Version 7 June 2007
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NEW ZEALAND ASSOCIATION OF ECONOMISTS CONFERENCE

CHRISTCHURCH

27 – 29 June 2007

UNOBSERVED COMPONENTS BUSINESS CYCLES FOR NEW ZEALAND. WHAT ARE THEY, AND WHAT MIGHT DRIVE THEM?

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Abstract

Bivariate, classical business cycle work for New Zealand has established that regional cycles exist, relative to an aggregate cycle (Hall and McDermott, 2007b). But despite the apparent robustness of the associated bivariate drivers, the work of Baxter and Kouparitsas (2005) suggests that such relationships are not always maintained when multivariate methods are used. Multivariate methods are more advanced for examining growth cycles than classical cycles.

Using unobserved components methodology (e.g. Watson and Engle (1983), Kouparitsas (2001, 2002), Norman and Walker (2004), and Hall and McDermott (2007a)), we first establish a New Zealand common cycle from economic activity data for 14 regions, and assess the extent to which the idiosyncratic/region-specific cycles are additionally important. We then aggregate the 14 regions to 5 regions, estimate a similar common cycle, and present the corresponding idiosyncratic cycles. This level of aggregation also provides us with an opportunity to assess the relative strengths of influence on the common cycle, of monetary and fiscal policy variables, and several external shock variables; also the extent to which shocks in turn affect idiosyncratic cycles and lead to regional spillover effects.

Our preliminary results suggest: (1) that structural breaks play an important role; (2) that New Zealand's idiosyncratic growth cycles have exhibited distinctively different features, relative to the common cycle; and (3) that monetary policy, net immigration and terms of trade variables may have had distinctive roles in influencing the common cycle. Our multivariate results are assessed in the context of recent findings for New Zealand and Australasia.

JEL Classification: C32; E32; R11; R15

Keywords: Unobserved components; common cycle; regional cycles; New Zealand.

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1. Introduction

Bivariate, classical business cycle work for New Zealand has established that regional cycles exist, relative to an aggregate cycle (Hall and McDermott, 2007b). Significant bivariate drivers of the regional cycles were also discovered. These included, for key regions, movements in New Zealand's terms of trade and real milk solids prices, and unusually dry climatic conditions, but not net migration movements. But despite the apparent robustness of these bivariate drivers, the work of Baxter and Kouparitsas (2005) suggests that bivariate relationships are not always maintained when multivariate methods are used.

Multivariate methods are more advanced than classical cycle methods for examining growth cycles, despite the well-known deficiencies associated with trend removal. For example, using unobserved components (UC) methodology, Kouparitsas (2002) finds that the 8 US BEA regions are largely subject to common sources of disturbance, and Norman and Walker (2004) conclude for 6 Australian States that the major source of the State fluctuations is shocks which are common to all States. But Norman and Walker also conclude that each overall State cycle is partly driven by fluctuations specific to that State, in particular for

* We acknowledge very helpful discussions with Michael Kouparitsas; also the use of EM algorithm programs kindly provided by David Norman and Thomas Walker, and by Michael Kouparitsas. Ian Scott and Daniel Vincent have provided excellent research assistance, under a grant from Victoria University of Wellington's School of Economics and Finance.

Western Australia. In contrast, recent UC work for Australasia by Hall and McDermott (2007a) has provided striking findings on the importance of region-specific cycles dominating an Australasian common cycle; this has been especially so for Western Australia and New Zealand. Our finding such a distinctive role for the New Zealand cycle, especially for the years prior to the late 1990s, emphasises that it is important to understand the relative importance of New Zealand's common and region-specific cycles, and which variables might drive them.

In this paper, therefore, we use UC methodology on regional economic activity data, to establish benchmark common cycles for New Zealand which are consistent with well-accepted regional growth rate trends. We also assess the extent to which idiosyncratic cycles are additionally important, and the relative strengths of influence on the common cycle of monetary policy, terms of trade, and net immigration variables[1].

The specific questions we address are: (i) what are the hypothetical New Zealand common cycles, consistent with well-accepted trend regional growth rates?; (ii) what are the corresponding idiosyncratic/region-specific cycles?; (iii) how sensitive are the idiosyncratic cycles to the common cycle?; (iv) is there a distinct role for region-specific cycles, and are there related groups of these cycles?; (v) what are the relative contributions of the common and idiosyncratic cycles to each region's total cycle? (vi) what are the responses of regional activity to region-specific and common shocks, and what role if any do spillover effects from one region to another play?; (vii) what are the relative strengths of influence on the common cycle of the monetary policy, terms of trade, and net immigration variables?; and (viii) are our model-related findings materially different from those reported for New Zealand (Hall and McDermott, 2007b; Buckle, Kim, McLellan, 2003; Claus, Gill, Lee and McLellan, 2006) and for Australasia (Hall and McDermott, 2007a; Grimes, 2005, 2006)?

The answers to these and related questions have important implications for the relative strengths of influence of monetary, fiscal and regional policies; as well as for the impacts of and responses to external shocks.

Data description, and evidence on bivariate comovements are presented in section 2. Section 3 provides the specification of our UC Model. Empirical results and their implications are reported and assessed in section 4. Section 5 concludes.

2. Business Cycle Fluctuations in New Zealand

In Hall and McDermott (2007b), it was established that there have been significant contemporaneous associations between the *classical* NZ business cycle and 11 of the corresponding 14 regional cycles. But they also found that over half the bi-regional comovements were not significant, findings which contrast with the much higher proportion of regional cycle comovements for the US (Kouparitsas, 2002), and perhaps imply idiosyncratic cycles may have a relatively more substantial role in New Zealand than for the US.

[1] Our analysis does not include explicit roles for industry structure effects, but Grimes (2005, 2006) evaluates the relative roles of industry cycle and structure effects for Australasian regions. Using cycles in employment gap data, 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.

So, to provide a comparable initial perspective on fluctuations in New Zealand's regional *growth* cycles, we assess cycles from the band-pass filter method made popular by Baxter and King (1999). This well-known filter uses spectral analysis theory to remove all but a band of frequencies from a time series associated with the business cycle, typically taken to be between 6 and 32 quarters.

The economic activity data we use for aggregate New Zealand and its 14 regions, are compiled by the National Bank of New Zealand (NBNZ) and published as their *Regional Trends* series[2]. The quarterly data sample period used is 1975q1 to 2006q2. Twenty-three series, which include leading and coincident indicators, are used to calculate the composite indices of regional economic activity. These include: business confidence; consumer confidence; retail sales; new motor vehicle registrations; regional exports; registered unemployment; building permits approved; real estate turnover; household labour force data; job ads; and accommodation survey data. All quarterly rates of change are calculated on seasonally adjusted and inflation adjusted data. The composite index for each region is essentially constructed by cumulating the mean rates of quarterly change, and the procedures to combine the components into an index are designed to prevent the more volatile series from dominating the index. The series are standardised to equalise their average absolute changes. Further detail can be found in Edwards (1994)

The national measure of activity is formed by constructing a (fixed) weighted average of the 14 regional activity indices. The weights are based on NBNZ estimates of relative gross regional product as of 1998. These NBNZ weights are consistent with those estimated by the NZIER for the March 2004 year (*NZIER Quarterly Predictions*, March 2005, p 67).

Panel A of Table 1 reports band-pass filter correlation coefficient measures, for contemporaneous regional cycle comovements over the full sample period. The strongest comovements with the New Zealand cycle involve the larger regions of Auckland, Canterbury, Waikato and Bay of Plenty (93 to 88 per cent); while the weakest associations are for the smaller regions of Gisborne, Nelson-Marlborough, Southland, and Taranaki (65 to 61 per cent). Wellington's contemporaneous cross-correlation is 76 per cent. The bi-regional co-movements shown in the off-diagonal cells of Panel A on the whole suggest relatively weaker associations, with 68 per cent of them being less than 75 per cent. Wellington provides the dominant number of these weaker associations (9 of its 13 being 50 per cent or less), but its associations with Auckland (80 per cent) and Canterbury (60 per cent) are noticeably stronger.

