THE UNIVERSITY OF MELBOURNE

Department of Economics

Working Paper Series

Regional Beveridge Curves: A Latent Variable Approach

Robert Dixon, G.C. Lim and
John Freebairn

August 2010

Research Paper Number 1103

ISSN: 0819-2642
ISBN: 978-0-7340-4456-3

Department of Economics
The University of Melbourne
Parkville VIC 3010
www.economics.unimelb.edu.au

Regional Beveridge Curves: A Latent Variable Approach

Robert Dixon, G.C. Lim and John Freebairn

Department of Economics

University of Melbourne

Abstract

It is important to understand how labour markets in different regions are affected by 'common' or 'national' shocks including national macroeconomic, monetary and fiscal policies. This paper applies a new econometric approach - involving an unobserved components model - to identify the direction and timing of the shifts in regional Beveridge Curves. The method allows for the presence of common national factor(s) and region specific factor(s) in the determination of activity in labour markets including regional specific loadings on the common factor. The method is applied to Australian data. The results show that equilibrium unemployment rate vary by region and over time. In terms of implications for policies to reduce unemployment, these results suggest a key potential role for regional policies.

Key words

Beveridge curve Regional unemployment Unobserved components model

JEL codes

R11 R12 E32

Corresponding author

Professor Robert Dixon

Department of Economics

University of Melbourne

VIC 3010

Australia

Email: r.dixon@unimelb.edu.au

Tel: 61 (0)3 8344 5352

REGIONAL BEVERIDGE CURVES: A LATENT VARIABLE APPROACH

INTRODUCTION

Regional Beveridge Curves have been examined for a number of countries[1] for two reasons. First, the performance of regional labour markets are of interest in their own right. Second, because it is important to understand how different regions are affected by 'common' or 'national' shocks including national macroeconomic, monetary and fiscal policies.

This paper applies a new econometric approach to identify the direction and timing of the shifts in regional Beveridge Curves allowing for the fact that there are common national factor(s) and specific state factor(s) in the determination of activity in labour markets. The method yields more accurate estimates of the regional equilibrium rates as well as resulting in a more accurate series for the 'national' factor which is common across the regions. The movement in the generated 'national' equilibrium rate of unemployment and the associated regional discrepancies would be particularly informative for the determination of national economic policies.

The paper contributes to the existing literature in two ways. First, we avoid the artificial way of allowing for time variation with the use of time dummies; instead the matching efficiency of unemployment and vacancies is modelled to evolve over time in the same manner as a number of related economic phenomena (GDP, technological change), namely as a random walk. Also whereas others[2] force the loading or coefficient on the time shifts to be identical for all regions we allow for regional coefficients to be different. This is an improvement on past work because apriori there is no reason to expect all regions to react in the same way to common or national shocks.

This paper unfolds as follows. In section II we motivate our estimating equation relying on HANSEN'S (1970) model of the labour market and in section III we set out the econometric approach. In section IV results for the case study – the connection between the Australian equilibrium rate of unemployment and its component region's (in this case State's & Territory's) Beveridge Curves – are presented. The empirical section

---

[1] For examples, see JONES and MANNING (1992) and WALL and ZOEGA (2002) for the UK; BORSCH-SUPAN (1991) for Germany; and SAMSON (1994) for Canada.

[2] For examples, GORTER and VAN OURS (1994) and WALL and ZOEGA (2002).

contains estimates of the shifts and slopes in the region and differences between them are discussed with reference to the industry structure of each state. We also extract the common factor driving the interactions between regional unemployment and vacancy rates and relate it to various measures of economic activity. Estimates of the implied individual state & territory and 'national' equilibrium rates of unemployment are also generated and discussed. The final section concludes.

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).[3] 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 'curve' nearest the 'price' axis. However in real-world labour markets there are informational imperfections, search & relocation costs and mismatches. "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.[4] 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-

---

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

[4] We are putting to one side issues related to taxation, superannuation, other labour on-costs and also the presence of fixed as well as variable labour costs (for a discussion see DIXON, FREEBAIRN and LIM (2005) and DIXON and FREEBAIRN (2009a))

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*).

[FIGURES 1 AND 2 NEAR HERE]

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 unemployment. This implies that there will be an inverse relationship between vacancies and unemployment, as depicted in Figure 2.

The equilibrium unemployment rate is when $U = V$. 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).

In algebraic terms, a typical model of the relationship between u and v is:

$$\ln(u_t) = \alpha + \beta \ln(v_t) \tag{1}$$

The relationship is usually expressed in (natural) logarithmic form, where the slope β is the elasticity of the unemployment rate to the vacancy rate. The intercept term α is also important as it determines the level of unemployment associated with any given level of vacancies.

Finally, with reference to (1) above, the equilibrium rate of unemployment occurs when $u = v$ and this is given by:

$$u_t^* = \exp\left(\frac{\alpha}{(1-\beta)}\right). \tag{2}$$

Equation (2) shows that u_t^* would be a constant, for all time *t*, unless some time variation is introduced into the model. We turn to a regional model allowing for a common stochastic trend next.

REGIONAL BEVERIDGE CURVE(S) WITH A COMMON STOCHASTIC FACTOR

Regional Beveridge curves will have the same functional form as (1). However, regions in a country will not only be subject to idiosyncratic shocks but, being open economies, will also be subjected to common ('national') shocks and trends.

The proposed empirical model of regional Beveridge curves for a country with *N* different regions with a common stochastic trend is:[5]

$$\begin{aligned}
&\ln(u_{it}) = \alpha_i + \beta_i \ln(v_{it-1}) + \delta_i F_t + \varepsilon_{it} \\
&F_t = F_{t-1} + \eta_t \\
&\varepsilon_{it} \sim N(0,\sigma_i^2); \quad \eta_{it} \sim N(0,1) \\
&i = 1,\ldots N \quad t = 1,\ldots T
\end{aligned} \tag{3}$$

where u_{it} is the unemployment rate in region *i* at time *t*; v_{it-1} is the vacancy rate in region *i* at time *t-1*;[6] *F* is the common latent national factor which is assumed to behave like a random walk. The parameters are: α_i a region-specific fixed effect; β_i a regional elasticity of unemployment with respect to vacancies, and δ_i the region's loading on the common factor. The term e_{it} is the error for region *i* at time *t* and the term η_{it} is the error associated with the common national factor.

Our approach is to pool data to obtain the common factor, while allowing for region specific fixed effects and state/region specific loadings on the common factor. A fixed effects approach has been selected over a random effects model because a priori, the regions have different industry and demographic structures (and thus different labour markets) and are dissimilar in many other substantive ways. The panel estimation

[5] An alternative would be to relate the unemployment rate to the inverse of the vacancy rate or to the vacancy rate together with the vacancy rate squared.
[6] It is also common in the literature to use the lagged vacancy rate as the instrument to avoid simultaneity bias. We follow this practice. Essentially the same results are obtained if we use the current vacancy rate instead of the lagged vacancy rate.

approach captures both spatial (across regions) and temporal (across time) dimensions and allows shocks to be both temporally and spatially correlated.

The regional equilibrium rates can be computed as:

$$u_{it}^{*} = \exp\left(\frac{\hat{\alpha}_i + \hat{\delta}_i F_t}{1-\hat{\beta}_i}\right) \tag{4}$$

As constructed, the equilibrium regional unemployment rates move along with the national factor, but its value is determined by region-specific factors via the parameters α_i, β_i and δ_i.

The equilibrium national unemployment rate in period t computed using regional rates would be:

$$u_t^{a*} = \sum_{i=1}^{N} w_{it} u_{it}^{*} \tag{5}$$

where w_i is the weight attributed to the region computed as $w_i = L_{it} / L_t$ where L_{it} is the labour force in the region in period t and L_t is the aggregate (national) labour force in the same period.

We turn now to a discussion of the data and our empirical analysis.

