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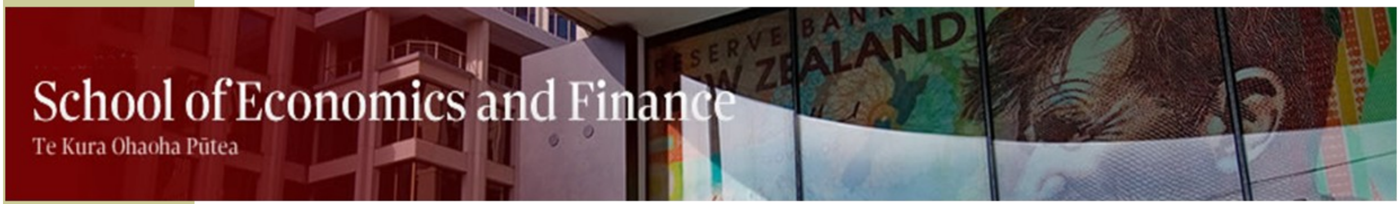

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An unobserved components common cycle for Australasia? Implications for a common currency

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An unobserved components common cycle for Australasia? Implications for a common currency*

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Abstract

We use unobserved components methodology to establish an Australasian common cycle, and assess the extent to which region-specific cycles of Australian States and New Zealand are additionally important.

West Australian and New Zealand region-specific growth cycles have exhibited distinctively different features, relative to the common cycle. For every Australasian region, the region-specific cycle variance dominates that of the common cycle, in contrast to findings for U.S. BEA regions and prior work for Australian States.

The distinctiveness of New Zealand's output and employment cycles is consistent with New Zealand retaining the flexibility of a separate currency and monetary policy, for periods when significant region-specific shocks occur.

JEL Classification: C32; E32; E52; F36; R11

Keywords: Australasian common cycle; regional cycles; Unobserved components; common currency; New Zealand; Australia

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An unobserved components common cycle for Australasia? Implications for a common currency

1. Introduction

There is ongoing interest in the degree of success of existing common currency areas, and in whether other groups of countries should adopt some form of common currency arrangement. In both contexts[1], major macroeconomic issues have to be addressed. This is especially so for small open economies, where key issues include the extent to which the countries face asymmetric shocks from time-to-time, and the adjustment mechanisms that countries can use to respond to domestic and external sourced shocks[2]. Moreover, particularly relevant to the latter is the extent to which the small open economy should maintain an independent currency and retain the ability to conduct its own monetary policy, and the extent to which flexible labour markets and appropriate fiscal policies can contribute towards successful adjustments. As noted by Kouparitsas (2001), regions that have similar business cycles are regions for which a common monetary policy could be optimal. It is in this spirit that our paper focuses on the question of how similar (or otherwise) business cycles are in the regions of Australasia.

Research into the implications of macroeconomic-based issues has evolved in different ways for different sets of countries. For the Euro area for example, the traditional optimum currency area (OCA) literature has featured potential gains from microeconomic efficiencies and international trade, set against potential macroeconomic costs associated with inabilities to adjust to asymmetric shocks (Mundell, 1961; McKinnon, 1963; Kenen, 1969). That literature was subsequently extended to reflect major financial market developments and evolving international trade patterns, and more recently a major focus has been on the extent to which endogeneities of OCAs might *ex post* be able to help provide sufficiently flexible adjustments to shocks (e.g. Frankel and Rose, 1998; De Grauwe and Mongelli, 2005).

For studies relating to the U.S., an important line of investigation has been whether movements in U.S. regional cycles and regional cyclical asymmetries have historically been consistent with the U.S. cycle and hence its single currency (e.g. Kouparitsas, 2001, 2002; Partridge and Rickman, 2005). A second, more recent focus has been on the extent to which U.S. State asymmetries have changed over time, and hence might have conditioned the degree of effectiveness of the single currency in satisfying OCA conditions during certain periods (Partridge and Rickman, 2005).

In an Australasian context, Hunt (2005, p 27) has concluded that "…the case for and against a common currency union remains an open issue from an economic perspective." Material contributions of a macroeconomic nature to this and subsequent judgements have focussed on the extent to which region-specific and industry-specific shocks have been dominant factors

[1] Political and microeconomic aspects, and potentially different steady state real economic activity, are not addressed in this paper. For New Zealand, an assessment of a wide range of microeconomic and macroeconomic issues and evidence has been presented in Hunt (2005). On the issue of potential structural change and possible alternative steady state underpinnings, the NZIER (2009, p iii) reports from an input-output study covering 53 years that " … structural change takes a very long time to work through an economy, even when conditions for economic transformation are conducive ... History tells us that our economic structure will not look hugely different in 10 years' time to how it looks now."

[2] Reference to a comprehensive range of adjustment mechanisms can be found in Hunt (2005) and in Grimes (2007, s 5).

in Australasian regional cycle movements (Grimes, 2005, 2006; Norman and Walker, 2007[3]), and the extent to which NZDAUD and NZDUSD exchange rate and interest rate movements might have conditioned output and employment cycle movements (Drew et al., 2004; Hall and Huang, 2004; Grimes, 2007). The roles of monetary policy decisions and monetary policy transmission mechanism adjustments (Haug et al., 2003; Björksten et al., 2004) have also been investigated. This body of literature has thrown substantial but far from complete light on (i) the nature of Australasia's national and regional output and employment cycles, (ii) the extent to which the floating NZDAUD exchange rate has had a primarily buffering or amplifying role following economic shocks, and (iii) the extent to which NZ, Australian and U.S. monetary policies have been broadly similar or dissimilar, may have thereby provided valuable adjustment mechanisms, and may have revealed that further work would be necessary to establish the extent to which effective labour market and fiscal policy adjustment mechanisms might additionally be needed.[4]

The specific contributions of this paper are therefore (i) to use unobserved components methodology to establish a representative real output-based common cycle for Australian States and NZ[5]; (ii) to assess the extent to which Australian State and NZ region-specific (idiosyncratic) cycles have been additionally important[6], and have varied over time; and (iii) to draw implications for whether NZ cycles and cyclical responses are consistent or inconsistent with NZ joining a common Australasian currency. The latter implications are subject to the usual qualification that our real economic activity-based parameters are not materially different from those that might have been estimated from a lengthy period of New Zealand and all Australian States having operated under a common currency and monetary policy regime.

