THE NEW ZEALAND BUSINESS CYCLE: RETURN TO GOLDEN DAYS?

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Abstract

The current economic expansion is one of the more enduring in New Zealand’s post-war period. But is this a change from past behaviour? We examine New Zealand’s post-war business cycles for the sample period 1946q1 to 2005q4, using a newly developed 60-year quarterly time series for real GDP. The non-parametric Bry and Boschan (1971) algorithm is used to derive Classical business cycle turning points, and to underpin the establishment of key cycle characteristics. The latter include cycle asymmetries, volatility, diversity and degree of duration dependence. Markov-switching models estimated by Gibbs-sampling methods (Kim and Nelson, 1999), are then used to derive mean growth rate and volatility regimes, and to draw implications. Results point to a return to a more rhythmic pattern of long expansions and short contractions, after that pattern was interrupted following the oil shocks of the 1970s and New Zealand’s reforms of the mid- to late-1980s and early 1990s. More rhythmic patterns should not be mistaken for a predetermined pattern, as duration test results show that cycle expansion paths do not age. This, together with the observation that rates of growth are not dissimilar across the more sustained expansion phases, implies that in order to enhance New Zealand’s prosperity, policies are required that extend business cycle expansions without allowing the excesses that undermine those expansions to build up.

JEL Classification E23 Production; E32 Business Fluctuations, Cycles

Key Words Classical business cycles, growth cycles, cycle duration, New Zealand
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1. Introduction

The current expansion phase of the New Zealand business cycle has been an enduring one – one that has left most macroeconomic indicators in very good shape. But is this a change from past behaviour?

Statistics New Zealand’s (SNZ) preferred SNC time series for quarterly real GDP is only available back to 1987, and its corresponding SNB series started only in 1977. This means that even after linking the two series, we would have only three or four complete Classical business cycles to work with.

However, by drawing on longer official and non-official annual real GDP series, and quarterly non-official data, we are able to temporally disaggregate the annual data into a new quarterly series, spanning the considerably longer period, 1946q1 to 2005q4. This provides eight Peak to Peak (P-T-P) cycles. The eight cycles are sufficient for us to be able to form preliminary views on key characteristics for New Zealand’s post-WWII Classical business cycles, to enable estimation of mean growth rate and volatility regimes, and to draw implications.

The main contributions of this paper are firstly, that we develop a new quarterly time series for New Zealand’s real GDP, covering the 60-year period 1946 to 2005, and present a new consistently derived set of Classical business cycle turning points. These extend back to 1946 the quantitatively-derived turning points presented in Hall and McDermott (HMcD) (2005) and Kim, Buckle and Hall (KBH) (1995), and also provide a somewhat extended and more quantitatively derived set than those offered in Easton (1997). Secondly, we estimate Markov-switching models by Gibbs-sampling methods. Thirdly, we establish business cycle growth rate and volatility regimes for a considerably longer time horizon than those reported in Buckle, Haugh and Thomson (2004)2. Fourthly, we use our sets of turning points and growth rate regimes to draw inferences on the nature of the business cycle, and to offer tentative economic policy implications.

∗ We thank James Tremewan for professional programming and research assistance, funded by a research grant from VUW’s School of Economics and Finance (SEF). Steve Edwards, Graham Howard and Lauren Rosborough have assisted valuably with data compilation, and Brian Easton provided very helpful insights on key data periods. We also acknowledge helpful comments from presentations to Motu Economic and Public Policy Research, the June 2005 Annual Conference of the New Zealand Association of Economists, a joint CAMA/RSSS Workshop at the ANU, the May 2006 A R Bergstrom Memorial Conference at the University of Essex, and the Reserve Bank of New Zealand. We have benefited considerably from Adrian Pagan’s detailed comments an early draft, and from stimulating discussions with him.

1 The HMcD, KBH and Easton turning points, together with earlier ones published by Haywood (1972), Haywood and Campbell (1976) and Kay (1984), are summarised in Table 1.

2 The Buckle, Haugh and Thomson (2004) sample period was 1978q1 to 2003q2.
The development of our new quarterly time series is described in section 2. Our Classical business cycle turning points and non-parametric cycle characteristics are presented in section 3. Results from two tests for duration dependence are reported in section 4. In section 5, results from estimating our Markov-switching models provide mean growth rate and volatility regimes, and enable us to draw implications. Conclusions are drawn in section 6.