EMPIRICAL ANALYSIS

A description of the data is given in the Appendix. For this study, N = 8 (NSW, VIC, QLD, SA, WA, TAS, NT & ACT) and T = 99 quarterly observations over the period 1983:4-2008:2. Panel unit root tests confirm that the series contains a stochastic trend (see Table 1).

[TABLE 1 NEAR HERE]

Table 2 presents the results of estimating equation (2) assuming a common stochastic trend for the eight 'regions' of Australia. We find that the regions had different reactions to the common factor (the δ_i) as well as different intercepts (the α_i) and slopes (the β_i) reflecting their different physical geographies and their economic and demographic structures.[7]

[TABLE 2 NEAR HERE]

In the remainder of this section of the paper we will discuss the results looking in turn at the slopes, the intercepts, our estimate of the common factor. A part of the output of the estimation process involves the generation of a time series for the common factor – this is the main benefit of adopting the latent variable approach – and the different regional loadings on the common factor. Once that has been completed we will look at what these results imply by way of the evolution of equilibrium (and dis-equilibrium) unemployment over time.

Regional elasticities of unemployment with respect to vacancies (β)

The first data column of Table 3 lists the value of the estimated slope by region.[8] 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.

[TABLE 3 NEAR HERE]

The Matching Function "sums up, at the aggregate level, the outcomes of encounters between persons in search of a job and firms with positions vacant" (CAHUC and ZYLBERBERG, 2004, p 517). The function 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

[7] For the regional elasticities of unemployment with respect to vacancies (the β_i), we found only 5 distinct significant coefficients. It appears to be the case that contiguous (smaller) regions experience similar labour market conditions as their bigger neighbours and hence these smaller regions (economically speaking) have been grouped with the economic regions. The grouped regions are VIC+SA+TAS – regions in the south east of Australia, and WA+NT – the 2 mineral resource rich states.

[8] In estimation the slopes for VIC, SA and TAS were constrained to be the same while the slopes for WA and NT were constrained to be the same.

restrictions with constant returns to scale in vacancies and unemployment" (PETRONGOLO and PISSARIDES, 2001, p 396f).

We may write the matching function as[9]

$$M = mU^{\gamma}V^{1-\gamma} \quad (6)$$

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

The empirical foundation for the Matching Model is the observed relationship between the hazard rate that an unemployed person finds a job in any period (*M/U*) and labour market tightness measured by the ratio of the number of vacancies to the number unemployed (*V/U*) – this ratio is often referred to as the degree of 'tightness' prevailing in the labour market – such that the 'hazard rate' or 'the exit rate from unemployment' depends positively upon labour market tightness:

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

Alternatively, standardising for the size of the labour force (and assuming constant returns to scale), the matching function (6) may be written as:

$$\frac{M}{LF} = m\left(\frac{U}{LF}\right)^{\gamma}\left(\frac{V}{LF}\right)^{1-\gamma} \quad (8)$$

The Matching Function and the Beveridge Curve are related. Letting *M/LF* = *g* (in the remainder of the paper we will refer to this as 'the finding rate') and rearranging (8) as an expression for *U/LF* in terms of *g*, *m* and *V/LF* gives the Beveridge Curve:

$$\left(\frac{U}{LF}\right) = \left(\frac{g}{m}\right)^{\left(\frac{1}{\gamma}\right)}\left(\frac{V}{LF}\right)^{-\left(\frac{1-\gamma}{\gamma}\right)} \quad (9)$$

Notice, in passing that equation (9) also shows why we would expect the intercept in the Beveridge curve (and thus our common factor) to vary over the business cycle as it

[9] We assume that the matching function is strictly increasing in each of its arguments and that $m(U,0) = m(0,V) = 0$.

depends on g (the finding rate which will be pro-cyclical) and not m alone[10] – more on this in a later section.

For γ less than 1, equation (9) 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 (β in equation (3)) and the elasticity of matches with respect to the number unemployed (γ in equations (6) and (9)), are related such that

$$\beta = 1 - \frac{1}{\gamma} \qquad \text{and} \quad \text{so} \qquad \gamma = \frac{1}{1-\beta}$$

The values of γ implied by our estimates of the slopes of the regional Beveridge curves (β) are set out in Table 3 together with the 95% confidence intervals of both estimates.

The question we posed earlier about differences between regions 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 this elasticity as (inversely) related to the severity of congestion externalities in the labour market.[11] If $\gamma = 0$ there is complete congestion while if $\gamma = 1$ 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 (say) equation (7), we would not expect the number of matches to rise at the same rate as the number unemployed. As the number searching increases there will not only be a greater number of competitors for each post, but also a higher number of applications to be processed, interviews to be held etc, for a given vacancy and thus an increasing marginal cost 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).

[10] For this reason it is not wise to think of the business cycle as only resulting in movements along a given Beveridge curve. HOLT (1996) also makes this point.
[11] See PISSARIDES (2000), PETRONGOLO and PISSARIDES (2001), SHIMER and SMITH (2001) and CAHUC and ZYLBERBERG (2004) for a discussion of this.

The number of regions in our study is such that we have only a small number of estimated values for the size of γ and so we are unable to formally test any hypotheses about the determinants of variation in its size (and thus in the size of β) across regions. 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 the size of the labour market, the diversity of the labour force relative to the diversity of the jobs available, how concentrated geographically the labour market is in each state or territory, 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.

In summary the value of γ (the degree of congestion) varies across regions. Congestion tends to be low in the large regions and to be high in the small regions, for example the smallest region, the ACT, has the highest degree of congestion. This is a region akin to the District of Columbia in the US, with the dominant employer being the Federal Government and its administrative units with their associated very similar labour demand characteristics, whereas the resident population is quite diverse in its characteristics.[12]

What can we say about the confidence intervals for the γ's ? The 95% confidence intervals for the β's are given in the second data column of Table 3. The fourth data column of Table 3 gives the implied 95% confidence intervals for the γ's. We notice

[12] Measures of the degree of regional specialisation invariably show the ACT as the most specialised of all the regions.

that none of the CIs for the β's includes -1 and that none of the CIs for the γ's includes 0.5. Three things follow from all this by way of conclusion. First, unemployment and vacancies have a statically significant negative relationship for Australia. Second, we must reject the hypothesis that the U-V curve is a rectangular hyperbola.[13] Third, it would appear that there is little or no congestion in the Australian labour market, with the most congested labour market being in the ACT.

Regional intercepts

With respect to the regional intercepts ($\hat{\alpha}$), our results imply that the Beveridge Curves for the ACT and the NT lie closest to the origin, with WA, NSW, VIC and QLD further out and with the Beveridge Curves for SA and TAS lying furthermost from the origin. These results correspond very closely to the ranking of the average levels of the observed unemployment rate in each of the regions over our sample period, which were (in order of lowest to highest) ACT, NT, WA, VIC, NSW, QLD, SA and TAS.

Regional loadings on the common factor

As mentioned in the introduction, whereas others use time dummies we have proceeded on the assumption that matching efficiency evolves over time in the same manner as a lot of related economic phenomena (GDP, technological change) - that is, as a random walk. Also, whereas others force the coefficient on the common factor (the common time shifts in the Beveridge curve), to be identical for all regions we are able to set up a model which allows these regional loadings or coefficients to be different (across regions but not across time). We think this is a major contribution to the literature as apriori there is no reason to expect all regions to have the same reaction to common or national shocks. Indeed, one of the main tasks of regional economics is to identify and draw attention to regional diversity and its consequences. Interpreting the loadings on the common factor as reflecting the 'sensitivity' of the regional markets to the common

[13] Another way to put this, is to say that it is not wise to assume γ = 0.5, which many modellers do (if the Beveridge curve is a rectangular hyperbola then γ = ½ and β = -1).

business cycle factor, our estimates suggest that this sensitivity differs across regions with QLD and WA being the most 'sensitive' while the NT is the least sensitive. [14]

The common business cycle factor

As mentioned earlier (see equation (3) and related text) *F* is the estimated time series for the latent variable or common or national factor which is assumed to behave like a random walk. A plot of the estimated time series of the common latent business cycle *F* is given in Figure 3.