A perspective on bivariate persistence and lead/lag relations can be obtained from the correlation coefficients presented in panels B and C, for one-period and four-period lead/lags respectively. The coefficients on the diagonal in Panel B show strong short-term persistence for all regional cycle fluctuations (all co-movements being between 94 and 89 per cent), but minimal persistence over the four-quarter horizon (all except one being between 6 and 29 per cent).

The coefficient estimates in the off-diagonal elements in Panel C suggest little in the way of material lead/lag relationships.

[2] In Hall and McDermott (2007b), a close relationship was reported between the aggregate/national economic activity series and official real GDP series.

The overall impression from these bivariate correlations is therefore that the three largest regions, Auckland, Canterbury and Wellington have moved together relatively strongly, and that together with the dominant rural region of Waikato being strongly associated with the New Zealand cycle, would be strong candidates to be core regions of a New Zealand common cycle. A number of the smaller regions, such as Gisborne, Nelson-Marlborough, Southland, and Taranaki seem potentially peripheral in their association with any common cycle

However, while this bivariate data analysis is suggestive, it should not be used on its own to formally test the questions posed in the introduction. For that we need to use a structural model that can be used to identify regional responses to common and region-specific shocks.

3. Specification of Unobserved Components Model

To estimate the common business cycle of New Zealand we use an unobserved components model. Such models are popular because it is possible to specify the trend and cycle components of time series data in a flexible manner while a range of diagnostic tools are available to test the robustness of the estimated cycle.

Since our aim is to estimate the business cycles in each of the regions in New Zealand, as well as a common or national business cycle, we employ a multivariate version of the unobserved components model. The particular model we use is the dynamic multiple indicator multiple causes (DYMIMIC) model. This model was used by Kouparitsas (2001 and 2002) to study regional business cycles in the United States, by Norman and Walker (2004) to study state business cycles in Australia, and by Hall and McDermott (2007a) to study the issue of a common currency in Australasia by determining whether there are asymmetric shocks across regions of Australasia.

Following commonly used notation, let y_{it} be the log of economic activity in region i. For each region, there are two unobserved components to be estimated, the trend and the cycle. Thus let τ_{it} and c_{it} be region-specific trend and cycle components, so that

$$y_{it} = \tau_{it} + c_{it} . \qquad (1)$$

Assume that the trend component τ_{it} can be represented as a process with a unit root and deterministic drift[3]

$$\tau_{it} = \delta_{it} + \tau_{it-1} + \mu_{it} . \qquad (2)$$

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, which is assumed to be an independent normal random variable with mean zero and variance $\sigma^2_{\mu i}$; and the innovations, μ_{it}, are assumed to be orthogonal for all t. Note that if $\sigma^2_{\mu i} = 0$ then τ_{it} is a linear trend. For most regions in our sample $\sigma^2_{\mu i}$ is very small implying our trend component is much closer to

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

a time trend than would be typically be estimated in a univariate setting, such as when a Hodrick-Prescott (HP) filter is used.

That said, some addition flexibility is required in the estimation of the trend component to deal with the changing structure of the economy following the economic reforms implemented in the 1980s and 1990s. We introduce this flexibility be adopting two break points in the trend component at 1986q4/1987q1 and 1991q1/1991q2.

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

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

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

The dynamics of the common cycle are captured by the model

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

The common cycle, which is unobserved, evolves according to an autoregressive process of order two with autoregressive coefficients ρ_1 and ρ_2, as well as responding to a $k\times 1$ vector Z_t of weakly exogenous variables. The innovation to the common cyclical component, ε_{nt}, is assumed to be an independent normal random variable with mean zero and variance σ_n^2 .

The weakly exogenous variables in Z_t, which we call the drivers of the common cycle, are specified as a monetary policy variable, the terms of trade, and migration. A monetary policy variable is included to capture the idea that if the economy is overheating, that is the common cycle is strongly positive, the monetary authorities will intervene to moderate the cycle to stop any inflation pressures from building up. A terms of trade variable is included to capture the influence of international prices on overall New Zealand economic activity. A migration variable is included to capture the idea that a large inflow of people will put pressure on resources, especially housing, and thus accelerate domestic demand in excess of the supply capacity of the domestic economy.

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 $X_t = [x_{1t}, x_{2t}, ..., x_{mt}]'$, Φ is an *m* by *m* matrix of coefficients and $\varepsilon_t = [\varepsilon_{1t}, \varepsilon_{2t}, ..., \varepsilon_{mt}]'$ is the vector of innovations to the regional cycles, which is assumed to an independent normal random vector with a zero mean and diagonal covariance matrix Λ. In principle, weakly exogenous drivers could be appended to equation (5) but the limited length of the available times series prohibits us from doing this at present. For example, estimating equation (5) with three additional weakly exogenous variables would use up 42 degrees of freedom.

At this point, it is worth summarising in one place the identifying assumptions we have successively imposed earlier in the paper. First, we assume that μ_{it} and c_{it} are uncorrelated at all leads and lags. When we convert the model into its state space form we impose the restrictions that all innovations are assumed to be orthogonal. Moreover, by limiting ourselves to the case where innovations to a particular regional cycle do not affect any other regional cycle (that is, the variance-covariance of the regional innovations is assumed to be diagonal), then we can identify the extent of any spillovers by examing the off-diagonal elements of the Φ matrix. This identifying assumption allows us to conduct a likelihood ratio test for the null hypothesis of no spillovers. The final identifying restriction we make 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 Auckland's sensitivity to unity.

For estimation purposes it is convenient to re-write the model in its state space representation. Thus, after incorporating the breaks in trend, the measurement equation is

$$\Delta Y_t = \begin{bmatrix} \delta_{75q2,86q4} & \delta_{87q1,91q1} & \delta_{91q2,06q2} \end{bmatrix} \begin{bmatrix} D_{75q2,86q4} \\ D_{87q1,91q1} \\ D_{91q2,06q2} \end{bmatrix} + \begin{bmatrix} \gamma & I_{m\times m} \end{bmatrix} \begin{bmatrix} \Delta x_{nt} \\ \Delta X_t \end{bmatrix} + \mu_t \tag{6}$$

and the transition equation is

$$\begin{bmatrix} x_{nt} \\ X_t \end{bmatrix} = \begin{bmatrix} \rho_1 & 0 \\ 0 & \Phi \end{bmatrix} \begin{bmatrix} x_{nt-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} \rho_2 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_{nt-2} \\ X_{t-2} \end{bmatrix} + \begin{bmatrix} \beta' & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} Z_t \\ 0 \end{bmatrix} + \begin{bmatrix} \varepsilon_{nt} \\ \varepsilon_t \end{bmatrix} \tag{7}$$

where $Y_t = \left[y_{1t}, y_{2t}, \ldots, y_{mt}\right]'$, $\delta_{t1,t2} = \left[\delta_{1t1,t2}, \delta_{2t1,t2}, \ldots, \delta_{mt1,t2}\right]'$, $D_{t1,t2}$ is one for $t1 \leq t \leq t2$ and zero for all other t, since we have two break points in this application we consider three sets of $t1$ and $t2$ (specifically 1975q2 to 1986q4, 1987q1 to 1991q1, and 1991q2 to 2006q2) $\gamma = \left[\gamma_1, \gamma_2, \ldots, \gamma_m\right]'$, $\mu_t = \left[\mu_{1t}, \mu_{2t}, \ldots, \mu_{mt}\right]'$, and I_{mxm} is a m by m identity matrix.

Maximum likelihood methods and recursive use of the Kalman filter can be used on the state space system (6) and (7) to provide estimates for the unknown parameters and the unobservable components. Using the state space representation, maximum likelihood can be used to estimate the model with the likelihood being evaluated using the Kalman filter. In particular, we use the recursive Expectation Maximization (EM) algorithm for our estimation, details of which are presented in Watson and Engle (1983).[4]

4. Empirical Results

Two key factors condition the empirical results which follow: the necessity to allow for structural breaks in the trend regional growth rates; and the exogenous variables which can potentially affect the common and/or idiosyncratic cycles[5].

[4] 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 3,712 iterations to converge when we estimated the model for 5 aggregated regions of New Zealand, and 7,242 iterations to converge when we estimated the model for the 14 regions of New Zealand.