The specific questions we address are: (i) is there a representative Australasian common cycle, consistent with well-accepted trend regional growth rates?; (ii) what are the corresponding idiosyncratic cycles?; (iii) how sensitive is each region's overall cycle to the common cycle?; (iv) is there a distinct role for region-specific cycles, and are there related groups of these cycles?[7]; (v) what are the relative contributions of the common and idiosyncratic cycles to each region's overall cycle, and have these varied considerably over time? (vi) what are the responses of regional activity to common shocks, and what role do spillover effects from one region to another play?; (vii) are our model-related findings materially different from those reported for the U.S. by Kouparitsas (2002), for Australia by Norman and Walker (2007), and for Australasia by Grimes (2005, 2006, 2007)?; (viii) does it matter whether output or employment data are used?; and (ix) what are the implications of these macroeconomic results for an Australasian common currency, relative to findings

[3] Norman and Walker (2007) investigated Australian State real aggregate activity cycles, but did not address implications for common currency issues.
[4] In an Australasian common currency context, labour market and fiscal policy adjustment mechanisms have received relatively little attention.
[5] The majority of regional studies including New Zealand have investigated *employment* cycles.
[6] Our analysis does not include the roles of the Australian Capital Territory (ACT) and the Northern Territory (NT), nor does it assess industry structure effects. On these issues, see Grimes (2005, 2006). Using cycles in employment data for the period 1985q4 to 2002q4, Grimes (2006, p 23) establishes that only the ACT, through its predominant central government influence, has a material industry structure effect. The cycles for all other regions differ considerably from the aggregate, due to region-specific cycle movements associated with region-specific shocks. Grimes (2005, p 385) also concluded that the ACT and NT could not be considered core Australasian regions in cyclical terms.
[7] In this paper, we do not address explicitly the question of what specific factors might drive the idiosyncratic cycles. For work on specific factors that might drive New Zealand growth cycles, see Hall and McDermott (2011), Dungey and Fry (2009).

reported in Grimes (2005, 2006, 2007), in Hall (2005), in Drew et al. (2004), and in Björksten et al.(2004)?

Our unobserved components (UC) approach is similar to that of Watson and Engle (1983), Kouparitsas (2001, 2002), Norman and Walker (2007), and Hall and McDermott (2010). A particular attraction of this unobserved components approach, as emphasised by Gerlach and Yiu (2004), is that it allows simultaneous estimation of trend growth rates and construction of confidence bands for the model's parameters[8].

Data description and a brief perspective on bivariate co-movements are presented in section 2. Section 3 provides the specification of our UC Model. Empirical results and their implications are assessed in section 4. Section 5 concludes.

2. Business Cycle Fluctuations in Australasia – An Initial Perspective

To provide an initial perspective on business cycle fluctuations in Australasia we report bivariate correlation coefficient measures for growth cycles obtained from using the well-known Hodrick-Prescott (HP) (1997) filter[9]. The data we use are quarterly logarithms of NZ real GDP and real state final demand (SFD) for the five largest Australian states: New South Wales, Victoria, Queensland, Western Australia and South Australia[10]. The sample period used is 1985q3 to 2007q4. For the remainder of the paper we will refer to this GDP and SFD data as regional economic activity.

In Panel A of Table 1, measures for contemporaneous regional cycle co-movements over the full sample period are reported. The strongest co-movements involve Australia's three largest states, NSW, Victoria and Queensland; and between them New Zealand and Western Australia have the majority of lowest associations with other regions' economic activity.

It is important to know whether these patterns of co-movements are sustained over sub-periods, given the substantial reforms and shocks over the full sample period. New Zealand initiated major microeconomic and macroeconomic reforms between 1985 and 1991, Australia subsequently undertook significant reforms, and both countries were affected by large external and internal shocks to their economies. Following Norman and Walker (2007,

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[8] Alternative multiple equation approaches were considered. These included the possibility of some form of VAR approach (Grimes (2007), a dynamic factor model (Kose et al., 2003), and a common trends/common cycles approach (Carlino and Sill, 2001; Vahid and Engle, 2003; Engle and Kozicki 1993). The modest size of our data set ruled out the use of dynamic factor methodology. A common trends/common cycles approach could be considered for subsequent research.

[9] Similar results were obtained from using the band-pass filter method made popular by Baxter and King (1999).

[10] New Zealand real GDP is sourced from *Statistics New Zealand*, and SFD from *Datastream*. We also conducted our analysis with the National Bank of New Zealand's aggregate economic activity index instead of real GDP. Results were consistent with those presented here for real GDP. We have not incorporated the SFD data available for Tasmania, partly due to a number of substantial spikes in the Tasmanian SFD series, but also because estimating 18 fewer parameters allowed us to compute more robust standard errors for the remaining 68 parameters. We have also not generated results using Australian Gross State Product (GSP) output data. These somewhat broader data, which could additionally reflect net international trade, are not available on a quarterly basis, and are only consistently available on an annual basis from 1989-90. Norman and Walker (2004) report comparative results for Australian States incorporating Chow-Lin temporally disaggregated quarterly data and SFD data (in combination with hours-worked employment data), and conclude (p 24) that " .. replacing SFD with our own constructed estimates of … GSP … produced qualitatively very similar results to those from the SFD-hours worked model."

p 368, fn 13), we use 1994q4/1995q1 as the break point for our illustrative sub-periods. Results are presented in Panel B. The co-movements amongst NSW, Victoria and Queensland are strong over both sub-periods. But it is surprising, given the strong business cycle expansions enjoyed by both Australia and New Zealand over the past decade, that the contemporaneous co-movements involving all other regions are consistently weaker over 1995q1 to 2007q4, relative to the period 1985q3 to 1994q4[11].

A bivariate perspective on persistence and lead/lag relations over the full sample can be obtained from the correlation coefficients presented in Panel C. The coefficients on the diagonal of the table show the persistence of regional fluctuations. The estimates range from around 0.60 in South Australia and Queensland to 0.82 in New Zealand, reflecting material short-term persistence in all the regional business cycles. In contrast, the coefficient estimates for the off-diagonal elements are lower than those on the diagonal, except for activity in NSW leading that in Victoria (0.66) and in Queensland (0.65).

The overall impression from these bivariate correlations is therefore that the three largest Australian states have moved together relatively strongly, that this is consistent with their being core regions of an Australasian cycle, and that the business cycles of the other regions would appear to belong to the periphery of any common currency area at best.

However, while these preliminary bivariate results are suggestive, they cannot be used in isolation to assess the specific questions posed in section 1. For that we need to use a structural model that can be used to identify regional responses to common and region-specific shocks. It would also seem important that this model should allow for appropriate break points in the data series.

3. Specification of Unobserved Components Model

To estimate the hypothetical common business cycle of Australasia we use an unobserved components model, specifically the dynamic multiple indicator multiple causes (DYMIMIC) model. Such models have the dual advantage of allowing us to specify the trend and cycle components of time series data in a flexible manner, and to use a range of diagnostic tools to assess the robustness of the estimated cycle.

Further, in order to estimate the business cycles for each of the six largest regions of Australasia, as well as an Australasian business cycle, we employ a multivariate version of the unobserved components model. This type of model has been used by Kouparitsas (2001 and 2002) to study regional business cycles in the United States, and by Norman and Walker (2007) to study state business cycles in Australia. It has also been used by Hall and McDermott (2011) to establish a New Zealand common cycle from regional economic activity data, to assess the extent to which the region-specific cycles are additionally important, and to assess the extent to which exogenous shocks can affect the common cycle and lead to regional spillover effects.

[11] An exception is the somewhat higher, relatively weak correlation involving New Zealand and South Australia (0.5 greater than 0.2). The New South Wales–Victoria correlation remained around 0.7.

Let y_{it} be the log of economic activity in region i, and let τ_{it} and c_{it} be the region specific trend and cycle unobserved components to be estimated.

$$y_{it} = \tau_{it} + c_{it}. \tag{1}$$

The trend component, τ_{it}, can be represented as a process with a unit root and deterministic drift[12]

$$\tau_{it} = \delta_{it} + \tau_{it-1} + \mu_{it} \tag{2}$$

The drift term, δ_{it}, captures the trend growth rate of economic activity in region i at time t; μ_{it} is the innovation to the trend of region i's activity at time t and is assumed to be an independent normal random variable with mean zero and variance $\sigma^2_{\mu i}$; the innovations, μ_{it}, are assumed to be orthogonal for all t. If $\sigma^2_{\mu i}$ were to be 0, then τ_{it} would be a linear trend. It can also be noted that for most regions in our sample, $\sigma^2_{\mu i}$ is very small. This implies that our trend component is much closer to a time trend than would typically be estimated in a univariate setting, such as when a Hodrick-Prescott (HP) filter is used.