[FIGURE 3 NEAR HERE]

In the context of the regional Beveridge curves, given that the loadings for all the regions are positive, the Beveridge curves for each region shift in and out as *F* goes down or up, respectively. Specifically, changes in *F* should be inversely related to matching efficacy and to the job finding rate. These are not observable measurable variables, and hence we find researchers[15] relating shifts in the U-V curve to measures of structural change (such as the Lilien index[16]), the relative generosity of unemployment benefits as measured by the replacement ratio, the presence or intensity of active labour market programs, measures of the business cycle (such as the GDP growth rate) and the incidence of long-term unemployment.

To gauge the role of these explanatory variables, we set out below the (heteroskedasticity corrected) regression[17] of the first differences in the common factor (*F*) on the non-farm GDP growth rate[18] (*GDPGR*), the change in the long-term

[14] These groupings likely correlate with regional industry structure. Measures of similarity of industry structure for Australian states and territories invariably show WA and QLD as having very similar structures and that they are more alike in this respect than they are with any of the other states and territories. See DIXON and SHEPHERD (2000) and DIXON and FREEBAIRN (2009b) for comparisons of industrial structures across the states and territories of Australia using Krugman's measure of similarity (or dis-similarity) amongst other measures (KRUGMAN,1991 p75f & 1993 p 250f).
[15] See for example: ARMSTRONG and TAYLOR (2000, p 183f), JONES and MANNING (1992), WALL and ZOEGA (2002) and PETRONGOLO and PISSARIDES (2001).
[16] The Lilien index is a time series of the weighted standard deviation of industry growth rates (LILIEN, 1982, p 787).
[17] All of the variables in the equation are I(0).
[18] We use the rate of growth in non-farm GDP at constant prices.

unemployment ratio[19] ($\Delta LTUR$) and the change in spending on labour market programs[20] ($\Delta ALMP$). The figures in parentheses are p-values.[21]

$$\Delta F_t = 0.0147 - 3.3289 GDPGR_t + 0.04314 \Delta LTUR_t - 0.5285 \Delta ALMP_t$$
$$(0.434) \quad (0.033) \qquad (0.000) \qquad (0.100)$$

We find that ΔF and *GDPGR* are negatively related, which we interpret to mean that the job finding rate (g) is higher in periods of fast growth than in periods of slow growth. We find that ΔF and $\Delta ALMP$ are negatively related which we interpret to mean that labour market programs appear to have a statistically significant (at the 10% level) and positive effect on matching efficiency. Finally, we find that ΔF and ΔLTU are negatively related (albeit only at the 10% level) which we interpret to mean that matching efficiency is significantly and negatively related to the long-term unemployment rate. We take this to indicate that the effectiveness of the 'competition' of the unemployed and the employed for jobs — and in this sense the efficiency of job search — is related to the characteristics of the unemployed and that the time out of employment may be being used by employers as a sorting device.

REGIONAL (EQUILIBRIUM) UNEMPLOYMENT RATES

Given the set-up of our model, there are three components to the unemployment rate for any region, given the region's vacancy rate (v_i): the size of the regions intercept (α_i) and slope (β_i); the size of the regions loading on the common factor (γ_i) – together with the sign and size of the common factor (F); and the regional idiosyncratic (random) component (the ε_i's). If we put to one side the regional idiosyncratic (random) components we may identify two systematic or 'equilibrium' unemployment rates (although it may be better to say 'two components of the equilibrium rate') for each region. The first is what we will refer to as a 'static' or 'autarkic' equilibrium rate for

[19] Long-term unemployment is defined as persons who have not held a job for 52 weeks or more. The 'long-term unemployment rate' is the ratio of the number of long-term unemployed to the labour force.
[20] Our labour market program measure is public expenditure on active LMPs per unemployed person expressed as a proportion of GDP. This is available on an annual basis back to 1986 from the *OECD Employment Outlook*, various years. This series has been interpolated to yield quarterly estimates.
[21] Estimated coefficients on the Lilien index and the replacement ratio were not significantly different from zero at the 10% level and were omitted from the final equation (the significance and sign of the other variables were unaffected).

the region. This will be given by setting common shocks equal to zero and solving for the value of unemployment in each region which will be consistent with unemployment equalling vacancies in that 'autarkic' state. We will refer to this notional 'autarkic equilibrium rate' as u_i^a and (given (3)) it will equal:

$$u_i^a = EXP\left(\frac{\hat{\alpha}_i}{1-\hat{\beta}_i}\right) \tag{10}$$

The values of u_i^a for each region are given in the second data column in Table 4, together with the mean value of the unemployment rate observed in each region over the period, this is reported in the first data column.[22]

[TABLE 4 NEAR HERE]

Regions, of course, are not autarkic, but are open to influences from outside and so we need to allow for this. We define the full-dynamic equilibrium rate for each region as that unemployment rate at which unemployment would equal vacancies when only region specific random shocks (the ε's) are excluded (or the ε's are set equal to their mean value of zero) but incorporating common shocks (F) and allowing each region to have its own region-specific loading on the common shocks. This rate will be time-varying since F is time varying. As we saw in section III above, it may be computed for each region (i) in each period t, as:[23]

$$u_{it}^* = EXP\left(\frac{\hat{\alpha}_i + \hat{\delta}_i F_t}{1-\hat{\beta}_i}\right) \tag{4}$$

The results are plotted in Figure 4 where we present for each region the actual unemployment rate and the 'dynamic' equilibrium rate (u_{it}^*).

[FIGURE 4 NEAR HERE]

The charts reveal a marked difference in the size and behaviour of the gap between the equilibrium and actual unemployment rates across regions. For some regions (eg QLD,

[22] Obviously, with α (and β) constant across time, the value of u_i^a will be constant over time for any region, hence our use of the word 'static' to describe it.
[23] This is arrived at by solving (1) for each state and territory, imposing the condition that vacancies equal the number unemployed and that the ε's are equal to their mean value of zero.

SA and TAS) the two are relatively close to each other. Since these three regions have the highest average rates of unemployment (all three are well above the national unemployment rate throughout the whole of the period we are looking at) the implication is that their high observed rates reflect (to a greater extent than other regions) persistent and high equilibrium unemployment, not persistent and high dis-equilibrium unemployment. Most of the other regions show evidence of sustained periods (especially during the recession of the early 90s) where actual unemployment was above, and for some well above and for some years, the equilibrium rate.

The mean value of u_{it}^{*} for each region is given in the last data column of Table 4. Since the regions are subject to the same common shocks, the figures in the last column differ (where they do) from those in the second data column is due to differences the loadings which each region has on the common shocks.

Comparing the second and third data columns the dominant source of differences in the equilibrium rate between regions is that of differences in the intercepts and slopes, ie that of differences in the determinants of the static-autarkic rates. Differences in δ_i appear to play a very minor role in accounting for differences in the mean rate of unemployment. This, of course, should not be taken to mean that differences in δ_i only play a very minor role in accounting for differences in the *variability* of the (equilibrium) rate of unemployment. We turn now to investigate that issue.

Variability of the equilibrium rates

In order to explore the variability of the (equilibrium) unemployment rates it is convenient to work in terms of logarithms, as this yields the key starting point in linear form. Given (4) we may write for the equilibrium unemployment rate in any region at any date as

$$\ln\left(u_{it}^{*}\right)=\left(\frac{\hat{\alpha}_i}{1-\hat{\beta}_i}\right)+\left(\frac{\hat{\delta}_i F_t}{1-\hat{\beta}_i}\right) \tag{11}$$

Since, for any given region, α and β are time invariant, the variability in that region's *equilibrium rate* around its mean (ie the mean of $\ln\left(u_{it}^{*}\right)$ for the region) will solely reflect the variability of the common factor (F_t) together with the size of the regions loading (δ_i) and slope (β_i). Given that α_i, β_i and δ_i are constant over time for any region we may write for the sum of the squared deviations of the (logarithm of the) equilibrium rate around its mean for any region (with obvious implications for the variance and standard deviation), over time:

$$\sum_{t=1}^{T}\left(\Delta \ln\left(u_{it}^{*}\right)\right)^{2} = \left(\frac{\hat{\delta}_i}{1-\hat{\beta}_i}\right)^{2} \sum_{t=1}^{T}\left(\Delta F_t\right)^{2} \qquad (12)$$

where $\Delta \ln\left(u_{it}^{*}\right)$ is the deviation of the equilibrium rate for region *i* around its mean while ΔF_t is the deviation of *F* around its mean.