2. Data

Our new quarterly real GDP time series covers the post-WWII sample period, 1946q1 to 2005q4 (see Figure 1). Its construction has involved piecing together data from various sources, and scaling the linked series to a 1995/96 base.

Official data has been used where available, but SNZ quarterly real GDP series start only in 1977q2. We therefore employ their SNB series (1991/92 base) for the period 1977q2 to 1987q1, and for the period 1987q1 to 2005q4 observations are taken from their SNC series (1995/96 base). For the period 1946 to 1977, however, annual observations obtained from SNZ’s long-term data series webpage, had to be the starting point. For the period 1946 to 1955, these observations are based on annual growth rates presented in Easton (1990), and for 1955 to 1977, the source is SNZ’s annual data SNB series (1991/92 base).

The annual GDP data is temporally disaggregated into a quarterly series using the regression approach of Chow and Lin (1971). The objective of the method is to derive an estimate of the underlying quarterly GDP series by exploiting information from related time series. Two diffusion indices constructed by Haywood and Campbell (1976) (HC) are the best information available on quarterly fluctuations in aggregate economic activity during this time period. From 63 time-series indicators, HC construct a weighted classical cycle index and a weighted amplitude adjusted index for the period 1947q1 to 1974q4. We extended this series out to 1977q4 using the weighted static deviation cycle index used in Easton (1997) and an assumed trend consistent with the indices of HC. All results presented below are based on the slightly smoother weighted classical cycle index.

3. Dating and characterising the Classical cycle

Bry-Boschan (1971) and Markov-switching (MS) methods have been advanced as useful for dating business cycle turning points, based on each having had considerable success in replicating the set chosen for the US by the NBER business cycle dating committee. Debate on the relative strengths of the Bry-Boschan and Hamilton (1989) approaches to cycle dating and to the provision of projections, can be found in Harding and Pagan (2003a, 2003b) and in Hamilton (2003). For the purposes of determining cyclical turning points and characterising cycles, and due essentially to differences between the methods relating to simplicity, transparency and robustness to


4 Analysis using the weighted amplitude adjusted index yields similar results. The only potentially material difference is that the growth slowdown in 1961 is declared as a classical contraction when the weighted adjusted index is used but not when the weighted classical index is used. But given that HC found that no classical contraction occurred in 1961, we prefer to use the weighted classical index.
the data generating process, Harding and Pagan conclude that the Hamilton Markov-switching approach has little attraction, relative to the Bry-Boschan algorithm. But they also suggest that the Markov-switching approach may provide a “better vehicle for prediction”.5

For more than a decade, the Bry-Boschan method has been applied successfully to assist in dating turning points for the New Zealand economy.6 One advantage of the Bry-Boschan method is that the dating of turning points in the series is largely determined by movements around the local minima or maxima. Thus, the addition of new observations to the times series rarely alters previously dated turning points.7 Moreover, large outliers in the times series do not influence the dating of turning points other than the point of the closest local minima or maxima. This is not the case for the MS method, under which large outliers can influence the model’s parameters and thus all cycle regimes.

In this paper, therefore, we utilise the non-parametric BB algorithm to underpin our business cycle dating, and estimate MS models to identify our business cycle growth and volatility regimes. In particular, we use what Harding and Pagan (2002, pp 369, 371) refer to as the BBQ algorithm. This algorithm in made up of two parts: (i) turning point identification, and (ii) a minimum phase and cycle rule. Turning points are identified as follows: peak at \( t = \{(\Delta^2 y_t, \Delta y_t) > 0, (\Delta y_{t+1}, \Delta^2 y_{t+2}) < 0\} \) and trough at \( t = \{(\Delta^2 y_t, \Delta y_t) < 0, (\Delta y_{t+1}, \Delta^2 y_{t+2}) > 0\}, \) where \( \Delta^2 y_t = y_t - y_{t-2} \). The minimum phase and cycle rule is such that each phase of the business cycle is required to be at least two quarters in duration and a complete cycle must be at least five quarters in duration. Turning points that fail this minimum phase and cycle condition are censored.