Kouparitsas (2002), Norman and Walker (2007), and Hall and McDermott (2011) all found it necessary to allow for breaks in the trend growth rate, to reflect structural changes in their economies. We also find it necessary to allow for break points in economic activity, and as explained below we introduce this flexibility by adopting the break in the trend growth rates at 1994q4/1995q1.

The cyclical component for region i is assumed to be composed of a common cycle across regions, x_{nt}, and a regional cycle, x_{it}

$$c_{it} = \gamma_i x_{nt} + x_{it} \tag{3}$$

where the parameter γ_i reflects the sensitivity of the response of activity in region i to the common cycle. Each region's response to the common cycle will therefore be identical in timing and shape but different in amplitude.

We allow for the dynamics of the *common* cycle to be captured by an autoregressive process of order two[13], with autoregressive coefficients ρ_1 and ρ_2. The innovation to the common cyclical component, ε_{nt}, is assumed to be an independent normal random variable with mean zero and variance σ^2_n:

$$x_{nt} = \rho_1 x_{nt-1} + \rho_2 x_{nt-2} + \varepsilon_{nt}. \tag{4}$$

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[12] The Augmented Dickey-Fuller test (with a constant and a time trend) indicates that the log-levels of regional economic activity for all 7 regions contain a unit root. The unit root tests are rejected for the first difference of the log-level of economic activity. We therefore conclude that the log-level of the regional activity is difference stationary.

[13] As, for example, specified and estimated in Kouparitsas (2002), who followed Watson's (1986) specification for the U.S. aggregate cycle. An AR(2) specification allows for the theoretical possibility of endogenous cyclical behaviour. That said, rarely do estimated parameters for AR(2) models of activity data ever produce endogenous cyclical behaviour.

The dynamics of the *regional* cycles are assumed to follow a first-order vector autoregression:

$$X_t = \Phi X_{t-1} + \varepsilon_t \tag{5}$$

where $X_t = [x_{1t}, x_{2t}, ..., x_{6t}]'$, Φ is a 6 by 6 matrix of coefficients and $\varepsilon_t = [\varepsilon_{1t}, \varepsilon_{2t}, ..., \varepsilon_{6t}]'$ is the vector of innovations to the regional cycle, which is assumed to an independent normal random vector with a zero mean and diagonal covariance matrix Λ[14].

The identifying assumptions we have successively imposed can now be summarised as follows. First, μ_{it} and c_{it} are assumed to be uncorrelated at all leads and lags. Secondly, when we converted the model into its state space form we imposed the restriction that all innovations are orthogonal. The implication of this is that while regional shocks are not allowed to spillover to other regions contemporaneously (that is, the variance-covariance of the regional innovations is assumed to be diagonal), the shocks are allowed to spillover after a lag of one quarter. The extent of any spillovers can therefore be identified by examining the off-diagonal elements of the Φ matrix. An added benefit of thinking about regional spillovers in this way is that it allows us to conduct a likelihood ratio test for the null hypothesis of no spillovers in a very simple way. Our third identifying restriction is that the vector measuring the sensitivity to the common cycle, γ, is normalized by setting one of its elements to unity. In all cases, we set the sensitivity of New South Wales to unity.

For estimation purposes it is convenient to re-write the model in its state space form and incorporate explicitly the break in trend. The corresponding measurement equation is

$$\Delta Y_t = \begin{bmatrix} \delta_{85q4,94q4} & \delta_{95q1,07q4} \end{bmatrix} \begin{bmatrix} D_{85q4,94q4} \\ D_{95q1,07q4} \end{bmatrix} + \begin{bmatrix} \gamma & I_{6\times 6} \end{bmatrix} \begin{bmatrix} \Delta x_{nt} \\ \Delta X_t \end{bmatrix} + \mu_t \tag{6}$$

and the transition equation is

$$\begin{bmatrix} x_{nt} \\ X_t \end{bmatrix} = \begin{bmatrix} \rho_1 & 0 \\ 0 & \Phi \end{bmatrix} \begin{bmatrix} x_{nt-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} \rho_2 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_{nt-2} \\ X_{t-2} \end{bmatrix} + \begin{bmatrix} \varepsilon_{nt} \\ \varepsilon_t \end{bmatrix} \tag{7}$$

where $Y_t = [y_{1t}, y_{2t}, ..., y_{6t}]'$, $\delta_{t1,t2} = [\delta_{1t1,t2}, \delta_{2t1.t2}, ..., \delta_{6t1,t2}]'$, $D_{t1,t2}$ is one for $t1 \leq t \leq t2$ and zero for all other t, $\gamma = [\gamma_1, \gamma_2, ..., \gamma_6]'$, $\mu_t = [\mu_{1t}, \mu_{2t}, ..., \mu_{6t}]'$, and I_{6x6} is a 6 by 6 identity matrix.

Estimates for the unknown parameters and the unobservable components of the state space system (6) and (7) can be obtained using maximum likelihood methods and recursive use of the Kalman filter. We use maximum likelihood to estimate the model, with the likelihood

[14] In principle, weakly exogenous or predetermined variables could be appended to both equations (4) and (5). These would be potential drivers of the common and idiosyncratic cycles, respectively. In particular, we have not tested for the extent to which movements in an AUDNZD exchange rate might have affected New Zealand and Australian region-specific cycles. The limited length of the available time series prohibits us from doing this at present. For example, estimating equation (5) with three additional weakly exogenous variables would use up 18 degrees of freedom.

being evaluated using the Kalman filter. Details of the recursive Expectation Maximization (EM) algorithm used in our estimation can be found in Watson and Engle (1983).[15]

4. Empirical Results

As illustrated in equation (6) above, a key factor underlying the empirical results which follow is the necessity to allow for the most appropriate structural break point or points in the trend regional growth rates. This was necessary because if no break is assumed, then the estimated common cycle from the model is not stationary[16].

We investigated an extensive range of economically meaningful single break dates common to all regions, in case that might have materially affected our results; also the possibility of an additional break point in common which might reflect an earlier New Zealand break such as 1991q1. Imposing the break at 1994q4, the same date as that determined by Norman and Walker (2007) as the most suitable for the Australian States, provided an economically meaningful Australasian common cycle, region-specific cycles, and associated parameter values.[17] The break date in this vicinity is consistent with Australian Bureau of Statistics' dating of productivity cycles, showing a pick-up in productivity growth in 1993/94 following the 1990 recession (Norman and Walker, 2007, fn 13). Imposing an additional common break point for dates in the vicinity of 1991q1 produced little change in the likelihood value and the corresponding common and region-specific cycles, but trend regional growth rate parameters for Australian States were no longer significant. The results presented and discussed below are therefore those for the single common break at 1994q4/1995q1[18].

4.1 Results from our Unobserved Components Model

Our regional growth cycles are considered initially in the context of their underlying trend growth rates, and then assessed in terms of their common and idiosyncratic cycle components. Consistent with equations (6) and (7), our results are presented for an AR(1) model with a common single break in trend growth rates. A likelihood ratio test showed that the AR(2) specification for the dynamics of the common cycle is rejected in favour of an AR(1) specification, with $\rho_1 = 0.85$.