Also, since *F* is common across all regions (but varies over time), it follows that the only reason why we will observe differences in the variability of the (dynamic) equilibrium rates (the u_{it}^{*}'s) across the regions will be due to differences in δ_i and β_i across regions.

The Sums of Squares of (the logarithms of) u_{it}^{*} for each region are given in the second data column in Table 5, together with the Sums of Squares of the (logarithms of the) observed unemployment rate in each region over the period – this is reported in the first data column. The final column – headed ‘Ratio’ – shows the proportion of the total variability in the *i*’th region’s unemployment rate – this is given in the first data column – which can be explained by variability in the common factor together with the size of that region’s loading (δ_i) and slope (β_i) – this is given in the second data column).

[TABLE 5 NEAR HERE]

The results given in Table 5 indicate that the contribution of common factors (and thus, by implication, the contribution of idiosyncratic factors) to fluctuations in the unemployment rate varies markedly across regions – thus demonstrating the gains from using our approach which, unlike our predecessors, does not assume loadings on common shocks are identical. The contribution of common shocks varies from a low of 18% to a high of 68%. The implication is that region specific shocks account for between 32% and 82% of fluctuations in regional unemployment rates.

Of interest is the relative importance of the two components of variability for the different regions. Common shocks appear to be relatively unimportant for the NT and ACT (accounting for less than 50% of the total variability in the unemployment rate for those two regions) while they appear to be relatively important for QLD, SA and TAS (accounting for more than 60% of the total variability in the unemployment rate for those three regions).

NATIONAL AND REGIONAL EQUILIBRIUM UNEMPLOYMENT RATES

The implied national equilibrium unemployment rate for each year calculated as the weighted average of the state and territory equilibrium rates using equation (5) is displayed in Figure 5 (this is the middle line in the figure) along with the actual national rate of unemployment over the period (the upper line in the figure).

[FIGURE 5 NEAR HERE]

Figure 5 shows that the (national) equilibrium rate of unemployment has not been constant over the period; it trended downwards throughout but jumped upwards at the time of the recession of the early 90s before resuming its downward path as the recovery took hold.[24]

The results in Table 2 show the significance of the regional coefficients. To illustrate the importance of regional diversity, Figure 5 also includes the implied national equilibrium unemployment rate based on assuming (i) no regional differences in the intercept terms α, (ii) no regional differences in the slope terms β and (iii) no regional differences in the loading terms δ. The implied national equilibrium rate when all parameters were constrained to be the same (in other words, making no allowance for regional diversity) is the lowermost line in the figure. Allowing for diversity in regional labour markets yields a higher value of the national equilibrium rate. This is important from a policy point of view in that recognition of regional diversity will result in a less aggressive (less expansionary) monetary policy stance compared with the case where

[24] Our series for the equilibrium rate of unemployment for the nation closely resembles that recently reported by KENNEDY (et al) (2008) whose estimates are based on aggregate unemployment and vacancy data.

the national equilibrium rate is thought to be much lower than the weighted sum of the regional equilibrium rates would suggest.

It is also our view that it is the weighted sum of (diverse) regional equilibrium rates, or some other "national" equilibrium rate series - a series constructed on the basis of common shocks or common trends, that should be the basis for national policy and not an 'aggregate series' which is not constructed so as to explicitly capture regional diversity. 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 and territories'. One way to identify these is to proceed as we have and use a technique which will identify the common shifts in state and territory Beveridge curves in Australia over time.

Another way to assess the significance, if not also the costs, of differences in the equilibrium rates of unemployment across regions is to construct a measure analogous to the concept of 'mismatch' often applied to assess the level of structural unemployment. JACKMAN and ROPER (1987) write that there is mismatch if "it would be possible to reduce unemployment, or more precisely to increase the rate of job hiring, by moving an unemployed worker from one [region] to another" (JACKMAN and ROPER (1987, p 11). Their measure is a measure of the number of workers who would have to be moved from one region to another to ensure that the ratio of unemployment to vacancies is the same across regions. We adapt their measure to gauge the implication of mis-calculating the rate of unemployment.

We define 'equilibrium structural or mismatch unemployment' (S^*) in terms of equilibrium unemployment rates

$$S_t^* = \frac{1}{2}\sum_i \left|(u_{it}^* - u_t^{a*})L_{it}\right| \tag{13}$$

The term S^* shows the total number who would be unemployed in the regions if all regions were to have the same equilibrium unemployment rate as the nation while at the same time allowing them to differ in the size of their labour force. This term will be zero if there is no mismatch or 'structural mis-allocation'. Figure 6 shows the number of "mismatches" in total for the alternative national equilibrium rates mentioned above –

allowing for regional differences (the upper line) and not allowing for regional differences (the lower line).

[FIGURE 6 NEAR HERE]

Regional disequilibria.

Up to this point in the discussion of the results we have focussed on the equilibrium rate of unemployment in each region and in the nation as a whole. However, in the context of demand management policy (especially) it is appropriate to ask if the time paths of *disequilibrium* unemployment across the regions (ie the time paths of $u_{it} - u_{it}^{*}$) have much in common (and in particular are they positively related) and also to seek to explain any commonality.

Table 4 gives the (contemporaneous) correlation matrix of the unemployment disequilibria components (ie $u_{it} - u_{it}^{*}$) for each pair of regions. Those correlations which are significantly different from zero at the 5% level are printed in italics. The number of negative correlations is striking (about 1/4 of the total) as are the number of correlations which are not significantly different from zero (also about 1/4 of the total). The number of significant negative correlations (6) is especially of concern (indeed, just over 1/3 of all of the significant correlation coefficients are negative) as it suggests that national demand management or other stabilization policy will likely have contrary effects on different regions. On the other hand it suggests consideration be given to the explicit formulation of regional policy (and regionally differentiated policy), something which at present is almost completely absent in Australia. Another implication of our findings is that the current highly popular notion that Australia is a two-track economy with the northern and western regions (WA & QLD especially) making up one ‘economy’ and the southern and the eastern regions (NSW and VIC especially) making up a second ‘economy’ is too simplistic and an inappropriate guide to policy (short run policy at least). There are no significant negative correlations involving WA and QLD on the one hand and NSW and VIC on the other.

Explaining regional co-movements

Many authors have looked at the co-movement of regional series and wondered if common cycles can be explained by similarity of industry composition, the distance between regions in geographic space, whether or not they share a common border (or if there is a national border), and their size. Examples include CLARK and WINCOOP (2001), BARRIOS and DE LUCIO (2003), BARRIOS et al (2003), BEINE and COULOMBE (2003), IMBS (2004), BELKE and HEINE (2006), MONTOYA and DE HAAN (2008), PONCET and BARTHELEMY (2008) and ANDRESEN (2010). Almost all of this research has been concerned either with comparisons between regions in Canada and the USA, European regions and regions in the USA or with comparisons between regions in Europe before and after EMU. While most authors find a role for such factors as the size of regions, "the existing evidence seems to suggest a rather limited role for a region's industry structure in explaining its employment growth [ie co-movements in employment or output growth]" (BELKE and HEINE, 2006, p 91). It is thus of particular interest to consider the role of industry structure in explaining co-movements in disequilibrium (or demand deficient) unemployment rates.