[5] Results on the extent to which the common cycle drivers examined in this paper, and any other exogenous (region-specific) variables, might additionally influence the idiosyncratic cycles, will be reported at a later date.

In our work establishing a common Australasian cycle (Hall and McDermott, 2007a), and in Kouparitsas (2002), it was found important to ensure both that the trend rates of growth were consistent with well-accepted regional growth rates, and that the resulting common cycle was stationary. At this stage, the break points stated in section 3 above as at 1986q4/1987q1 and 1991q1/1991q2 have been chosen as consistent with the mode breaks from univariate Andrews-Ploberger tests[6].

Consistent with the bivariate findings in Hall and McDermott (2007b), with the potential shocks summarised in Hall and McDermott (2007c, p 8) as capable of triggering or terminating business cycle phases, with the structural VAR results reported in Buckle, Kim and McLellan (2003), and in Claus, Gill, Lee and McLellan (2006), we have assembled data to enable testing the relative strengths of influence on the common cycle, of monetary and fiscal policy variables[7], and two external shock variables reflecting New Zealand's terms of trade and immigration movements. We felt it important to utilise the maximum number of observations from our economic activity sample period of 1975q1 to 2006q2, but this has conditioned the form of the monetary policy variable tested to date. Monetary policy is reflected through the RBNZ's real first mortgage housing rate, historical series; movements in the terms of trade variable are represented by quarterly changes in SNZ's Terms of Trade Index (Merchandise), base June 2006 = 1000; and immigration movements come from SNZ's seasonally adjusted Net Permanent and Long Term Arrivals series. All three variables have been used in de-meaned form.

4.1 The 14-region common and idiosyncratic cycles

Sources of disturbances

Our regional growth cycles need to be seen first in the context of their underlying trend growth rates, and then in terms of their common and idiosyncratic cycle components. Results are presented for the model given by (6) and (7), with two breaks in the trend growth rates.

The trend regional growth rates

Table 2 contains estimates of the (annualized) trend growth rates, δ_{it}. There is evidence that for the short second period associated with New Zealand's major economic reforms, almost all the trend economic growth rates are materially lower than those for both the preceding and following periods. Canterbury is the key exception, with successive trend growth rates of 2.7, 3.1 and 3.4 per cent. It is also evident that for eight of the 14 regions, trend growth was higher post-reforms than pre-reforms, the eight being Waikato, Gisborne, Taranaki, Wellington, and all the South Island regions except Southland (which has grown at 2.4 per cent more recently, relative to its pre-reforms' 2.6 per cent). This confirms that it is important to control for structural breaks when comparing the response of each regional economy to various shocks.

[6] See Andrews (1993), Andrews and Ploberger (1994). If no break is assumed then the estimated common cycle from the model is not stationary. The imposition of one or more breaks is therefore material to the results. We experimented with the possibility of imposing just one break, and with different break dates in the neighbourhood of our imposed two breaks, and found either that the estimated common cycle was not stationary or the resulting smallest sample period had too few observations to be meaningful.

[7] Work reflecting the influence of fiscal policy variables will have to utilise data from the somewhat shorter sample period from 1982q2, and will reflect the government spending and net tax (government tax revenue less transfer payments) variables successfully examined in Claus et al. (2006). The work may also reflect a quarterly equivalent of a first round fiscal impulse measure developed in Philip and Janssen (2002).

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

Figure 1 shows the common cycle and region-specific cycles, expressed as percentage point deviations from each region's trend growth rate. The common cycle reproduced in Figure 3 is 75 per cent correlated with a benchmark HP growth cycle for New Zealand aggregate economic activity.

Examination of the time paths and amplitudes of the idiosyncratic cycles in Figure 1 shows there is considerable diversity of cycles across regions. Taranaki has by far the strongest region-specific cycle, suggesting that its cyclical behaviour is not well explained by fluctuations in the common cycle. Other regions with particularly distinctive region-specific cycles are Nelson-Marlborough, Auckland, Gisborne, Northland, and Southland. Only the Waikato and Hawkes Bay region-specific cycles seem to show reasonable overall consistency with the common cycle.

The regional sensitivities of the response of activity in region i to the common cycle are reported in Table 3. The sensitivity is normalized to unity for Auckland. The point estimates show that Northland and Manawatu-Wanganui (and Canterbury and Otago) are somewhat more sensitive, and that seven of the 14 regions display approximately the same sensitivity as Auckland. However, Gisborne and Nelson-Marlborough are considerably less sensitive to the common cycle than are the other New Zealand regions.

The autoregressive parameters from equation (4), which describe the response of the common cycle to a common cyclical shock, are reported in Table 4. The estimated parameters inform us that the half-life of shocks to the common cycle is nearly 3 quarters. The shape of each region's response is forced to be identical and is one of steady decay. The amplitude of each region's response to a common shock depends additionally, however, on the sensitivity of the parameter values reported in Table 3. Hence the response of the Gisborne region to the common cyclical shock is considerably more muted than those for the other regions.

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

The importance of idiosyncratic shocks relative to the common cycle can also be illustrated through the variances of the cyclical components, reported in Table 5. The key result is that for every region, the variance of the idiosyncratic cycle component dominates that of the common cycle. Within this overall result, the region-specific cycle variance for Taranaki is particularly dominant, and for Nelson-Marlborough, Auckland, Manawatu-Wanganui, Gisborne, Northland and Southland, their region-specific variance contributions are also very strong relative to that of the common cycle. The idiosyncratic variance contributions for Waikato and Hawkes Bay are the least in magnitude (3.29 and 3.31 per cent), but are still greater than their respective common cycle variances of 2.04 and 1.77 per cent.

Results in this area therefore complement the visual impressions gained from Figure 1 and reinforce the importance of region-specific cycle influences relative to those of the common cycle.

Potential exogenous influences on the common cycle

We are able to report coefficient values for the monetary policy, terms of trade, and net immigration variables in Table 4, but due to insufficient sample observations we cannot report standard errors for those coefficients (nor for those of the other parameters estimated).[8] Testing the null hypothesis that the three drivers are jointly zero was conducted by using a likelihood ratio (LR) test. The reported LR statistic is 4.0. The 5 per cent critical value taken from the asymptotic Chi-squared distribution with three degrees of freedom is 7.81. Therefore the null hypothesis is not rejected. This may or not have been due to the potential influence of these exogenous influences having been swamped by our capturing movements from the comprehensive 14-region classification.

In summary then, despite potentially useful point estimate results having been obtained from the 14-region classification, the fact that we have too many parameters to be estimated relative to the number of observations has meant that to this point, we had not been able to assess the robustness of our parameter estimates and in particular to form a judgement on the significance of our exogenous influences. Accordingly, we aggregated economic activity in the 14 regions to five regions, using weights based on NBNZ estimates of relative gross regional product of 1998[9]. The five regions, with weights in parentheses, are: Auckland (31.0), Wellington (13.2), Rest of the North Island (RNI) (31.9), Canterbury (12.3) and the Rest of the South Island (RSI) (11.6). The RNI and RNI groupings, which incorporate key rural-based regions, should enable any potential terms of trade and commodity price influences to be tested for.

4.2 The 5-region common and idiosyncratic cycles, and their potential drivers

Sources of disturbances

Given that the data series for the Auckland, Wellington and Canterbury regions were as for our 14-region analysis, we imposed the same two break points for the 5-region estimations.

The trend regional growth rates

The results in Table 2 show that the 5-region annualized trend growth rates for Auckland, Wellington and Canterbury for the first and third sub-periods are consistent with those from the 14-region estimations. There is some variability in the results for the trend growth rate in the second sub-period, but the trend growth rates in this period are generally lower than in the other two periods. In particular, Wellington's second period growth is approximately one per cent and is not statistically significant; the RNI trend growth is 1.4 per cent and significant at five per cent level; while the aggregate RSI trend growth is estimated to be around 0.9 per cent and not significantly different to zero at the 5 per cent level. Again, therefore, it is clear that breaks need to be imposed.