In using the BBQ algorithm, we recognise that the binary random variables coming from a non-parametric termination rule are conceptually distinct from those coming from a parametric termination rule, but that in practice the two sets of binary observations can often be quite close.8 This means that while a basic two-state MS model has been utilised with considerable success to replicate US turning points, it need not automatically follow that it should be as successful when used on real GDP series for a country such as New Zealand. In what follows, our non-parametric phases or states between business cycle turning points are termed “expansions” and “contractions”, and the states derived from the parametric models are referred to as “high-growth” and “low-growth” periods of the business cycle.

The resulting BBQ Peaks and Troughs are presented in Table 1, and the corresponding turning point dates for expansion and contraction phases appear in the second and third columns of Table 2. The BBQ procedure identifies nine classical

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5 See Chauvet and Piger (2003) for real time estimations and projections for US data, and for their “recession probability index”.

6 For examples, see Kim, Buckle and Hall (1995) who use the method to establish turning points for both production and expenditure-based GDP series; Hall, Kim and Buckle (1996) for Pacific Rim business cycles, including for New Zealand; and Hall and McDermott (2005) who utilise National Bank of New Zealand regional activity data from 1975q1 to 2002q1 to establish turning points for regional economic activity.

7 Of course, revisions to the historical times series can and do alter somewhat, previously dated turning points. See Hall and McDermott (2005, fn 17).

8 See Pagan (2005, pp 7-8) on this distinction.
contractions that are considered important episodes in New Zealand’s economic history.

The more recent, commonly known contractions seem to be represented well, as the contractions of the early 1980s and 1990 are clearly identified. The “Asian financial crisis” contraction is also well identified. Earlier in the period, the BBQ algorithm identifies a number of contractions that occurred around the time of exchange rate crises which were experienced in 1957 to 1958 and 1966 to 1967 (Hawke 1985, p 174). Previous research has identified other exchange rate crisis episodes around 1955 and 1961 as contractions, but while those episodes are clearly growth slowdowns they are not classical contractions. This conclusion is consistent with conclusions drawn by Haywood and Campbell (1976). It is also consistent with the history recorded by King (2004, p 431) who identified particular episodes in the 1950s as important, as in his view “Apart from the temporary drop in overseas reserves which triggered the Labour Government’s ‘Black Budget’ in 1958, and its highly unpopular reimposition of severe import controls, the 1950s was generally a prosperous decade – especially after the Korean War created a sales boom for New Zealand wool.”

Figure 1 summarises the turning points and phases of the New Zealand business cycle. The shaded areas represent the contraction phases, with peaks and troughs at their left- and right-hand edges respectively. Individual expansion phases are shown in Figure 2.

Cycle characteristics for duration, amplitude, cumulated gains or losses, and excess gains or losses are presented in Table 2. They cover individual expansion and contraction phases, and their average values. Together with the coefficients of variation (CV), these descriptive statistics enable us to form summary judgements on the range of asymmetries and the degrees of volatility associated with the New Zealand cycle.

The average duration for expansion phases has been over 5 years (20.6 quarters), considerably longer than the average contraction phase of a year (4.0 quarters). New Zealand’s average expansion phase, for not dissimilar periods\(^9\), is somewhat longer than those reported by Harding and Pagan (2002, p 372) for the US (17.8 quarters) and the UK (16.1 quarters), but identical to Australia’s (20.6 quarters). The average contraction phase for New Zealand is somewhat longer than those of the other three countries (3, 3.75 and 3.3 quarters, respectively). The CV of 0.47, associated with the average expansion duration, reflects noticeably different durations for the individual phases, and is somewhat lower than the US experience (0.60)\(^{10}\). Also striking, though, is the influence of two relatively long six and seven quarter contraction phases during the first half of the sample, which contribute to the CV of 0.4, 18 percent greater than the figure of 0.34 for the US.

The mean amplitude of New Zealand’s expansion phases is 21.1 percent, above that of the UK (14.5) but close to amplitudes for the US and Australia (20.2 and 24.7). The

\(^9\) The data periods were 1947q1 to 1997q1 for the US, 1955q1 to 1997q1 for the UK, and 1959q1 to 1997q1 for Australia.