We turn now to see if we can explain the co-movements of the regional business cycle (given in Table 6). In addition to industrial structure, researchers have typically included the distance between regions in geographic space, whether or not they share a common border, and their size in explanatory regressions. In this study we will include as explanatory variables, the following:

Krugman index of dissimilarity in industrial structure (KI): This is a measure which is commonly used in the literature.[25] Suppose we have data for (say) employment in *i* *i*ndustries[26] and we want to compare two regions, region A and region B, then the Krugman index would be calculated as:

---

[25] See KRUGMAN (1991, p 75f and 1993, p 250f). The Krugman measure is related to a measure with a long history in regional studies called the 'Coefficient of Regional Specialisation' (see ISARD (1960), p 270ff) and DIXON and THIRLWALL (1975, p 16f)). CLARK and WINCOOP (2001), BARRIOS et al (2003), BARRIOS and DE LUCIO (2003), IMBS (2004), BELKE and HEINE (2006) and PONCET and BARTHELEMY (2008) provide examples of the use of this variable in the context of studying regional co-movements.

[26] Data for employment by industry is available for 53 industries covering all sectors in the economy. We use the average value of KI for each pair of regions over our sample period. This gives essentially the same results as we obtain if we use the values of the KI for the middle year of our sample period (1993).

$$KI_{AB} = \sum_i \left| \left(X_{iA} / X_A \right) - \left(X_{iB} / X_B \right) \right|$$

where employment in a particular industry in region A is X_{iA}, employment in the same industry in region B is X_{iB},, total employment in all industries in region A is X_A, and total employment in all industries in region B is X_B. It is in the nature of the Krugman index that it will always lie between the values of 0 (indicating that the two distributions are the same) and 2 (where the two distributions have nothing in common). Because the index is higher the more dissimilar the two distributions, the index is sometimes said to be an "Index of Dissimilarity". Since we would expect synchronicity of disequilibrium unemployment to be greater the greater is the similarity in the region's industrial structures, we would expect synchronicity to be negatively related to the Krugman Index.

'Adjacency': This is a dummy variable which takes on a value of 1 if the two regions share a border and 0 if they do not.[27] As an alternative to adjacency we also use a variable, *Distance:* This is measured as the natural log of the geographic distance between capital cities in kilometers. In the case of TAS we have summed the distance between TAS to VIC and the distance between VIC and the other region. We would expect synchronicity to be positively related to the presence of a shared border (adjacency) and negatively related to distance.

Size: This is measured as the sum of the natural log of the populations of the two regions in the middle year of our sample period.[28] We would expect synchronicity to be positively related to size, not least because the larger the size the greater the likelihood that the two regions will have the same central place functions including insurance, finance, restaurants & accommodation and other service industries.

---

[27] TAS (a large island to the south of VIC) is separated from VIC by Bass Strait which is around 250 km wide. Since there is considerable sea and air traffic between TAS and VIC (and much less direct sea or air traffic between TAS and other states) we have recorded TAS as being adjacent to (having border) with VIC but not being adjacent to any other state. In terms of climate etc TAS is more like VIC than any other state.

[28] CLARK and WINCOOP (2001), BARRIOS and DE LUCIO (2003) and IMBS (2004) provide examples of the use of this variable in the context of studying regional co-movements. It clearly has its origin in the gravity model of trade and other regional interactions.

Gravity (GRAV): To overcome multi-collinearity between size and distance we also use as an explanatory variable the traditional gravity measure, ie the logarithm of the product of the two populations divided by the distance between them squared.

The results obtained by regressing the pair-wise correlations of the unemployment disequilibria (*PC*) given in Table 4 on *KI* and *GRAV* as explanatory variables are set out below. Since the dependent variable is itself a sample estimate, WHITE's (1980) correction for heteroskedasticity has been applied in each case. The figures in parentheses are p-values.[29]

$$PC_{AB} = 1.2673 - 0.9520KI + 0.0485GRAV$$
$$(0.001) \quad (0.020) \quad (0.064)$$

We find that cross-region correlations (ie synchronicity) are higher the more similar are the industry structures[30] (recall that the KI is an index of *dis*similarity) and that they are higher the higher the Gravity measure, in other words synchronisation or 'regional co-movements' appears to be positively related to the size of the two regions and inversely related to the distance between them.[31]

CONCLUDING REMARKS

This paper has proposed a way to obtain estimates of regional and national equilibrium and disequilibrium rates of unemployment which vary over time and across regions from Beverage Curves and the closely related job matching model. At the national level, an estimated latent variable allows changes over time to follow a random walk rather than via the use of time dummy variables. Regional differences are allowed via different weightings on the flow-through from changes in the national trend to the regional response and via time invariant but different parameters for each region's Beverage Curve. The model and our estimates, respectively, allow for and support the a priori

---

[29] A regression with KI and (the logarithms of) size and distance separately yielded essentially the same result for KI and a positive coefficient on Size and a negative coefficient on Distance. However the coefficients on Size and Distance were not significantly different from zero at the 10% level. Since the two variables were highly correlated it was decided to combine them (as explained in the text) into a single Gravity variable. These are the results reported in the text.

[30] DIXON and SHEPHERD (2000) found that Australian states and territories with similar industrial structures also have similar unemployment rates.

[31] Interestingly, we find no role for adjacency (in other words, we find no evidence of an internal border effect) - this is not uncommon in the regional literature.

hypothesis that there is no reason to expect all regions to have the same reaction to common or national shocks to the labour market. The paper highlights the importance of regional diversity in unemployment, both the equilibrium rate and the disequilibrium rate, as determined from a Beverage Curve. This regional variation has some policy implications.

Some key results of estimates of the equilibrium and disequilibrium rates of unemployment derived from our estimates for eight Australian states with quarterly data over the period 1983(4) through 2008(2) are as follows. The estimated latent variable driving region wide or national changes in the rates, and which acts as a proxy index for the intensity of job matching and the job finding rate, explains a general downward trend in the equilibrium unemployment rate nationally and in each of the states interrupted by the recession of the early 1990s and a smaller cyclical down trend in 2001. The common factor (ie the latent variable) is explained by changes in the real GDP growth rate, changes in the long term national unemployment rate, and changes in real expenditure on active labour market programs; but with no significant effects for either the replacement rate or the Lilien index measure of industry structural change. This common or national trend contributes from a low of 18 per cent to a high of 68 per cent of the estimated variation in the regional rate of equilibrium unemployment, with the rest due to idiosyncratic state factors. Quite different equilibrium, and especially disequilibrium, rates of unemployment are estimated for the different states. Of particular interest is the relatively low, and in some cases negative, correlation coefficients for the estimated disequilibrium rates of unemployment across the different states; with the pair-wise correlations higher the more similar are industry structures, the larger the state economies, and the closer they are to each. A weighted average estimate of the national equilibrium unemployment rate from the regional Beverage Curves is higher than the estimate obtained using an aggregate series which does not account for regional differences.

The marked differences across regions in the estimated equilibrium and disequilibrium unemployment rates found for Australian states have important implications for policy options to reduce unemployment. First, they caution on the effectiveness of national policies, including macroeconomic policies, in reducing unemployment and on the sustainable level of unemployment. Second, the importance of state idiosyncratic causes of unemployment raises the potential for regional policies as a part of a broader policy package. While regional initiatives to reduce unemployment play a role in many countries, they have to date not played a significant role in Australia.

DATA APPENDIX

The data for vacancies, unemployment and the labour force by state originates from the Australian Bureau of Statistics and has been obtained from the DX database. The Vacancies data is for persons and is taken 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 the “private & public” series is very highly correlated with the “private” alone series and is therefore preferred as it overcomes the problem of missing observations in the “private” alone series for some states and territories. The data is only available from the December quarter of 1983.[32] Our sample ends in 2008 because the Job Vacancies Survey was not conducted in 2008–09. The May issue of the publication Job Vacancies, Australia (cat. no. 6354.0), released in June 2008, was the final issue for 2008–09. The survey was reinstated in November 2009.