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[8] Problems in computing standard errors occur because the information matrix is not block diagonal (see Watson and Engle, 1983). Rather than the usual method of computing the standard errors, it is necessary to compute the entire information matrix for all the parameters once the parameter estimates have converged.

[9] These weights are consistent with those estimated by the NZIER for the March 2004 year (NZIER 2005, Table A27, p 67). The reformulated 5 regions correspond with those for which Statistics New Zealand publishes regional CPI series (see *CPI Review – outcome of review* at http://www.stats.govt.nz/developments/price-index-developments/review-cpi-regions.htm).

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

Figure 2 shows the common cycle and region-specific cycles, expressed as deviations from each region's trend growth rate. The five-region common cycle is 87 per cent correlated with the corresponding 14-region cycle and, like the 14-region common cycle, is 75 per cent correlated with the HP growth cycle (Figure 3).

Examination of the time paths and amplitudes of the idiosyncratic cycles in Figure 2 confirms there is considerable distinctiveness in the regional cycles relative to the common cycle, and noticeable diversity of cycles across regions. The Auckland and Canterbury region-specific cycles have moved quite similarly, though with some timing and amplitude differences in the late 1980s/early 1990s and during 2005-06. Wellington's movements were similar to those of Auckland and Canterbury up until the 1990s, displayed different patterns during the 1990s, and have been relatively similar to Canterbury's during the current decade. From the 1980s onwards, the RNI region-specific cycle has significant periods in common with Canterbury, whilst the RSI idiosyncratic cycle is distinctively different from those of the other four regions.

The regional sensitivities of the response of activity in region i to the common cycle, reported in Table 3, are all statistically significant. With Auckland's sensitivity coefficient again normalized to unity, the RNI and RSI now join Wellington in displaying approximately the same sensitivity as Auckland, while Canterbury shows somewhat greater sensitivity than before (1.25 instead of 1.14).

The autoregressive parameters in Table 4 are statistically significant and little changed for the five-region level of aggregation. The corresponding half-life of shocks to the common cycle remains at nearly 3 quarters.

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

When 14-regions are aggregated to five-regions, it is not surprising that the magnitudes of the overall cycle variances and idiosyncratic variances are smaller. The overall cycle variances now lie between 7.1 and 5.0 per cent, and the idiosyncratic variances between 5.7 and 2.6 per cent. Nevertheless, the key result from the 14-region analysis is preserved - the variance of the idiosyncratic cycle component dominates that of the common cycle for every region. This is especially so for Wellington and Auckland (contributing 85 and 80 per cent of the overall cycle variance), remains markedly so for RNI and Canterbury (72 and 70 per cent), and is to a somewhat lesser extent for RSI (50 per cent)

Potential exogenous influences on the common cycle

Coefficient values and standard errors for the monetary policy, terms of trade, and net immigration variables are reported in Table 4. The coefficients on all three variables are of correct sign, but are not statistically significant at the 5 per cent level. However, net immigration is significant at the 10 per cent level. Furthermore, the likelihood ratio test for the null hypothesis that the three drivers are jointly zero was 17.2 and so, in contrast with the test for the 14-region case, we can reject the null hypothesis. In this case our candidate drivers do help us understand the evolution of the common cycle, with net migration perhaps being the more important factor.[10]

Responses to disturbances

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

The estimated VAR coefficients, Φ, for equation (5) are reported in Table 6. The estimates along the diagonal show that the autoregressive behaviour varies across region-specific cycles: very strong autoregression for Canterbury, Auckland and the RNI, and relative weak persistence for Wellington. The off-diagonal point estimates suggest limited spillover of region-specific shocks into other regions. There is, however, the possibility of spillovers to Wellington from Canterbury and RSI (from coefficients of 0.34 and -0.41). To formally test the hypothesis of no spillovers we use a likelihood ratio test, the LR values of which are 497.2 and 110.6 for the 14 and 5 region cases, respectively. The 5 per cent critical values taken from the asymptotic Chi-squared distribution with 182 degrees of freedom (the number of restrictions in the 14 region case is 214.5, and with 20 degrees of freedom is 31.4). Therefore the likelihood ratio test of the null of no spillover effects is clearly rejected in both cases.

4.3. Results, relative to previous New Zealand and Australasian studies

Key findings from the *bivariate comovements* reported in section 2 for our BK growth cycles, are consistent with those from the classical cycle analysis presented in Hall and McDermott (2007b). In particular: the regions most highly synchronised with the New Zealand cycle are Auckland and Canterbury, and those least synchronised include Gisborne and Southland; bi-regional synchronisations are essentially contemporaneous; and while there is strong short-term persistence for all regional cycle fluctuations, there is minimal persistence over a four-quarter horizon.

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 (2004, fn 21 and Figure 1) present a weighted average common cycle for Australia that has a correlation of 0.85 with a Hodrick-Prescott filtered cycle for domestic final demand. Here, we provide evidence in a New Zealand context that UC estimation can be used to derive credible common growth cycles. We report 14-region and five-region common cycles for New Zealand, which are very similar to each other and closely match movements in a benchmark Hodrick-Prescott growth cycle.

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 (2004, p i) conclude for 6 Australian States that the major source of fluctuations in states' economic activity is shocks which are common to all states. But Norman and Walker's (2004, p 21) variance analysis also shows that each overall state cycle is driven partly by fluctuations specific to that State, in particular for Western Australia, but also for South Australia and Tasmania.

[10] Some simple diagnostic checking also suggests the monetary policy variable has more explanatory power in the latter part of the sample and especially once the Reserve Bank's inflation target regime has been established.

In major contrast, the Hall and McDermott (2007a) results for Australasia show a substantially more distinctive role for *region-specific cycles*, especially for Western Australia and New Zealand. Results from their variance contributions analysis differ markedly from those of Kouparitsas, and Norman and Walker, as for all six Australian states and New Zealand, the *region-specific variance contributions* dominate those from the common cycle. This is especially the case for Western Australia, Tasmania and New Zealand. The results presented in sections 4.1 and 4.2 above are in the same vein. For both the 14-region and five-region groupings, and despite our additionally allowing for three potentially important exogenous variable influences on the respective common cycles, every region-specific cycle variance contributes more to its overall cycle variance than does the common cycle variance.

With respect to previous findings on *exogenous cycle drivers*, Kouparitsas (2001) placed considerable emphasis on whether the relative price of oil and the U.S. federal funds rate might have been significant. He concluded (2001, pp 2-3, 19-20, Table 5) that the largest share of regional fluctuations is due to common shocks rather than region-specific shocks; that the common income component explains on average 70 per cent of the variation attributable to all three common shocks; and that there is considerable variation across regions associated with oil shocks but quite uniform variation for monetary policy shocks.

From Buckle, Kim and McLellan's (2003, p 14) 13-variable SVAR model of the New Zealand business cycle, international shocks, domestic climate shocks and non-financial domestic shocks were shown to have been pro-cyclically important, while domestic (90-day interest rate) financial shocks were generally moderately counter-cyclical. Specific fiscal variables were not include in that SVAR, but recent work reported in Claus, Gill, Lee and McLellan (2006) focussed on potential discretionary fiscal policy impulses. They established that government spending increases have led to GDP increases in the short term, and that net tax increases have led to GDP reductions. It was also the case that when net tax shocks are decomposed, tax revenue increases lead to (small) reductions in GDP, and increases in government transfers result in short-term increases in GDP but subsequent declines.

On the issue of whether New Zealand cycles have been driven by or associated with Australian regional cycles, Grimes (2005, p 395, Tables 3, 5) found no strong evidence of the New Zealand cycle having been "caused" by the cycles in other Australasian regions or industries[11]. This finding is consistent with that in Hall and McDermott (2007a). Their analysis could find no material evidence of New Zealand's economic activity cycle having responded to the region-specific shocks of the six Australian states, nor of those states responding to a New Zealand-specific shock. The two studies are therefore consistent in suggesting that an Australian cycle need not be a strong candidate to be an exogenous driver for New Zealand cycles. A more promising candidate is likely to be an appropriate "world" economic activity variable dominated by the U.S., with or without including China[12].

Our findings to date on potential exogenous drivers are preliminary, so are not yet assessed against the above findings.