\(^{10}\) See Pagan (2005, p 12) for the CV figures for the US, covering the extended period 1947q1 to 2002q2.
corresponding CV of 0.58 is again similar to that for the US (0.56). The average contraction-phase amplitude of -4.1 percent is below those of Australia (-2.2), the US (-2.5), and UK (-2.5). However, it is again striking that for the contraction-phase amplitude, New Zealand’s CV of -0.78 percent is greater in absolute terms than the CV of -0.52 for the US.

These results provide clear evidence of asymmetry for the average duration and amplitude of the New Zealand business cycle, considerable evidence of individual cycle diversity, and preliminary evidence of greater than “standard” volatility of cycles, especially over contraction phases. The key difference of the New Zealand business cycle relative to those of Australia, the US and the UK is the longer duration of contractions.

But what of cycle “shape”, which combines knowledge of durations and amplitudes? Two illustrative measures offered by Harding and Pagan (2002) are “triangle area” cumulated gains or losses in real GDP relative to no growth, and excess gains or losses relative to a constant rate of growth. These measures further confirm considerable diversity across cycle phases. The average cumulated gain during expansions is 264 percent for New Zealand, a measure straddling the 196 percent for the UK, 256 percent for the US and 320 percent for Australia. New Zealand’s average cumulated losses during contractions of 9.8 percent have been somewhat greater than those sustained by the others (4.1, 6.1 and 4.0 percent respectively), with its largest losses accumulated during two of the early period contractions. The average excess loss of 7.3 percent is similar to that of the US (6 percent) but the excess gain of 0.5 percent is well below that of the US (9 percent). A number of New Zealand expansions seemed to be very hesitant in their initial stages.

4. Testing for Duration Dependence

Classifying economic fluctuations into expansions and contractions naturally leads to thinking about the length of time until a given phase of the cycle comes to an end and whether the time already spent in a phase influences the probability of that phase ending. We use two tests for duration dependence: the Brain-Shapiro (1983) test as used by Diebold and Rudebusch (1990); and the state-based (SB) test of Ohn, Taylor and Pagan (2004) (OTP). The null hypothesis of both tests is that the probability of exiting a phase is independent of the length of time the economy has already been in that phase, i.e. no duration dependence.

The Brain-Shapiro test is based on the regression

\[ z_i = \alpha + \beta i + e_i, \quad i = 2, \ldots, N \]

For details, see Pagan (2005, pp 8-12). Pagan cautions that the excess area measure may not be very reliable for contractions where these are very short, and that as a measure of “shape” of the cycle it is not completely satisfactory where the phase line moves above and below the hypotenuse of the triangle.
where \( z_i = (N-i+1)\left(x_i - x_{i-1}\right) \), \( N \) is the number of phases, and \( x_i \) is the number of quarters in each \( i \)th ordered duration \( (x_1 < \ldots < x_N) \). The hypothesis of no duration dependence is given by \( \beta = 0 \). The OTP-SB test is based on the regression

\[
S_t = \alpha + \beta d_{t-1} + e_t
\]

where \( S_t \) is the state variable which equals one in expansions and zero in contractions, and \( d_t \) is the number of consecutive quarters spent in an expansion (less one) up to time \( t \). Unity is subtracted from the duration to account for the minimum phase censoring rule. The regression is run only on half-cycle data; for example, when considering duration dependence for expansions, contraction periods are excluded from the regression. The hypothesis of no duration dependence is again given by \( \beta = 0 \) but in this case standard \( t \)-tables cannot be reliably used and appropriate \( p \)-values must be simulated from a geometric distribution. We use a simulation size of 10,000, as in OTP.

Density estimates of duration data or simple plots of the hazard functions are suggestive of some positive duration dependence (i.e. the probability of an expansion or contraction phase of the business cycle increasing the longer the economy is in a given phase). However, given the relatively small number of business cycles in our sample, we need to be cautious interpreting such plots, so we use the formal test of duration dependence to examine whether this suggestion is spurious.

For expansions, the Brain-Shapiro and OTP-SB \( p \)-values are 0.218 and 0.054, respectively. The corresponding \( p \)-values for contraction phases are 0.268 and 0.015. For expansions, therefore, we have no evidence to reject the null hypothesis of no duration dependence\(^{12}\). But for contractions, the evidence is less clear cut.