Unemployment and labour force data is taken from the DX ABS Labour 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. We convert both unemployment and vacancy levels to (comparable) rates by deflating both with the same variable (the labour force) - although it is the volatility in the two numerators which dominate each ‘rate’ series.

[32] 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 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.

REFERENCES

ANDRESEN M. (2010) The geography of the Canada-United States border effect, *Regional Studies* **44**, 579-594.

ARMSTRONG H. and TAYLOR J. (2000) *Regional Economics and Policy*, Third edition. Blackwell Publishers, Oxford.

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.

BARRIOS S. and DE LUCIO F. (2003) Economic integration and regional business cycles: evidence from the Iberian regions, *Oxford Bulletin of Economics and Statistics* **65**, 497-515.

BARRIOS B., BRULHART M., ELLIOT R. and SENSIER M. (2003) A tale of two cycles: co-fluctuations between UK regions and the Euro Zone, *The Manchester School* **71**, 265–292.

BEINE M. and COULOMBE S. (2003) Regional perspectives on dollarization in Canada, *Journal of Regional Science* **43**, 541–570.

BELKE A. and HEINE J. (2004) 'Specialisation patterns and the synchronicity of regional employment cycles in Europe' IZA Discussion Paper No. 1439. IZA, Bonn.

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**, 279-297.

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

CLARK T. and VAN WINCOOP E. (2001) Borders and business cycles, *Journal of International Economics* **55**, 59-85.

DIXON R. and FREEBAIRN J. (2009a) Models of labour services and estimates of Australian productivity, *Australian Economic Review* **42**, 131-142.

DIXON R. and FREEBAIRN J. (2009b) Trends in regional specialisation in Australia, *Australasian Journal of Regional Studies* **15**, 281-296.

DIXON R., FREEBAIRN J. and LIM G.C. (2005) An employment equation for Australia, *Economic Record* **81**, 204-214.

DIXON R., FREEBAIRN J. and LIM G.C. (2007) Time-varying equilibrium rates of unemployment: an analysis with Australian data, *Australian Journal of Labour Economics* **10**, 205-225.

DIXON R. and SHEPHERD D. (2000) *Trends and cycles in Australian state and territory unemployment rates*. Department of Economics Working Paper No 730, University of Melbourne, Melbourne.

DIXON R. and THIRLWALL A. (1975) *Regional Growth and Unemployment in the United Kingdom*, Macmillan, London.

FAHRER J. and PEASE A. (1993) The unemployment-vacancy relationship in Australia, *Australian Economic Review* **28**, 43-57.

GORTER C. and VAN OURS J. (1994) Matching unemployment and vacancies in regional labour markets: an empirical analysis for the Netherlands, *Papers in Regional Science* **73**, 153-167.

HANSEN B. (1970) Excess demand, unemployment, vacancies and wages, *Quarterly Journal of Economics* **84**, 1-23.

HOLT C. (1996), Flow analysis of labour markets: origins and policy relevance', in SCHETTKAT R. (Ed) *The Flow Analysis of Labour Markets*, pp. 66-86. Routledge, London.

IMBS J. (2004) Trade, finance, specialisation and synchronization, *Review of Economics and Statistics* **86**, 723–734.

ISARD W. (1960) *Methods of Regional Analysis*, MIT Press, Cambridge, Mass.

JACKMAN R. and ROPER S. (1987) Structural unemployment, *Oxford Bulletin of Economics & Statistics* **49**, 9-36.

JONES D. and MANNING D. (1992) Long term unemployment, hysteresis and the unemployment–vacancy relationship: a regional analysis, *Regional Studies* **26**, 17-29.

KENNEDY S., LUU N. and GOLDBLOOM A. (2008) Examining full employment in Australia using the Phillips and Beveridge curves, *Australian Economic Review* **41**, 286-297.

KRUGMAN P. (1991), *Geography and Trade*, MIT Press, Cambridge, Mass.

KRUGMAN P. (1993) Lessons of Massachusetts for EMU, in TORRES F. and GIAVAZZI F. (Eds) *Adjustment and Growth in the European Monetary Union*, pp. 241-261. Cambridge University Press, Cambridge.

LILIEN D. (1982) Sectoral shifts and cyclical unemployment, *Journal of Political Economy* **90**, 777–793.

MONTOYA L. and DE HAAN J. (2008) Regional business cycle synchronization in Europe?, *International Economics and Economic Policy* **5**,123–137.

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, MIT Press, Cambridge, Mass.

PONCET S. and BARTHELEMY J. (2008) China as a integrated area?, *Journal of Economic Integration* **23**, 896–926.

SAMSON L. (1994) The Beveridge curve and regional disparities in Canada, *Applied Economics* **26**, 937-947.

SHEPHERD D. and DIXON R. (2002) The relationship between regional and national unemployment, *Regional Studies* **36**, 469-480.

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**, 257-276.

WHITE H. (1980) A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity, *Econometrica* **48**, 817-838.

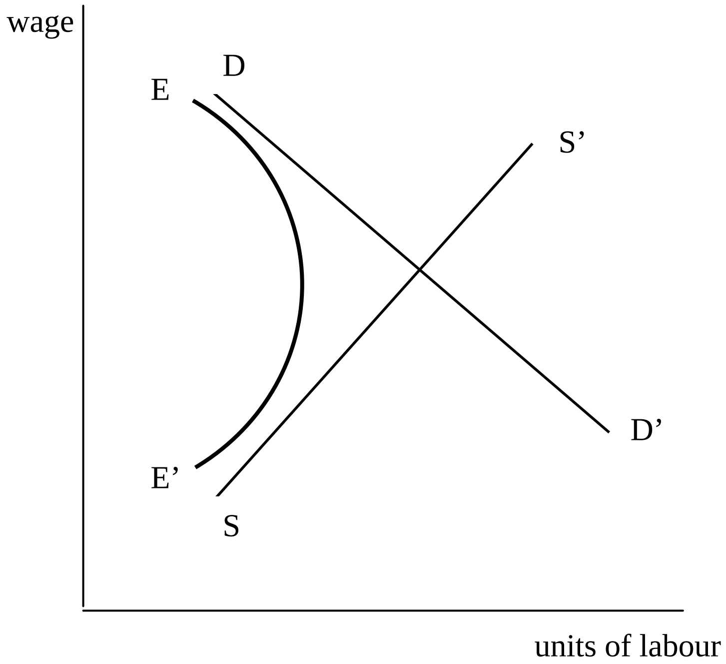


Fig. 1. The labour market

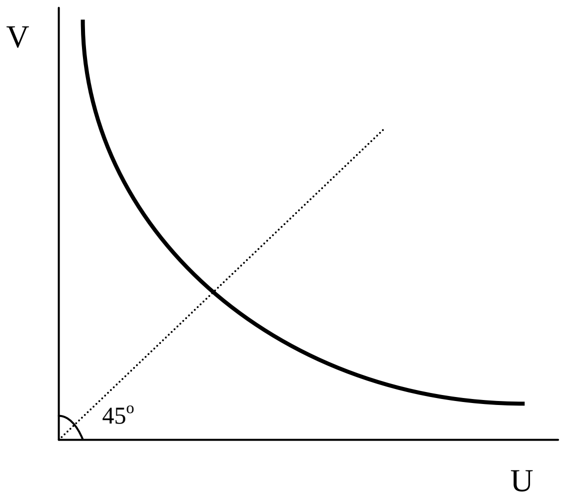


Fig. 2. The Beveridge curve.