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[11] This was despite the fact that since 1991, the New Zealand employment cycle has generally been closely correlated with the Australasian and larger Australian regional employment cycles.
[12] "World" economic activity variables have yet to be tested. But such an influence is consistent with the work of Selover and Round (2005, p 239), who established from VAR analysis that Australian GDP was not significant in explaining NZ GDP, and that both Japan and the U.S. had statistically significant effects on Australian GDP and on NZ GDP.

The issue of *spillovers* of region-specific shocks to other regions is also potentially important. Kouparitsas (2001, p 30) concluded that spillovers do not contribute a statistically significant share of regional-cycle variation, and Norman and Walker (2004, p i) conclude similarly that spillovers 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, was assessed in Hall and McDermott (2007a, section 4.1), there also seemed minimal evidence of material spillover effects. We have yet to form equivalent views in a New Zealand regional context.

In summary, for New Zealand, and as for Hall and McDermott's (2007a) Australasian analysis, region-specific cycles have had a considerably more important role, than has been the case for the Australia's 6 States and the 8 BEA regions of the US. The specific roles in this of New Zealand's four biggest regions (i.e. Auckland, RNI, Canterbury, and Wellington), and each of which has a particularly dominant idiosyncratic cycle, is particularly interesting and is the subject of ongoing investigation.

5. Conclusion

We have established from regional economic activity data, *two common cycles* for New Zealand, which are consistent with well-accepted regional growth rate trends. These common cycles, one derived from data for 14 regions and the other from data aggregated to five regions, are very similar to each other and closely match movements in a benchmark Hodrick-Prescott growth cycle. They are conditional on allowing for two breaks in trend growth rates, at 1986q4/1987q1 and at 1991q1/1991q2.

The corresponding *region-specific cycles exhibit considerable diversity*, relative to the common cycle. The idiosyncratic cycle of Taranaki is particularly distinctive, and those of Nelson-Marlborough, Auckland, Wellington, Manawatu-Wanganui, Gisborne, Northland, and Southland are also most notable. This diversity result is sustained for the five-region analysis, especially so for Wellington and Auckland, and markedly so for the Rest of the North Island region and Canterbury.

Variance analysis of the common and idiosyncratic cycle components establishes that for both the 14-region and five-region data sets, the region-specific cycle variance dominates that of the common cycle. This finding of *dominance of the idiosyncratic cycle contribution* for New Zealand regions is consistent with the findings for Australasia in Hall and McDermott (2007a), but in direct contrast to those of Kouparitsas (2002) for US BEA regions, and Norman and Walker (2004) for the six Australian states.

Our findings in relation to potential *exogenous drivers* are preliminary, as we have not yet allowed for fiscal policy or world economic activity influences on the common cycle, nor assessed the extent of influences on the idiosyncratic cycles. But our results to date are consistent with suggesting that monetary policy, net immigration and terms of trade variables may have had distinctive roles in influencing the common cycle.

Further work is required. In particular, we plan to utilise the 5-region model to establish (1) the relative role of key New Zealand fiscal and world economic activity variables, and (2) the extent to which the common cycle drivers examined to date and any other exogenous (region-specific) variables might additionally influence the idiosyncratic cycles.

Table 1

Regional business cycle comovement and persistence, 1975q1 – 2006q2

A. Contemporaneous correlation

Economic activity at time t

Activity at time t	Nthld	Auck	Waik	BOP	Gisb	HB	Tar	M-W	Well	NM	WC	Cant	Otago	Sthld
New Zealand	0.79	0.93	0.89	0.88	0.65	0.82	0.61	0.86	0.76	0.65	0.76	0.92	0.72	0.64
Northland	1.00													
Auckland	0.60	1.00												
Waikato	0.88	0.75	1.00											
Bay of Plenty	0.75	0.79	0.82	1.00										
Gisborne	0.71	0.49	0.58	0.68	1.00									
Hawkes Bay	0.82	0.61	0.79	0.78	0.76	1.00								
Taranaki	0.69	0.39	0.69	0.43	0.46	0.62	1.00							
Manawatu-Wanganui	0.77	0.68	0.78	0.78	0.66	0.86	0.64	1.00						
Wellington	0.50	0.81	0.58	0.65	0.29	0.48	0.21	0.47	1.00					
Nelson-Marlb.	0.45	0.47	0.49	0.54	0.58	0.75	0.56	0.73	0.26	1.00				
West Coast	0.83	0.57	0.73	0.67	0.68	0.83	0.60	0.86	0.39	0.58	1.00			
Canterbury	0.70	0.79	0.81	0.78	0.56	0.79	0.67	0.84	0.60	0.80	0.72	1.00		
Otago	0.58	0.53	0.59	0.62	0.69	0.82	0.58	0.77	0.29	0.86	0.75	0.78	1.00	
Southland	0.50	0.53	0.63	0.51	0.50	0.58	0.50	0.67	0.21	0.50	0.63	0.63	0.67	1.00

Note: Regional and aggregate economic activity data, natural logged and filtered using quarterly business cycle band-pass filter described in Baxter King (1999)

Table 1 (continued)

Regional business cycle comovement and persistence, 1975q1 – 2006q2

B. Lead/lag correlation for t + 1

Economic activity at time t + 1

Activity at time t	Nthld	Auck	Waik	BOP	Gisb	HB	Tar	M-W	Well	NM	WC	Cant	Otago	Sthld	NZ
New Zealand	0.75	0.88	0.83	0.79	0.57	0.70	0.52	0.73	0.71	0.50	0.72	0.80	0.59	0.50	0.91
Northland	0.94	0.56	0.83	0.65	0.63	0.74	0.62	0.65	0.49	0.35	0.75	0.59	0.48	0.37	0.72
Auckland	0.55	0.93	0.68	0.70	0.40	0.47	0.30	0.53	0.76	0.31	0.50	0.68	0.39	0.40	0.83
Waikato	0.80	0.68	0.91	0.73	0.49	0.66	0.60	0.65	0.52	0.36	0.67	0.68	0.46	0.43	0.78
Bay of Plenty	0.73	0.76	0.76	0.89	0.59	0.70	0.31	0.68	0.67	0.40	0.66	0.67	0.48	0.37	0.81
Gisborne	0.72	0.54	0.60	0.68	0.93	0.74	0.40	0.64	0.36	0.47	0.71	0.49	0.61	0.41	0.65
Hawkes Bay	0.79	0.64	0.77	0.71	0.69	0.92	0.58	0.79	0.51	0.63	0.83	0.72	0.75	0.48	0.80
Taranaki	0.71	0.40	0.67	0.47	0.48	0.59	0.94	0.61	0.20	0.56	0.60	0.64	0.57	0.39	0.60
Manawatu-Wanganui	0.79	0.69	0.77	0.72	0.62	0.79	0.57	0.90	0.46	0.61	0.83	0.75	0.66	0.56	0.81
Wellington	0.41	0.72	0.47	0.47	0.19	0.30	0.14	0.32	0.89	0.10	0.30	0.45	0.17	0.11	0.62
Nelson-Marlb.	0.49	0.52	0.51	0.56	0.63	0.75	0.50	0.73	0.30	0.92	0.66	0.75	0.85	0.47	0.68
West Coast	0.81	0.56	0.69	0.57	0.60	0.72	0.55	0.75	0.37	0.43	0.93	0.59	0.59	0.49	0.69
Canterbury	0.72	0.78	0.79	0.74	0.59	0.74	0.60	0.77	0.59	0.70	0.74	0.91	0.71	0.53	0.88
Otago	0.62	0.57	0.61	0.63	0.69	0.76	0.53	0.77	0.30	0.76	0.81	0.73	0.93	0.61	0.72
Southland	0.56	0.57	0.71	0.56	0.52	0.57	0.52	0.68	0.21	0.44	0.68	0.60	0.61	0.92	0.67

Note: Regional and aggregate economic activity data, natural logged and filtered using quarterly business cycle band-pass filter described in Baxter King (1999)

Table 1 (continued)