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[15] For the results which follow, we set the convergence criterion on the log likelihood function at a relatively severe level of 1×10^{-5}. The EM algorithm then took 2,022 iterations to converge.

[16] Additionally, using a standard likelihood ratio test, the hypothesis of no break was rejected in favour of a single common break at 1994q4/1995q1.

[17] All possible single break points in common were considered, excluding the ends of sample dates by the customary 15 per cent. Except for dates in the vicinity of 1994q4/1995q1, the common cycle and/or region-specific cycles were not credible, due either to the estimated common cycle or one or more of the regional cycles having unit roots. Our results are not materially different for single break points in the vicinity of 1994q4.

[18] Our key results are also robust to successively dropping one Australian State at a time, first Western Australia, next Queensland, and then South Australia. The shapes and amplitudes of the successive NZ cycles were not materially different, either individually or relative to the corresponding common cycle. Also, as States were dropped, NZ parameter magnitudes were not materially affected, no phi matrix problems emerged, and spillover coefficients involving NZ remained statistically insignificant. A further robustness check was to see whether specifications involving (i) 4 core Australian States (NSW, Vic, QLD, SA), WA and NZ, and (ii) 3 core Australian States (NSW, Vic, SA), QLD, WA and NZ, materially changed our key results. Here, too, our key results involving WA and NZ were not materially altered.

The trend regional growth rates

The top panel in Table 2 contains estimates of the annualized trend growth rates, δ_{it}[19]. For the states of Australia and for New Zealand, all trend growth rate estimates are significant at least at the 5 per cent level, and there is clear evidence of all these growth rates being materially higher over the second half of the sample.

What is the common cycle, and are the regional cycles sensitive to the common cycle?

The unobserved components model decomposes the regional activity data into region-specific trend components that allow for a break after 1994q4, a common cycle, and region-specific cycles. Figure 1 shows the common cycle and region-specific cycles, expressed as deviations from each region's trend growth rate. The recession of the early 1990s, common to the U.S., Australia and New Zealand, and associated with a global monetary policy tightening, is particularly evident in the cycles of NSW, Victoria, South Australia, and New Zealand.

The regional sensitivities of the response of activity in region *i* to the common cycle, that is the γ_i parameters from (3), are reported in the middle panel of Table 2. The sensitivity is normalized to unity for New South Wales. The point estimates show that Victoria and Queensland display approximately the same sensitivity as NSW[20], and that South Australia displays somewhat lesser sensitivity. However, both Western Australia and New Zealand have markedly lower sensitivities to the common cycle from those of the other Australian States. The respective z-statistics for the hypothesis that $\gamma_i = 1$ are 0.11, 0.10, 0.33, 1.00 and 2.11. Victoria and Queensland do not have significantly different sensitivities, relative to NSW, but New Zealand does so. This sensitivity-coefficient-based evidence is therefore consistent with New Zealand not naturally being part of a core (NSW, Victoria, Queensland) Australian common currency area.

The bottom panel in Table 2 includes the AR(1) parameter from equation (4). This parameter describes the response of the common cycle to a common cyclical shock, and informs us that the half-life of shocks to the common cycle is approximately 5 quarters. The shape of each region's response is forced to be identical and is one of steady decay (see Figure 2). The amplitude of each region's response to a common shock depends additionally, however, on the sensitivity parameter values reported in Table 2. The responses of West Australia and New Zealand are clearly far more muted than those of the other regions.

These multivariate-based sensitivity results therefore reinforce the impression formed from our bivariate correlations. Movements in economic activity in the three largest Australian states of New South Wales, Victoria and Queensland have been consistent with those states

[19] For this model and data set, we are able to present standard errors as well as point estimates. Our standard errors should be treated with some, but not undue, caution, as ideally it seems one needs the number of data observations to be *considerably* greater than the number of parameters to be estimated. If there are insufficient sample observations, problems in computing standard errors occur because the information matrix is not block diagonal (see Watson and Engle, 1983). For example, our running this model with a 6 Australian State-New Zealand data set for the sample period 1986q3 to 2006q2 could not produce estimates for the standard errors. This is because, unlike for the usual method of computing the standard errors, for this model it is necessary to compute the entire information matrix for all the parameters once the parameter estimates have converged. We have also been able to report standard errors for the parameters estimated for the 5-region models for New Zealand, presented in Hall and McDermott (2011).

[20] Both coefficients are significantly different from zero at the 10 per cent level or better.

constituting the core regions of an Australasian common cycle[21], but West Australia and New Zealand could not belong to the core of such a cycle.

Relative contributions of the common and idiosyncratic cycles to each region's total cycle?

An examination of the time paths and amplitudes of the idiosyncratic cycles in Figure 1 shows there is very considerable diversity of cycles across regions. Western Australia has by far the strongest region-specific cycle, suggesting that its cyclical behaviour is not well explained by fluctuations in the common cycle. New Zealand also has a distinctive region-specific cycle through to the late 1990s, but not in the years since then. South Australia has the least distinctive region-specific cycle. The region-specific cycles of NSW and Victoria show considerable similarity of movement.

The importance of idiosyncratic shocks relative to the common cycle can also be assessed by considering the variances of the cyclical components, reported in Table 3. The key message is that for every region, the variance of the idiosyncratic cycle component dominates that of the common cycle. Western Australia's region-specific cycle variance of 28.4 per cent is particularly dominant. It is by far the largest in magnitude, and provides 98 per cent of its overall cycle variance. New Zealand's idiosyncratic variance component is a not inconsiderable 6.2 per cent in magnitude, and this also contributes 98 per cent of its overall cycle variance.

Results in this area therefore reinforce the importance of region-specific cycle influences relative to those of the common cycle, and add further doubt to the existence of an Australasian common cycle that could help underpin the macroeconomic case for an Australasian common currency.

What are the responses of regional activity to common shocks, and what role if any do spillover effects from one region to another play?

For the Φ matrix in equation (5), Table 4 reports the estimated VAR coefficients and their standard errors. The estimates along the diagonal show that there is variation in the autoregressive behaviour across region-specific cycles: very strong autoregression for New Zealand and Victoria, and relatively weaker persistence for New South Wales, Western Australia and Queensland. The off-diagonal values in the sixth row and the sixth column suggest there is very limited spillover of region-specific shocks either to or from New Zealand. All coefficients are very small in magnitude and none are statistically significant. For the Australian states, none of the estimates are significant at the 5 per cent level, but there does seem the possibility of a small number of spillovers involving Western Australia, New South Wales, Queensland and Victoria. To formally test the hypothesis of no spillovers we use a likelihood ratio test, the LR value of which is 92.4[22]. The 1 per cent critical value taken from the asymptotic Chi-squared distribution with 30 degrees of freedom is 50.89, and so the likelihood ratio test of the null of no spillover effect is clearly rejected. The rejection would seem essentially due to spillovers amongst the Australian states mentioned.

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[21] Norman and Walker (2007, pp 360, 373) have also concluded that there are particularly strong links between the cycles of the three largest states.

[22] This test is a simple test of parameter restrictions, reflecting in particular that the off-diagonal elements of the Phi matrix are zero for no spillovers. This test can be handled in the standard manner when maximum likelihood methods are being used.