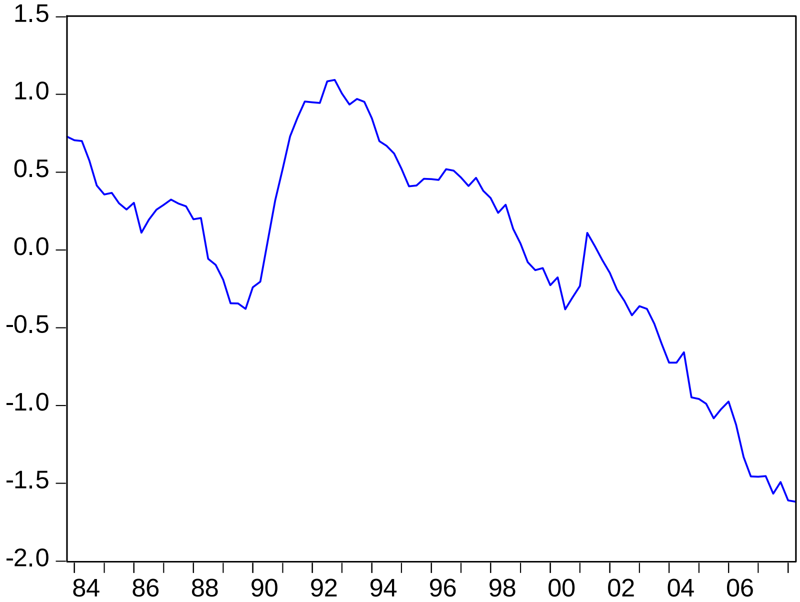
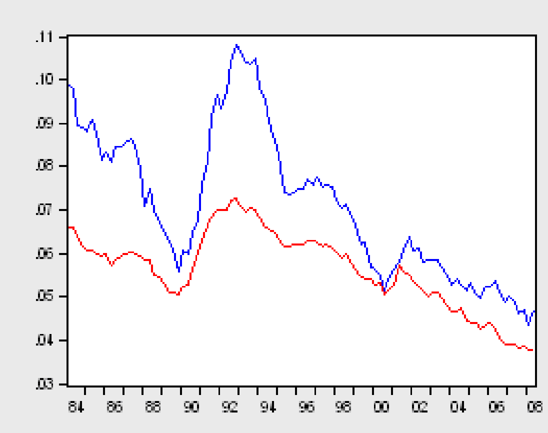
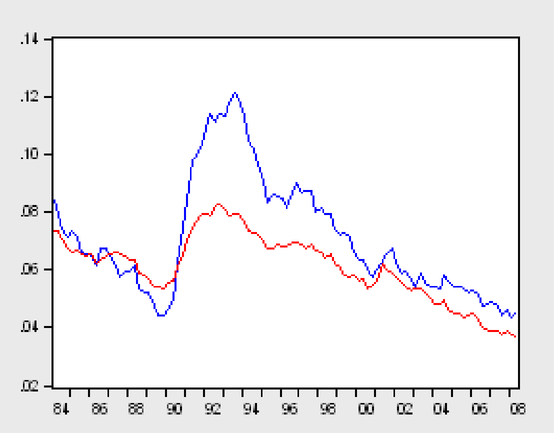


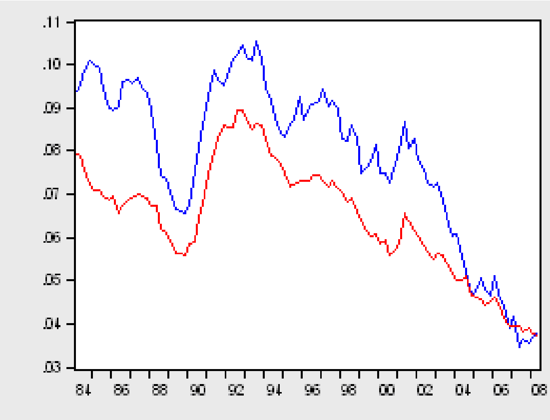
Fig. 3. Evolution of the common factor (F) over time



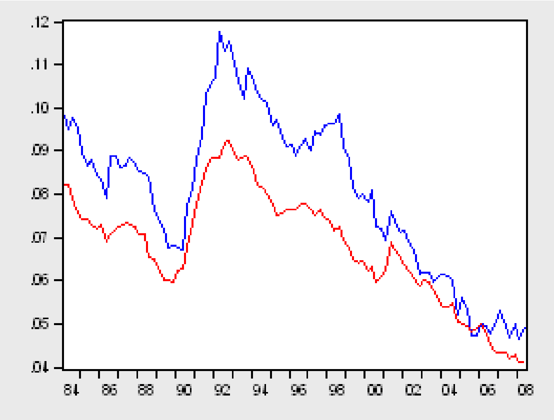
NSW



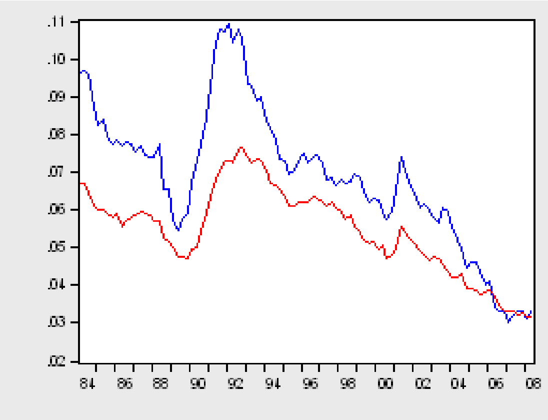
VIC



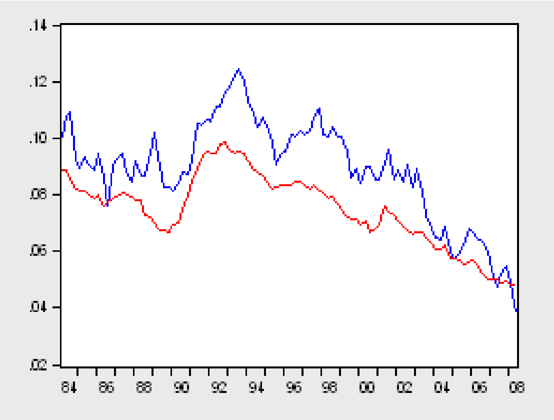
QLD



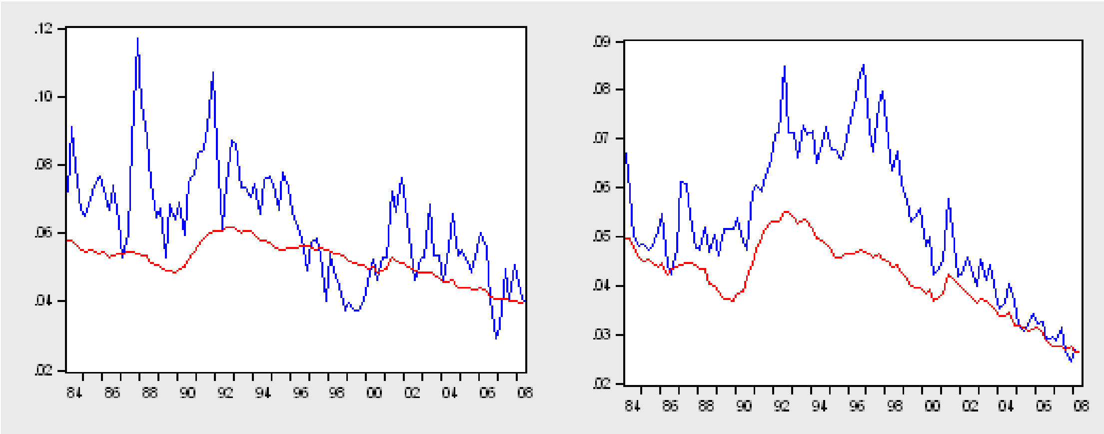
SA



WA



TAS



NT ACT

Fig. 4. Actual unemployment rates (u_{it}*, dark (blue) line) and the 'dynamic' equilibrium unemployment rates (*u^*_{it}*, red (light) line) for each region*