Regional business cycle comovement and persistence, 1975q1 – 2006q2

C. Lead/lag correlation for t + 4

Economic activity at time t + 4

Activity at time t	Nthld	Auck	Waik	BOP	Gisb	HB	Tar	M-W	Well	NM	WC	Cant	Otago	Sthld	NZ
New Zealand	0.28	0.21	0.15	0.12	0.12	0.05	0.05	-0.10	0.21	-0.10	0.16	0.06	-0.05	-0.14	0.17
Northland	0.21	0.29	0.24	0.12	0.12	0.17	0.25	0.03	0.20	0.04	0.18	0.08	0.02	-0.18	0.19
Auckland	0.28	0.09	0.08	0.11	0.00	-0.11	-0.12	-0.21	0.29	-0.22	0.02	0.01	-0.17	-0.16	0.13
Waikato	0.09	0.17	0.10	0.05	0.06	0.04	0.10	-0.10	0.05	-0.04	0.07	0.01	-0.11	-0.28	0.14
Bay of Plenty	0.25	0.19	0.15	0.06	0.10	0.09	-0.04	-0.11	0.26	-0.18	0.12	0.00	-0.12	-0.13	0.39
Gisborne	0.46	0.43	0.35	0.33	0.27	0.34	0.17	0.28	0.39	0.00	0.43	0.16	0.15	0.04	0.23
Hawkes Bay	0.29	0.27	0.19	0.11	0.19	0.20	0.25	0.09	0.13	0.09	0.28	0.14	0.17	-0.04	0.32
Taranaki	0.20	0.51	0.34	0.29	0.42	0.41	0.49	0.29	0.09	0.41	0.43	0.37	0.36	-0.05	0.29
Manawatu-Wanganui	0.32	0.34	0.31	0.24	0.25	0.30	0.25	0.10	0.14	0.12	0.26	0.21	0.18	0.03	-0.17
Wellington	0.03	-0.17	-0.23	-0.25	-0.19	-0.38	-0.23	-0.48	0.09	-0.45	-0.24	-0.28	-0.37	-0.31	0.30
Nelson-Marlb.	0.32	0.29	0.22	0.25	0.38	0.36	0.18	0.21	0.07	0.24	0.45	0.24	0.37	0.08	0.27
West Coast	0.30	0.37	0.33	0.18	0.15	0.19	0.35	0.10	0.15	0.04	0.22	0.14	0.06	0.02	0.23
Canterbury	0.27	0.31	0.21	0.17	0.28	0.22	0.18	0.03	0.11	0.08	0.32	0.16	0.13	-0.07	0.36
Otago	0.38	0.40	0.31	0.32	0.40	0.34	0.25	0.29	0.11	0.20	0.49	0.26	0.29	0.21	0.27
Southland	0.25	0.37	0.40	0.26	0.23	0.19	0.32	0.24	-0.04	0.09	0.34	0.22	0.09	0.21	0.17

Note: Regional and aggregate economic activity data, natural logged and filtered using quarterly business cycle band-pass filter described in Baxter King (1999)

Table 2. Trend Regional Growth Rates (Average annualised percentages)

14-regions	Trend Growth Rate, δ_{it}				5-regions	Trend Growth Rate, δ_{it}			
	1975q2 - 1986q4	1987q1 - 1991q1	1991q2 - 2006q2	$\sigma_{\mu i}$		1975q2 - 1986q4	1987q1 - 1991q1	1991q2 - 2006q2	$\sigma_{\mu i}$
Northland	4.08	1.67	3.74	2.4E-05	Auckland	3.59	2.84	3.13	.0001
						(9.69)	(3.35)	(11.21)	
Auckland	3.90	1.04	3.14	3.7E-05	Wellington	2.71	0.95	3.13	.0001
						(5.70)	(0.85)	(10.76)	
Waikato	3.07	2.78	3.48	2.6E-05	Rest of	3.05	1.43	3.14	.0001
					North Island	(9.40)	(2.33)	(13.59)	
Bay of Plenty	4.18	1.09	3.10	3.7E-05	Canterbury	2.55	3.57	3.40	.0001
						(5.50)	(2.89)	(9.00)	
Gisborne	2.28	-1.50	2.59	1.9E-05	Rest of	2.52	0.92	2.96	.0066
					South Island	(7.26)	(1.63)	(18.69)	
Hawke's Bay	2.82	0.78	2.85	7.1E-05					
Taranaki	2.49	2.18	3.38	2.9E-05					
Manawatu	3.54	0.81	2.40	4.8E-05					
Wellington	2.66	0.63	3.21	3.7E-05					
Nelson	3.27	1.31	3.52	3.3E-05					
West Coast	1.49	2.02	3.09	1.6E-05					
Canterbury	2.69	3.08	3.42	2.7E-05					
Otago	2.21	0.09	2.98	4.7E-05					
Southland	2.62	-0.19	2.43	0.0070					

Notes: $\sigma_{\mu i}$ is the standard deviation of the innovation to the regional trend, initial value of $\sigma_{\mu i}$ being 0.13; z-statistics in parentheses.

Table 3. Sensitivity to the common cycle, of economic activity in region i (Normalised to unity for Auckland)

14-regions	Sensitivity coefficient, γ_i	5-regions	Sensitivity coefficient, γ_i	
Northland	1.249	Auckland	1.000	
Auckland	1.000	Wellington	0.962	(5.02)
Waikato	1.071	Rest of North Island	1.096	(7.07)
Bay of Plenty	1.073	Canterbury	1.252	(7.78)
Gisborne	0.705	Rest of South Island	0.996	(7.20)
Hawke's Bay	0.999			
Taranaki	0.916			
Manawatu	1.260			
Wellington	0.950			
Nelson	0.796			
West Coast	0.881			
Canterbury	1.139			
Otago	1.122			
Southland	1.006			

Notes: z-statistics in parentheses.

Table 4. Common cycle parameters

14-regions		5-regions	
Coefficient	**ParameterValue**	**Coefficient**	**Parameter Value**
ρ_1	0.999	ρ_1	0.995 (8.57)
ρ_2	-0.279	ρ_2	-0.286 (2.50)
Monetary policy	-0.024	Monetary policy	-0.031 (0.88)
Terms of Trade	0.026	Terms of Trade	0.031 (0.83)
Immigration	0.023	Immigration	0.054 (1.84)
σ_n	2.86E-05	σ_n	.0001
LR	4.0	*LR*	17.2

Notes: ρ_1 and ρ_2 are the autoregressive coefficients; σ_n is the standard deviation of the common cycle; z-statistics in parentheses; *LR* denotes the likelihood ratio test for the test that the three drivers of the common cycle are jointly and significantly different from zero. The 5 per cent critical value taken from the asymptotic Chi-squared distribution with three degrees of freedom is 7.81.

Table 5. Variances of Cyclical Components (Percentage points)

14-regions

	Common Cycle	Idiosyncratic cycle	Covariance of cycles	Overall Cycle
Northland	2.77	12.50	-2.03	13.23
Auckland	1.78	13.92	0.34	16.04
Waikato	2.04	3.29	-0.84	4.49
Bay of Plenty	2.05	6.61	0.17	8.83
Gisborne	0.88	12.84	-0.24	13.48
Hawke’s Bay	1.77	3.31	-0.97	4.10
Taranaki	1.49	33.42	-2.29	32.62
Manawatu	2.82	12.96	-1.05	14.72
Wellington	1.60	5.67	-0.69	6.59
Nelson	1.13	15.52	-0.69	15.96
West Coast	1.38	9.52	-0.83	10.07
Canterbury	2.30	6.58	-1.15	7.73
Otago	2.24	5.73	-0.87	7.10
Southland	1.80	10.70	0.98	13.48

5-regions

	Common Cycle	Idiosyncratic cycle	Covariance of cycles	Overall Cycle
Auckland	1.76	5.72	-0.36	7.12
Wellington	1.62	4.60	-0.82	5.40
Rest of North Island	2.11	3.63	-0.71	5.03
Canterbury	2.75	4.98	-0.63	7.10
Rest of South Island	1.74	2.62	0.70	5.06