In this context, with only eight expansion phases and nine contraction phases in our sample, the power of the formal tests used is likely to be relatively low. So, to supplement our evidence, we consider the duration of economic expansions from 1860 to 2005, based on the long-term SNZ data series referred to above\(^{13}\). There are 21 completed expansions for this 146 year period, yielding Brain-Shapiro and OTP-SB \( p \)-values of 0.359 and 0.078. There appears to be even less evidence of duration dependence, for the longer sample period.

In other words, New Zealand business cycle expansion paths are likely not to have died of old age, but rather to have been terminated by particular events. Potential candidates for such events include unusually dry climatic conditions (Buckle et al., 2002; Hall and McDermott, 2005), external price shocks (Wells and Evans, 1985; Buckle et al., 2002; Hall and McDermott, 2005), excessive movements in asset price (especially housing), and the efficacy of monetary policy. Other candidates include structural policy, resilience to shocks, and the effectiveness of New Zealand’s major policy reforms of the mid- to late-1980s and early 1990s.

\(^{12}\) These findings are consistent with the results reported in Hall and McDermott (2005, Table 5), for turning points in National Bank of New Zealand (NBNZ) aggregate economic activity, between 1975q1 and 2002q1.

\(^{13}\) Unfortunately, we cannot analyse contractions. Most contractions last a year or less, so an estimate of the durations of contractions cannot be obtained from annual data.
5. Parametric Approaches: the Stochastic Behaviour of Output Growth

The historically diverse nature of business cycles in New Zealand, suggested by the key characteristics presented in Table 2, is intriguing. The salient feature of the data seen in Figure 1 is its changing growth and volatility over time. Consider the period 1946q1 to 1955q4, termed by us the “post-WWII adjustment” period. It has a reasonable growth rate (3.2 percent), but high volatility as measured by standard deviations of annualized growth ($\sigma = 0.46$). The key feature of the period 1956q1 to 1976q4, which we refer to as the “golden days” period, is high growth (3.7 percent) and moderate volatility ($\sigma = 0.21$). The “terms of trade shock and reform” period, 1977q1 to 1991q4, is one of low growth (1.0 percent) and moderate volatility ($\sigma = 0.22$). Finally, the last period (1992q1 to 2005q4), which we refer to as “new golden days”, is one of high growth (3.3 percent) and low volatility ($\sigma = 0.16$).

To explore these features of the data further we employ an autoregressive model with possible regime change to the growth rate and volatility, to examine the stochastic behaviour of economic fluctuations. That is, we adopt a regime-switching model. This model assumes that the mean growth rate and variance of real GDP evolves according to a two-state Markov-switching process. State one refers to periods when growth is low and variance is high, while state two refers to periods when growth is high and variance is low.¹⁴ This is a natural model to choose in the current context, because it allows for the possibility of structural change in the data being only temporary and the data reverting to behaviour seen early in the sample. The model we use assumes that the log of real GDP growth (denoted $y_t$) follows the process

$$\Delta y_t - \mu_{s_t} = \phi_1 (\Delta y_{t-1} - \mu_{s_t}) + \phi_2 (\Delta y_{t-2} - \mu_{s_t}) + u_{s_t}$$

where $s_t = 1$ if the economy is in a low-growth high-variance state at date $t$, and $s_t = 2$ if it is in a high-growth low-variance state at date $t$. Based on some data exploration and initial estimates of the Akaike Information Criteria (AIC) we start with an AR(2) model.

We assume that the transition from different states follows a first-order Markov process where the transition probabilities are given by $p_{ij} = \text{Pr}(S_t = j \mid S_{t-1} = i)$, subject to the constraints $0 \leq p_{ij} \leq 1$, $p_{11} + p_{12} = 1$ and $p_{21} + p_{22} = 1$.