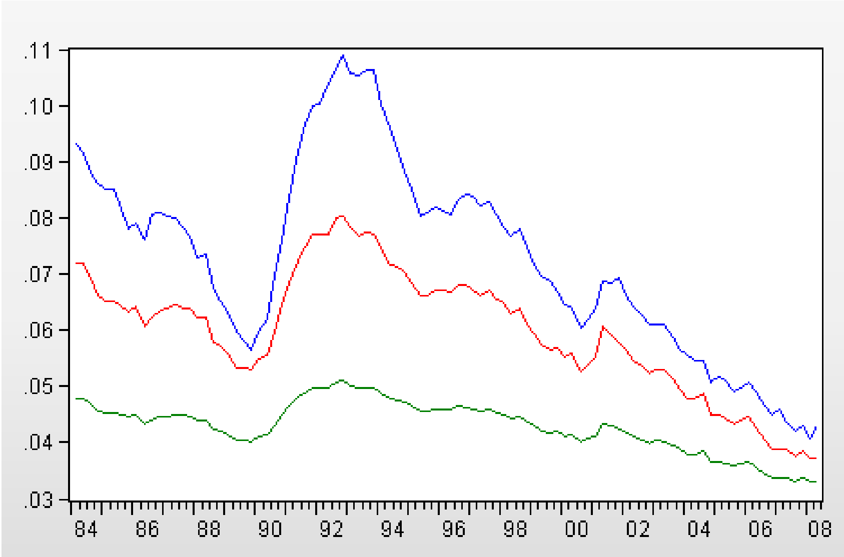


Fig. 5. Actual national unemployment rate (top (blue) line), implied national equilibrium rate which allows for regional differences (middle (red) line) and implied national equilibrium rate which ignores regional differences (bottom (green) line)

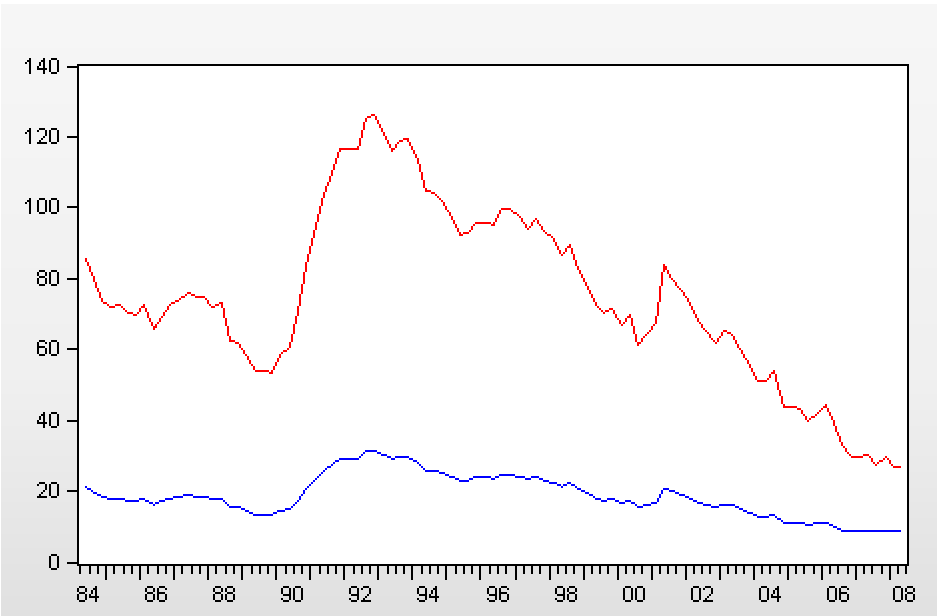


Fig. 6. Number of "mismatches" in total for the alternative national equilibrium rates shown in Figure 5 – allowing for regional differences (top (red) line) and not allowing for regional differences (bottom (blue) line).

Table 1. Panel unit root tests

	ln(*u*)	ln(*v*)
Levin, Lin & Chu test		
Null: Unit Root (assumes common unit root process)	1.2860	1.0278
	(0.9008)	(0.8486)
Im, Pesaran & Shin		
Null: Unit Root (assumes individual unit root process)	1.9492	-0.0146
	(0.9744)	(0.4942)

Note: The values in parenthesis are the p-values.

Table 2. Estimated coefficients: equation (2)

	Coefficient	p-value
Intercepts (α_i)		
NSW	-3.25737	0.000
VIC	-3.01025	0.000
QLD	-3.01399	0.000
SA	-2.8943	0.000
WA	-3.27376	0.000
TAS	-2.78621	0.000
NT	-3.30902	0.000
ACT	-3.84362	0.000
Loadings (δ_i)		
NSW	0.272676	0.000
VIC	0.3134	0.000
QLD	0.3507	0.000
SA	0.3173	0.000
WA	0.3646	0.000
TAS	0.2821	0.000
NT	0.1835	0.000
ACT	0.3249	0.000
Slope (β_i)		0.000
NSW	-0.1269	0.001
VIC	-0.0680	0.000
QLD	-0.0897	0.000
SA	-0.0680	0.000
WA	-0.1163	0.000
TAS	-0.0680	0.000
NT	-0.1163	0.000
ACT	-0.2024	0.000

Note: The standard errors are *Panel Corrected Standard Error* (PCSE); the results were not affected by the method used.

Table 3. Estimates of β, implied estimates for γ, and their associated (95%) Confidence Intervals (CI's)

	Estimated slope (β)	CI for β	Implied estimate of γ	Implied CI for γ
NSW	-0.1268	[-0.1929, -0.0608]	0.8874	[0.8383, 0.9427]
VIC	-0.0679	[-0.1066, -0.0294]	0.9364	[0.9037, 0.9715]
QLD	-0.0896	[-0.1579, -0.0215]	0.9177	[0.8637, 0.9790]
SA	-0.0679	[-0.1066, -0.0294]	0.9364	[0.9037, 0.9715]
WA	-0.1163	[-0.1863, -0.0464]	0.8958	[0.8429, 0.9557]
TAS	-0.0679	[-0.1066, -0.0294]	0.9364	[0.9037, 0.9715]
NT	-0.1163	[-0.1863, -0.0464]	0.8958	[0.8429, 0.9557]
ACT	-0.2023	[-0.2776, -0.1271]	0.8317	[0.7827, 0.8872]

Table 4. Average actual and estimated equilibrium unemployment rates

Region	Mean of Actual Unemployment Rate	Static- Autarkic Equilibrium Rate[1]	Mean of the Dynamic Equilibrium Rate[2]
NSW	0.072	0.056	0.056
VIC	0.071	0.060	0.060
QLD	0.079	0.063	0.063
SA	0.081	0.067	0.067
WA	0.069	0.053	0.053
TAS	0.089	0.074	0.074
NT	0.063	0.052	0.052
ACT	0.053	0.041	0.041

Notes: 1. Calculated using equation (10); 2. Calculated using equation (4)

Table 5. Sum of squares (of the logarithms) of the actual and dynamic equilibrium unemployment rates and the ratio of the second to the first

Region	Actual Unemployment Rate over time	Dynamic Equilibrium Rate over time	Ratio
NSW	5.5747	2.7658	0.4961
VIC	7.4376	4.0684	0.5470
QLD	8.2060	4.8915	0.5961
SA	6.1468	4.1707	0.6785
WA	9.3617	5.0396	0.5383
TAS	5.1389	3.2951	0.6412
NT	6.9309	1.2766	0.1842
ACT	9.0931	3.4491	0.3793

Table 6: (Contemporaneous) Correlation matrix of the unemployment disequilibrium components (ie $u_{it} - u_{it}^{*}$) for each pair of regions

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
NSW	1.000							
VIC	*0.410*	1.000						
QLD	*0.404*	0.102	1.000					
SA	*0.521*	*0.567*	*0.606*	1.000				
WA	*0.484*	*0.241*	*0.645*	*0.492*	1.000			
TAS	0.186	*0.384*	*0.489*	*0.601*	*0.255*	1.000		
NT	0.094	*-0.326*	-0.085	*-0.295*	0.186	*-0.414*	1.000	
ACT	-0.189	*0.316*	0.037	*0.350*	*-0.199*	*0.423*	*-0.554*	1.000

Note: Correlations which are significantly different from zero at the 5% level are printed in italics.