Table 6. Regional cycle parameters

region	Φ Matrix				
	AKL	WLG	RNI	CA	RSI
AKL	**0.89**	0.04	0.11	0.05	0.11
WLG	0.02	**0.57**	-0.07	0.34	-0.41
RNI	-0.09	-0.21	**0.88**	0.19	-0.16
CA	-0.09	-0.02	0.12	**0.98**	-0.01
RSI	-0.17	-0.10	-0.04	0.18	**0.78**

Figure 1. New Zealand’s 14-region Common and Region-specific Cycles Deviations from trend

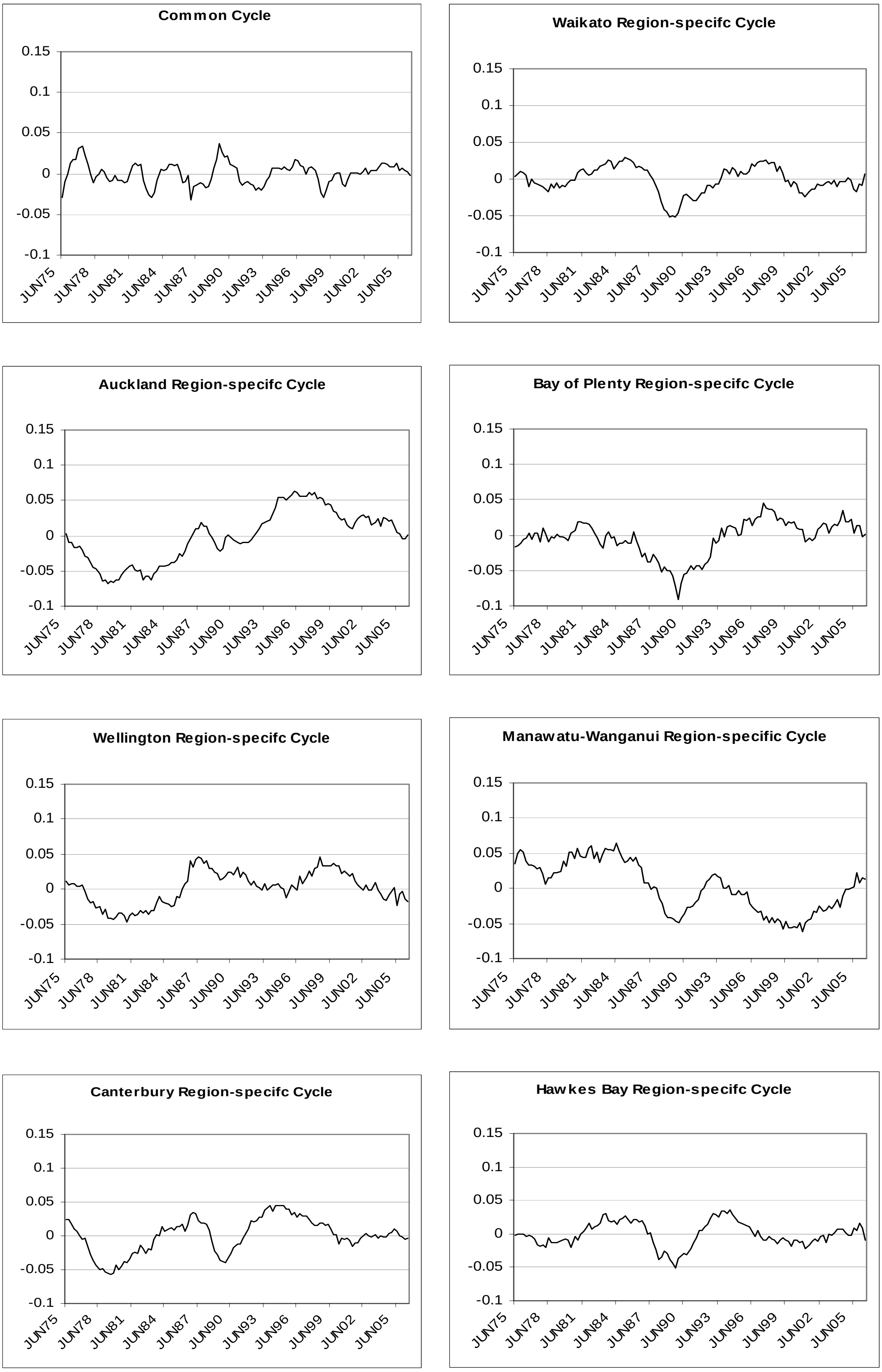


Figure 1. (continued)

New Zealand’s 14-region Common & Region-specific Cycles
Deviations from trend

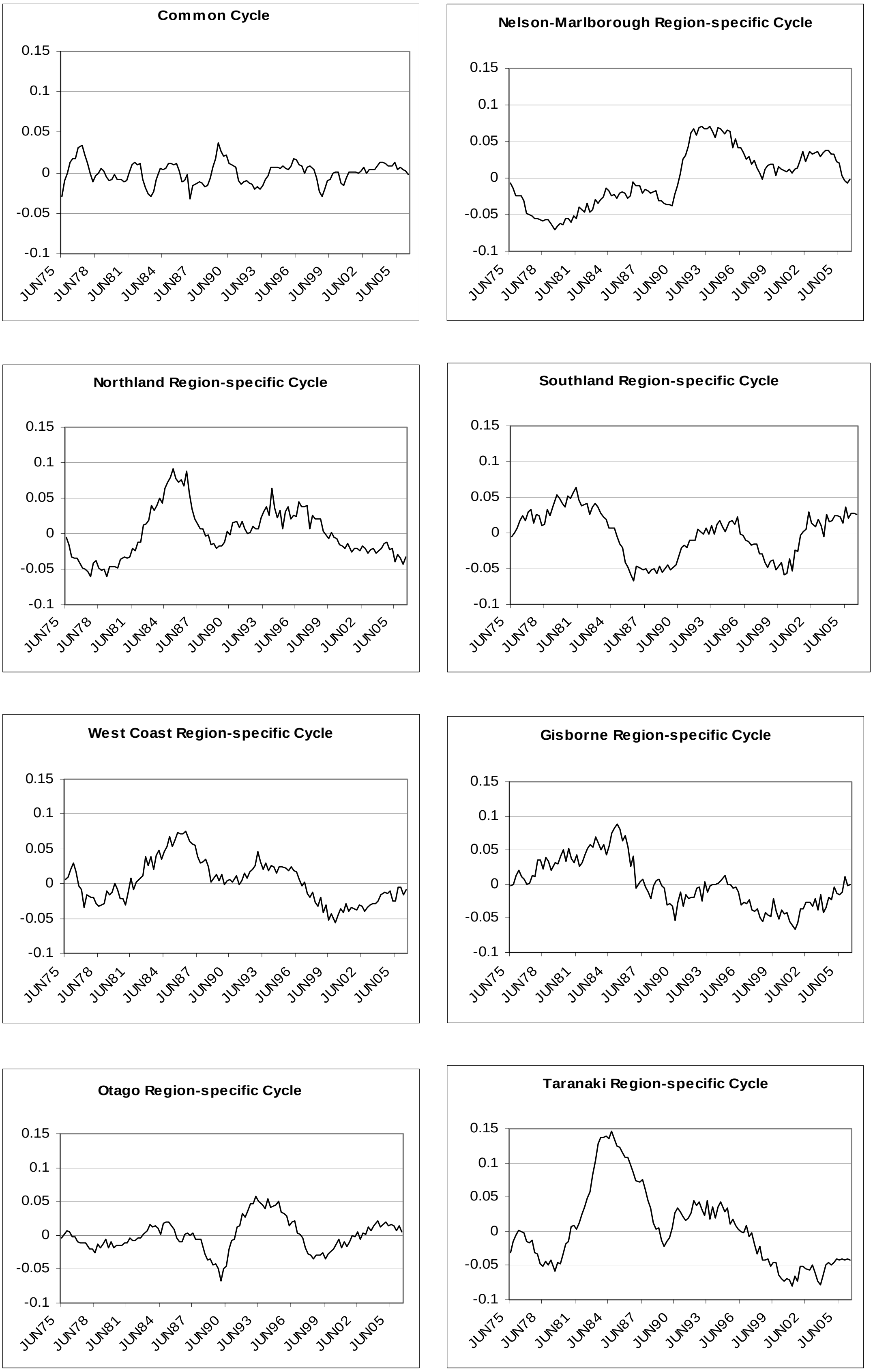


Figure 2. New Zealand's 5-region Common and Region-specific Cycles
Deviations from trend