4.2 Results, relative to those from Kouparitsas (2001), Norman and Walker (2007), and Grimes (2005, 2006)

Kouparitsas (2001, Figure 1) has established a *common cycle* for the U.S. which has turning points that closely match those of the NBER Dating Committee; and Norman and Walker (2007, fn 19 and Figure 4) present a weighted average common cycle for Australia that has a correlation of 0.79 with a Hodrick-Prescott filtered cycle for domestic final demand. We have established an output-based Australasian common cycle, consistent with well-accepted regional growth rate trends, but we know of no sufficiently similar Australasian cycle with which to compare it.

For the U.S., Kouparitsas (2002, p 30) finds that its BEA regions are largely driven by common sources of disturbance and that they have similar responses to a common shock. In a relatively similar vein, Norman and Walker (2007, pp 360, 373) conclude for 6 Australian States that the major source of fluctuations in the states' economic activity is shocks which are common to all States. But their variance analysis (2007, p 371) also shows that each overall state cycle is driven partly by fluctuations specific to that State, in particular for Western Australia. Our unobserved components results show a substantially more distinctive role for *region-specific cycles*, especially for Western Australia and New Zealand. Our variance analysis results, for the relative contributions of the common and idiosyncratic cycle components, differ markedly from those of Kouparitsas, and Norman and Walker. We establish that the region-specific cycle variance dominates that of the common cycle, for all five of our Australian States and for New Zealand. This is especially the case for Western Australia and New Zealand.

Kouparitsas (2001, p 30) concludes that *spillovers* of region-specific shocks to other regions do not contribute a statistically significant share of regional-cycle variation, and Norman and Walker (2007, pp 360, 373) conclude similarly that spillovers of shocks from one Australian State to another seem to play only a minor role. When the role of Australian State shocks potentially affecting New Zealand, and New Zealand-specific shocks potentially affecting Australian States, are examined (section 4.1 above, and Grimes (2005)), there also seems minimal evidence of material spillover effects.

4.3 Does it matter whether output or employment data are used?

A key finding in the work of Grimes (2005, pp 392, 395) was that from 1991 through to 2002, the New Zealand cycle had generally been as correlated with the Australasian cycle and with those of the larger Australian regions, as those Australian regions had been with each other. His finding was derived from bivariate analysis of Australasian employment data for the period 1985q4 to 2002q4.

In the context of the results reported above in section 4.1 for regional output data, Grimes' finding raises two issues for assessment: (i) would the key results from our unobserved components model using output data have been materially different if we had used employment data instead?; and (ii) are our key overall conclusions consistent with the key broad messages and the above specific finding of Grimes?

New Zealand's employment series[23] behaved very differently from the Australian state series, for the period 1986 through till 1992 (Figure 3). Our extensive structural break analysis showed that, in order to establish a stationary common cycle, two break points in the series were required, at 1991q1 and at 1993q4[24].

The unobserved components common cycle we obtain for employment is very similar to the employment growth cycles derived from aggregate Australasian employment data, using Baxter-King and Hodrick-Prescott filters (Figure 4).

A comparison of our Australasian common cycles for output and employment shows that, while there are lengthy periods during which the two common cycles move in the same direction (with the output cycle generally leading the employment cycle), the amplitudes of the employment common cycle have been considerably more damped than those of the common output cycle since the turn of this century. (Figure 5).

The region-specific employment cycles are very different from each other and from the common cycle (Figure 6), reinforcing the key general finding from our output model that Australasian region-specific cycles have a distinct role, relative to the estimated common cycle.

It is also important, particularly in the context of the Partridge and Rickman (2005) finding for the U.S., to assess the extent to which the relationship between the common and idiosyncratic cycles has varied over time. Grimes (2007) found that it is since 1991 that the New Zealand idiosyncratic employment cycle has been closely correlated with the cycle in the larger Australian regions. Our employment cycle movements are similarly closely correlated for the period since 1991 (Figure 6). From our output-based cycles (Figure 1), though, it is only since the *mid- to late*-1990s that a similarly close association has been evident.

4.4 Implications for an Australasian Common Currency

Kouparitsas' (2002, p 30) research provided support to the view that the U.S. is an optimum currency area, and to the notion that a common monetary policy is the ideal choice for the U.S. Essentially, this is based on his eight BEA regional cycles being largely driven by common sources of disturbance to which they have similar responses. However, on the basis of finding that U.S. regional cyclical asymmetries and sychronizations have changed over time, Partridge and Rickman (2005, p 373) concluded that the U.S. was less likely to fit common currency criteria in the 1990s. Assessment of movements over time in key cycle measures would therefore seem important for any implications drawn.

Grimes (2005, pp 380-381, 396; 2006, pp 23-25, 41-42; 2007, pp 248-249) summarises key issues, and important industry structure and macroeconomic implications, which should be

[23] The quarterly seasonally adjusted series for New Zealand were sourced from *Statistics New Zealand*, and those for our five Australian states from *Datastream*.

[24] As was the case for our output data set, we assessed the possibility of imposing no break, one break in common, or two breaks in common. For the no break and single break cases, all results had to be rejected, due to cycle unit roots. It can also be noted that 1991q1 was one of the two break points required for the New Zealand regional output work reported in Hall and McDermott (2011).

assessed if an Australasian common currency were to be considered[25]. In particular, Grimes (2005) established that it is shocks to region-specific cycles rather than industry-specific shocks which have been the dominant factor in Australasian regional cycle movements. An important implication of this is that a further major economic shock to either Australian state or NZ economic activity could lead to New Zealand's idiosyncratic cycle again diverging from that in key Australian regions, and hence require that a separate currency and monetary policy play important roles in adjusting to such shocks[26]. Grimes (2007, pp 248-249) has subsequently concluded that while the NZDAUD cross rate has responded to shocks emanating from both Australia and New Zealand, the dominant response of the NZDAUD has been to NZ-sourced shocks, thereby suggesting that further work on establishing the origins of NZ-sourced shocks could be valuable, as would assessment of alternative adjustment mechanisms[27].

Our unobserved components based findings, particularly those on the distinctiveness of New Zealand's output-based cycles prior to the mid- to late-1990s, and its employment-based cycles prior to the early 1990s are broadly consistent with Grimes emphasis on New Zealand's having the flexibility of a separate currency and monetary policy for when "major economic upheaval" occurs again, in either Australia or New Zealand. In a "major economic upheavals" sense, though, the period from the late 1990s to the end of 2007 has been a relatively benign one for New Zealand.

5. Conclusion

We have established an output-based Australasian common cycle, consistent with well-accepted regional growth rate trends. This required allowing for a break in the trend rates at 1994q4/1995q1.

The associated region-specific cycles exhibit considerable diversity, with the idiosyncratic cycles of Western Australia and New Zealand being particularly distinctive and quite insensitive to a shock to the common cycle.

From variance analysis of the common and idiosyncratic cycle components, it has been established that for the five largest Australian states and for New Zealand, the region-specific cycle variance dominates that of the common cycle. This is especially so for Western Australia and New Zealand. The finding of dominance of the idiosyncratic cycle contribution is in contrast to the findings of Kouparitsas (2002) for U.S. BEA regions, and Norman and Walker (2007) for the six Australian states.