Our estimation strategy is based on the Bayesian Gibbs-sampling approach. For Bayesian inference of the model, given appropriate priors, we need the marginal posterior distributions for the following: $\mu = (\mu_1 \mu_2)'$; $\phi = (\phi_1 \phi_2)'$; $\sigma = [\sigma_1 \sigma_2]'$; $S_T = [S_1, \ldots, S_T]$; and $p = [p_{11} p_{22}]'$. As outlined by Kim and Nelson (1999) these marginal

¹⁴ We experimented with variations of this model. We considered a three-state model, to allow for the possibility of a high-growth high-variance state. While the post-WWII adjustment period would seem a likely candidate for such a state, the post-WWII adjustment period is relatively short and we could not get the data to fit the model well. The three-state model seemed to be over-parameterized for the available data. This is in contrast to results from Buckle, Haugh and Thomson’s (2004) considerably shorter period, estimated from a wider set of Markov-switching models by the method of maximum likelihood. Their preferred 3-2 model suggested 3 growth rate and 2 volatility regimes for the period 1978q1 to 2003q2.
posterior distributions may be obtained from the joint posterior distribution, \( p(\mu, \phi, \sigma, S_T, p, Y_T) \), where \( Y_T = [\Delta y_1, \ldots, \Delta y_T]' \). Gibbs sampling can be used to obtain the marginal posterior distributions of interest. This is done by successively sampling from the full conditional densities. Kim and Nelson outline the sampling procedure as iterating the following five steps:

1. Generate \( \mu \), conditional on \( \phi, \sigma, S_T \) and \( Y_T \);
2. Generate \( \phi \), conditional on \( \mu, \sigma, S_T \) and \( Y_T \);
3. Generate \( \sigma \), conditional on \( \mu, \phi, S_T \) and \( Y_T \);
4. Generate \( S_T \), conditional on \( \mu, \phi, \sigma, p \) and \( Y_T \);
5. Generate \( p \), conditional on \( S_T \).

The prior distributions are:

1. \( \mu_1 \sim N(0, 0.04) \), \( \mu_2 \sim N(1, 0.04) \), \( \phi_1 \sim N(0.4, 0.04) \), \( \phi_2 \sim N(0.2, 0.04) \), \( 1/\sigma_j^2 \sim Gamma(1,1) \), and \( p_j \sim Beta(9,1) \), where \( Beta(., .) \) and \( Gamma(., .) \) refer to the Beta distribution and Gamma distribution, respectively. The Bayesian posterior estimates for the sample period 1947q1 to 2005q4 and for the sample period 1956q4 to 2005q4 are reported in Table 3. The plotted, smoothed probabilities \( Pr(S_t = j | \Delta y_1, \Delta y_2, \ldots, \Delta y_T; \hat{\theta}) \), are presented in Figure 1’s second panel.

Before we discuss our estimation results we briefly note the diagnostics used to satisfy ourselves that the Markov chain has converged to something sensible. The first test we use is the Geweke (1992) statistic, which aims to monitor convergence of each scalar estimand and can be useful in determining the appropriate burn-in size. We guessed the initial burn-in size to be 1,000 simulations. Following the suggestion of Gelman et al (2004) we then tested whether the initial burn-in size was appropriate. If not the burn-in size was doubled. This procedure continued until the burn-in size was sufficient according to the formal diagnostics. The Geweke (1992) statistic is defined as

\[
z = \frac{\bar{\theta}_a - \bar{\theta}_b}{\sqrt{\text{Var}(\bar{\theta}_a) + \text{Var}(\bar{\theta}_b)}} , \]

where \( \bar{\theta}_a = \frac{1}{n_a} \sum_{i=N+a+1}^{N+n_a} \theta_i \) and \( \bar{\theta}_b = \frac{1}{n_b} \sum_{i=N+n_a+1}^{N+n_a+n_b} \theta_i \) for a chain run \( N+n \) steps with \( n > n_a + n_b \). The variances are estimated using the Newey-West estimator. The distribution of \( z \) is approximated standard normal if the chain has converged. Computing \( z \) for a range of values \( N \), provides a guide for the required burn-in. In practice a large range of \( N \) can be computed very quickly but to save space we show results in Table 3, only for the final case where \( N = 11,000 \) and \( n_a = n_b = 500 \).