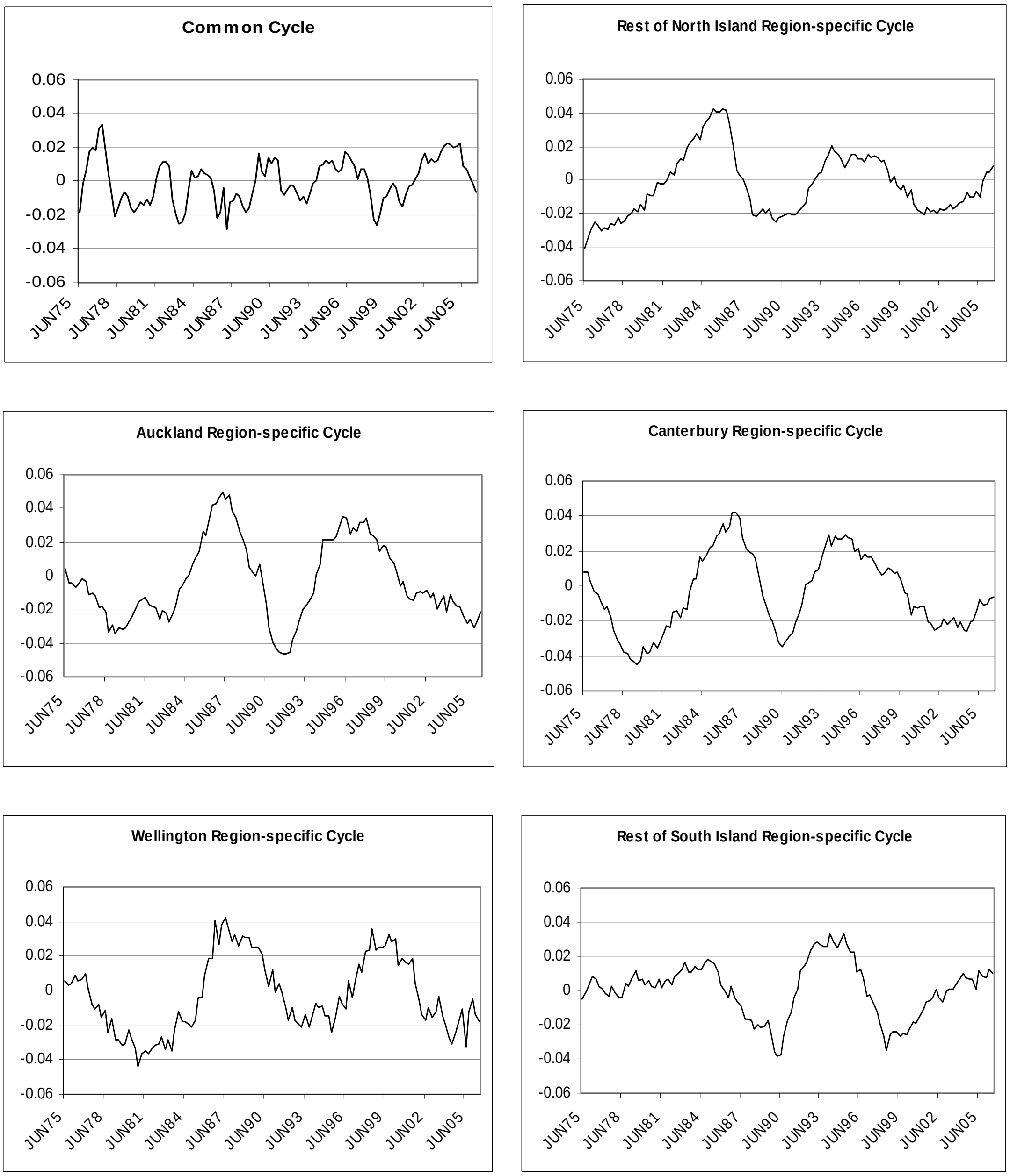
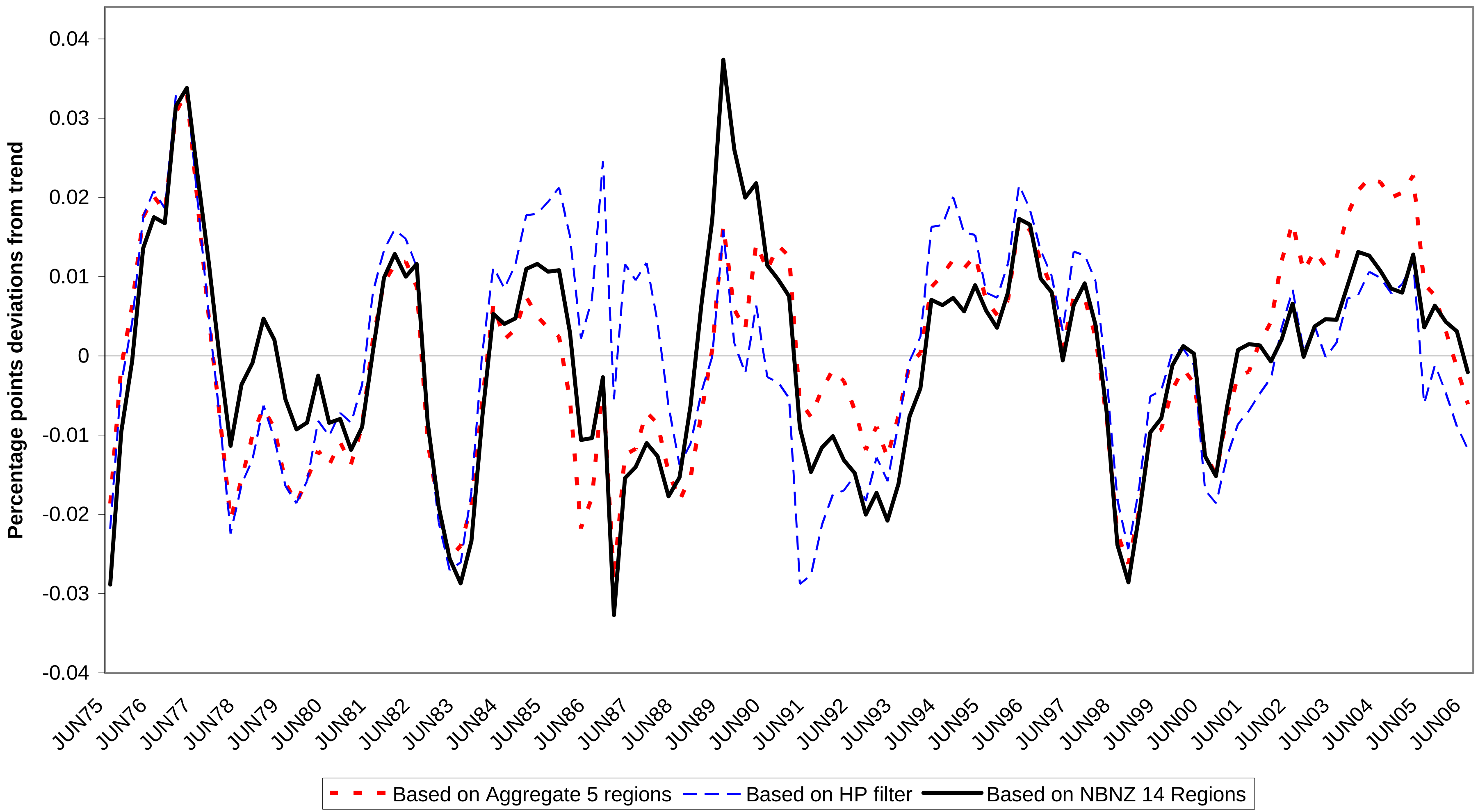


Figure 3. New Zealand's Common and HP Aggregate Activity Cycles



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