We have also estimated employment-based Australasian common and region-specific cycles, to facilitate assessing our key output-based results relative to the findings of Grimes' (2005). Our comparison of the Australasian common cycles for output and employment shows that there are lengthy periods during which the two common cycles move in the same directions.

[25] See also Hunt (2005), Hall (2005, pp 19-22), and Drew et al. (2004), for conclusions and implications of a macroeconomic nature.
[26] Grimes (2005, p 396) also concludes that the more important loss could be that of exchange rate flexibility, following a New Zealand-specific shock.
[27] For an evaluation of the behaviour of the New Zealand business cycle over a period of nearly 60 years, and the role of major economic shocks, see Hall and McDermott (2009). See also Hall and McDermott (2011) and Dungey and Fry (2009) for recent work evaluating the relative importance of drivers of New Zealand growth cycles.

We further find that the region-specific employment cycles look very different to each other and to the common cycle, reinforcing the key general finding from our output model that Australasian region-specific cycles have a distinct role, relative to the estimated common cycle.

Our *output*-model analysis has shown that New Zealand's idiosyncratic growth cycle has shown little variation since the *late-1990s*, and that for this period NewZealand's cycle has been closely associated with that of the Australasian common cycle. This late-1990s dating of a close association is somewhat later than the year 1991 identified in Grimes (2005) and in our *employment* data-based analysis, and reflects different movements in the output and employment series. The difference in findings would also be consistent with New Zealand's mid-1990s monetary policy tightening having had an importantly different influence on output, and New Zealand's output cycle also having been differentially affected over 1997-98 by the Asian financial crisis and two successive summers of drought.

Conditional on our parameter values providing a reasonable reflection of those that might be estimated for any common currency and monetary policy regime for New Zealand and all Australian States, our findings on the distinctiveness of New Zealand's output cycles prior to the late 1990s are consistent with New Zealand's retaining the flexibility of a separate currency and monetary policy for when "major economic upheaval" occurs again.

New Zealand was fortunate, during the relatively short period from the late 1990s through to the end of 2007, in not having experienced a major international or domestic economic upheaval. But this period of relative stability has been disturbed in a major way since then by the current global financial crisis and subsequent recessionary activity. Accordingly, once sufficient additional data observations are available to reflect this period, it will be necessary to assess further our findings on the variation over time in the New Zealand specific cycle relative to the corresponding Australasian common cycle. The additional data observations might also assist a formal evaluation of the extent to which divergent movements in the NZD and AUD may have been associated with divergences between the NZ cycle and those of the Australian States. Our implications should also be considered in the context of previous and ongoing work on the relative strengths of exchange rate and monetary policy adjustment mechanisms, and adjustments operating through labour market flexibility and fiscal policy.

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Table 1

Regional business cycle comovement and persistence
1985q3 to 2007q4

A. Contemporaneous correlation with Hodrick-Prescott filter

Activity at time t	**Activity at time t**					
	NSW	VIC	QLD	WA	SA	NZ
NSW	1.00					
VIC	0.66	1.00				
QLD	0.59	0.61	1.00			
WA	0.35	0.46	0.46	1.00		
SA	0.49	0.43	0.27	0.23	1.00	
NZ	0.29	0.36	0.33	0.08	0.38	1.00

B. Contemporaneous correlation with Hodrick-Prescott filter
LOWER TRIANGLE period 1985q3 to 1994q4
UPPER TRIANGLE period 1995q1 to 2007q4

Activity at time t	**Activity at time t**					
	NSW	VIC	QLD	WA	SA	NZ
NSW	1	0.68	0.59	0.17	0.33	0.22
VIC	0.67	1.00	0.50	0.13	0.38	0.24
QLD	0.63	0.86	1.00	0.30	0.20	0.29
WA	0.61	0.82	0.81	1.00	0.19	-0.17
SA	0.78	0.51	0.42	0.31	1.00	0.50
NZ	0.37	0.48	0.43	0.42	0.20	1.00

C. Lead/lag correlation with Hodrick-Prescott filter

Activity at time t	**Activity at time t+1**					
	NSW	VIC	QLD	WA	SA	NZ
NSW	0.79	0.46	0.40	0.15	0.35	0.19
VIC	0.66	0.73	0.53	0.43	0.43	0.32
QLD	0.65	0.53	0.60	0.48	0.27	0.27
WA	0.40	0.45	0.48	0.69	0.15	0.04
SA	0.43	0.30	0.27	0.28	0.61	0.21
NZ	0.30	0.31	0.29	0.15	0.42	0.82

Note: Regional economic activity data natural logged and filtered using quarterly business cycle filter described in Hodrick and Prescott (1997) with $\lambda = 1600$ as value for the smoothing parameter.

Table 2. Unobserved Components business cycle parameters
5 Australian States and New Zealand, 1985q4 – 2007q4

Trend Regional Growth Rates, δ_{it} (Annualised)			
Region	**1985q4 – 1994q4**	**1995q2 – 2007q4**	$\sigma_{\mu i}$
New South Wales	2.61	3.46	.0001
	(4.10)	(4.01)	
Victoria	1.73	4.52	.0002
	(2.21)	(3.72)	
Queensland	2.94	5.51	.0003
	(3.53)	(8.86)	
Western Australia	2.86	5.18	.0002
	(1.97)	(3.34)	
South Australia	1.38	3.74	.0005
	(2.22)	(9.51)	
New Zealand	1.52	3.43	.0076
	(2.23)	(3.28)	

Notes: $\sigma_{\mu i}$ is the standard deviation of the innovation to the regional trend; z-statistics in parentheses.

Regional Sensitivity coefficients, γ_i		
New South Wales	1.00	
Victoria	1.08	(2.54)
Queensland	0.95	(1.84)
Western Australia	0.33	(0.50)
South Australia	0.73	(0.78)
New Zealand	0.28	(0.96)

Notes: z-statistics in parentheses.

Common cycle parameters	
Coefficient	**Value**
ρ_1	0.85 (3.19)
σ_n	0.0001

Note: ρ_1 is the AR1 autoregressive coefficient. σ_n is the standard deviation of the common cycle.

Table 3

Variances of Cyclical Components						
Region	**Common cycle**	**Idiosyncratic cycle**	**Covariance of cycles**	**Overall cycle**	**Common/ Overall**	**Idio./ Overall**
	Percentage points				**Percentages**	
New South Wales	1.53	4.89	-1.39	5.03	30.5	97.2
Victoria	1.79	6.35	-1.37	6.76	26.4	93.9
Queensland	1.39	7.05	0.65	9.09	15.3	77.6
Western Australia	0.16	28.53	0.16	28.85	0.6	98.9
South Australia	0.82	4.13	0.26	5.22	15.7	79.1
New Zealand	0.12	6.25	-0.05	6.32	1.9	98.9

Notes: The common variance for each state is $1.53*\gamma_i^2$

Table 4

Φ Matrix, 1985q4 – 2007q4						
Region	**NSW**	**VIC**	**QLD**	**WA**	**SA**	**NZ**
New South Wales	**0.64**	0.32	0.20	-0.06	-0.02	0.03
Victoria	-0.04	**0.93**	-0.06	0.04	-0.10	0.09
Queensland	-0.27	0.08	**0.51**	0.21	0.08	0.05
Western Australia	-0.70	0.38	0.67	**0.62**	0.25	-0.05
South Australia	-0.21	0.27	0.18	-0.10	**0.73**	0.02
New Zealand	-0.15	0.08	-0.01	-0.01	-0.13	**0.96**

