	0	0
VIC	-0.067	-0.124	0.057
QLD	0.202	0.428	-0.226
SA	0.121	0.262	-0.141
WA	-0.048	-0.024	-0.024
TAS	0.568	1.088	-0.520
NT	0.363	1.130	-0.767
ACT	-0.254	-0.531	0.277

1993	Difference in LU^*	Contribution of differences in α	Contribution of differences in β
NSW	0	0	0
VIC	-0.069	-0.124	0.055
QLD	0.213	0.428	-0.215
SA	0.128	0.262	-0.134
WA	-0.047	-0.024	-0.023
TAS	0.596	1.088	-0.492
NT	0.405	1.130	-0.725
ACT	-0.266	-0.531	0.265

2006	Difference in LU^*	Contribution of differences in α	Contribution of differences in β
NSW	0	0	0
VIC	-0.061	-0.124	0.064
QLD	0.176	0.428	-0.251
SA	0.106	0.262	-0.156
WA	-0.051	-0.024	-0.027
TAS	0.503	1.088	-0.585
NT	0.267	1.130	-0.863
ACT	-0.227	-0.531	0.303

TABLE A1

Regression Results for Equation (1): Dependent Variable is LOG(UR)

Variable	Coefficient	p-value
Intercepts		
NSW	-3.69339	0.0000
VIC	-3.69339	0.0000
QLD	-3.60372	0.0002
SA	-3.60372	0.0002
WA	-3.69339	0.0000
TAS	-2.43954	0.0006
NT	-3.69339	0.0000
ACT	-3.85127	0.0000
Year dummies		
1989-1990	-0.11432	0.0004
1991-1995	0.11271	0.0000
2000-2003	-0.13356	0.0000
2004-2006	-0.34970	0.0000
Slopes		
NSW	-0.22547	0.0000
VIC	-0.22547	0.0000
QLD	-0.22547	0.0000
SA	-0.22547	0.0000
WA	-0.22547	0.0000
TAS	-0.01705	0.0037
NT	-0.22547	0.0000
ACT	-0.22547	0.0000
Observations	176	
Adjusted R^2	0.829	
Log-likelihood	138.5369	