Figure 1: The Australasian Common and Region-specific Output Cycles
Deviations from trend

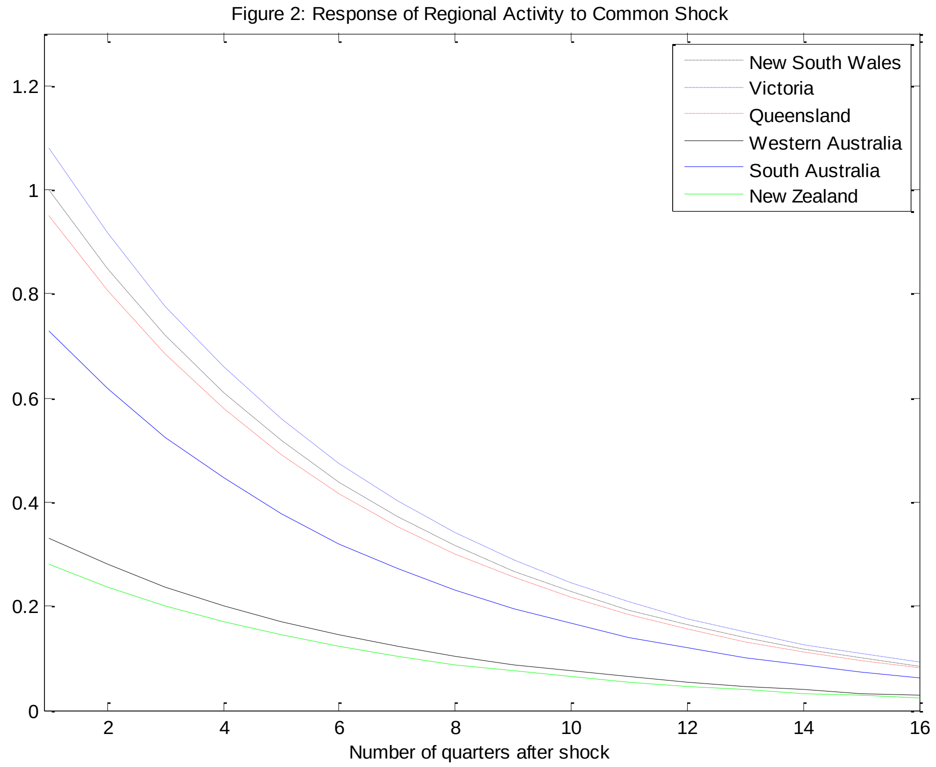
Figure 2: Response of Regional Activity to Common Shock
New South Wales
Victoria
Queensland
Western Australia
South Australia
New Zealand
1.2
1
0.8
0.6
0.4
0.2
0
2
4
6
8
10
12
14
16
Number of quarters after shock

Figure 3: Australasian Employment Growth, 1986q1 – 2007q4
Natural logarithms

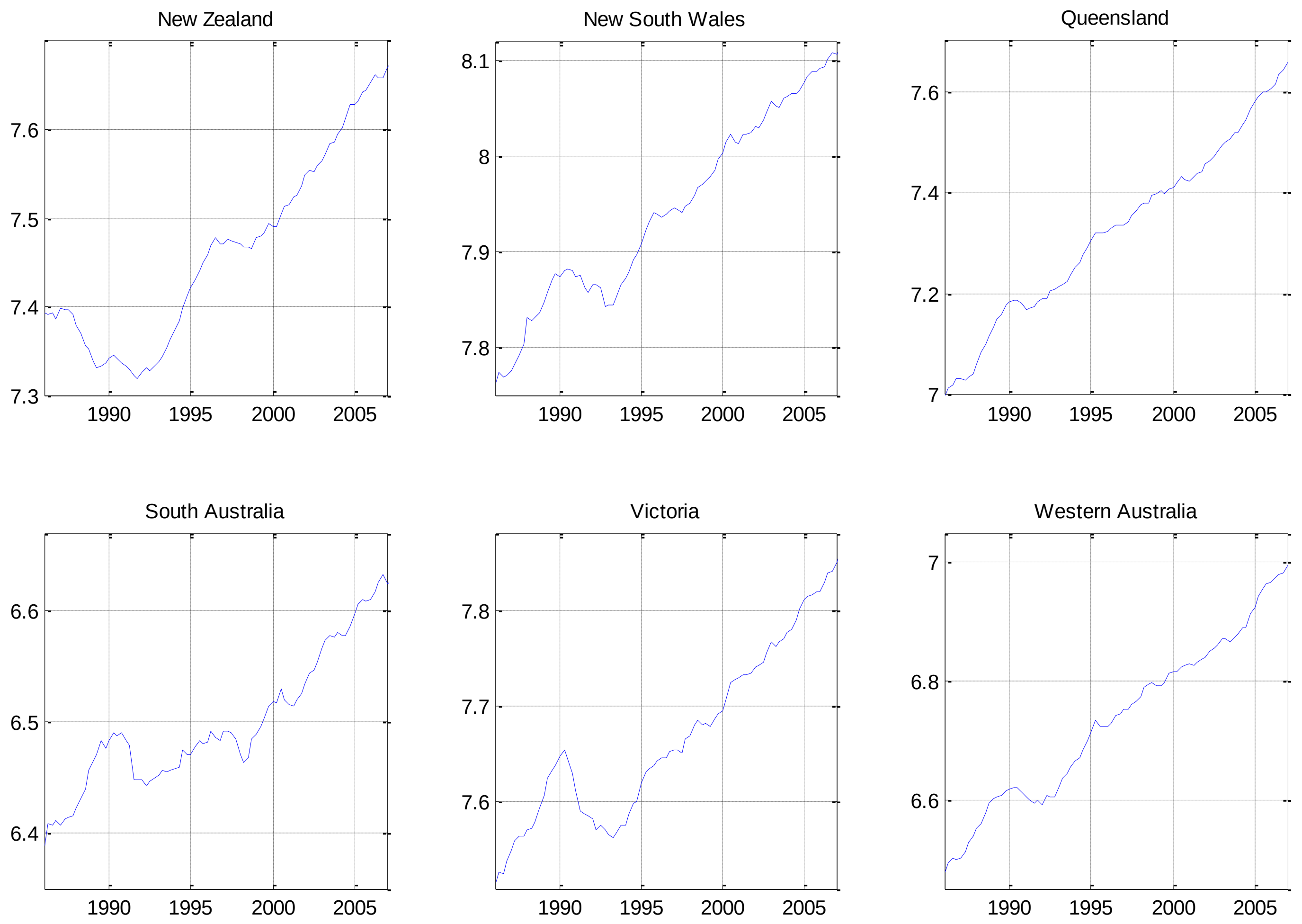

Figure 4: Australian 5 States plus New Zealand Total Employment
Hodrick-Prescott, Band Pass, and Unobserved Components Common Cycles

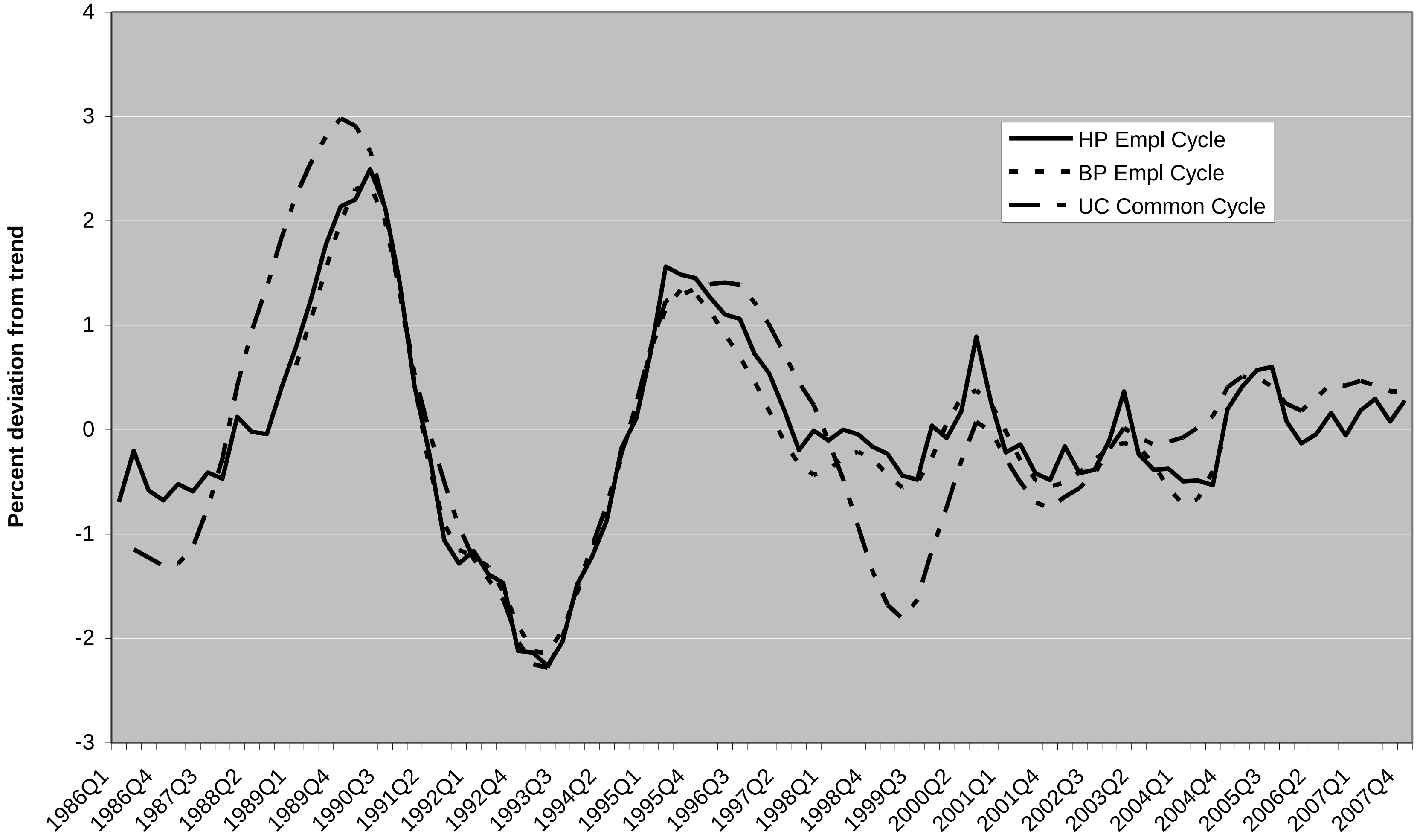

Figure 5: Australasian Unobserved Components Common Cycles
Australian SFD and NZ GDP Output, and Total Employment

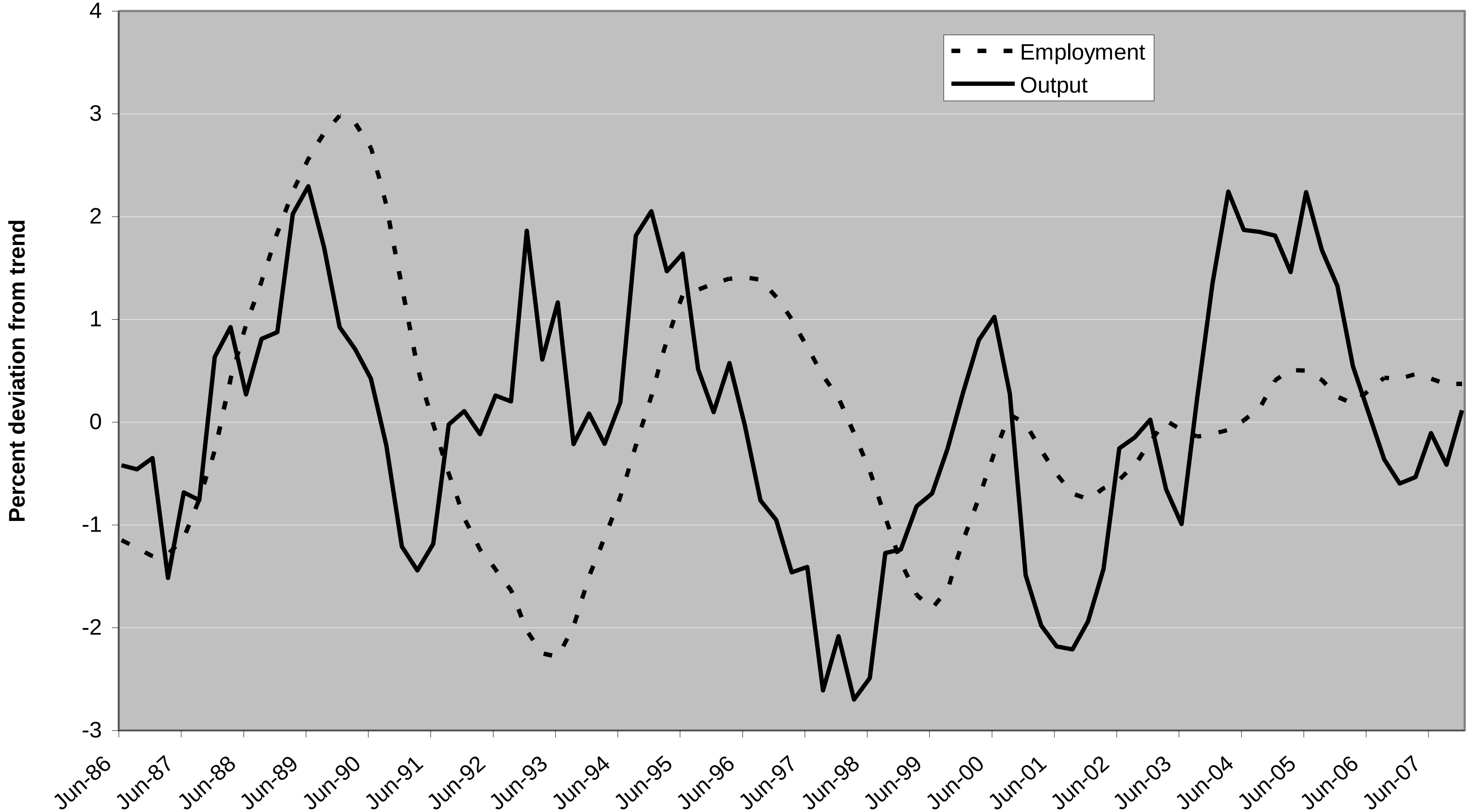

Figure 6: The Australasian Common and Region-specific Employment Cycles
Deviations from trend