The second test we used was the Gelman and Rubin (1992) test which is designed to monitor the convergence of each scalar estimand. Gelman and Rubin (1992) propose simulating \( m \) parallel chains, each of length \( n \) (after excluding the burn-in period of 10,000 replications). For each scalar estimand \( \theta \), denote the simulation draws as \( \theta_{ij} \) \( (i = 1, \ldots, n; j = 1, \ldots, m) \), and compute the between-chain variance as

\[
B = \frac{n}{m-1} \sum_{j=1}^{m} (\bar{\theta}_j - \bar{\theta})^2 , \]

where \( \bar{\theta}_j = \frac{1}{n} \sum_{i=1}^{n} \theta_{ij} \), \( \bar{\theta} = \frac{1}{m} \sum_{j=1}^{m} \bar{\theta}_j \).
and the within-chain variance as

\[ W = \frac{1}{m(n-1)} \sum_{j=1}^{m} \sum_{i=1}^{n} (\theta_{ij} - \bar{\theta})^2. \]

An estimate of the total variance is given by

\[ V = \frac{n-1}{n} W + \frac{1}{n} B. \]

Gelman et al (2004) suggest using \( R = \sqrt{V / W} \) as a measure of convergence and accepting convergence if \( R < 1.1 \), although they note that the exact criteria depends on the problem under consideration. For our purposes their recommendation is suitable. In our simulation exercise we run thirty parallel chains \( (m = 30) \), each of length 10,000, the results of which are in Table 3. For both estimated models, the diagnostic statistics suggest the chain has converged.

Having satisfied ourselves as to the burn-in period and convergence of the chain, we evaluate the parameter estimates for the regime switching model presented in Table 3. For the sample period from 1947q1, the smoothed probabilities of being in the low-growth high-volatility regime are close to one in the first ten years and relatively high (around 0.8) in the period 1977 to 1991. The model reveals the very different time series behaviour of economic growth in these periods. The mean growth rate in state 1 is less than half that of state 2 while the point estimate of volatility is very much higher in state 1, revealing this to be an undesirable state.

The large fluctuations in the first decade after WWII, due to post-war shifts in production and shocks from the Korean wool boom, account for most of the high volatility of state 1. This finding is consistent with conclusions from earlier research. For example, Easton (1997) suggests that unlike most countries, where the business cycle took about five years to settle down to normal patterns, New Zealand’s cycle took about ten years.

Restricting the sample to 1956q1 to 2005q4 allows to us to estimate a more parsimonious model, where the autoregressive parameters no longer enter the model and regime change is restricted to shifts in the mean growth rate parameter. The parameter estimates for this model are also shown in Table 3 and the smoothed probabilities are plotted in the lower panel of Figure 1.

It is common to use the smoothed probabilities to identify economic contractions by using the rule that a contraction occurs if \( \Pr[S_t=1/\Delta y_1, \ldots, \Delta y_t] > 0.5 \). Harding and Pagan (2003a) warn that such a rule has no guarantee of identifying classical contraction phases, and for New Zealand data this warning very appropriate. For example, while the rule is successful in identifying two classical contractions in the

\[ ^{15} \text{The draws from the Markov chain used in the Gibbs-sampling approach show evidence of serial correlation. To account for this the standard deviation for each parameter was computed using the Newey-West variance estimator that is robust to heteroskedasticity and autocorrelation.} \]

\[ ^{16} \text{However, the coefficient } \sigma_1 \text{ is not statistically significant.} \]
period from the late-1950s to the mid-1970s and one during the later-1990s, classical contraction phases and low growth regimes do not consistently correspond with each other, from the late 1970s through to the early 1990s. These findings emphasise the importance of differentiating between classical contraction phases and low growth regimes.

Findings from this model also highlight that if New Zealand had been more resilient to the terms of trade shocks of the 1970s (through having better institutional frameworks, institutions and macroeconomic policies) and thus been able to avoid the great slowdown that state 1 represents, it would have had around 2 percent extra growth each year for a period of 14 years. This period of significant external shocks and subsequent major economic reforms represents a huge welfare loss to New Zealand, since its economy would have been nearly a third larger had it avoided this lost growth.

Finally, it is worth noting that the parsimonious model’s unconditional probabilities of being in a given date are \( \Pr[S=1] = 0.37 \) and \( \Pr[S=2] = 0.63 \). These imply that New Zealand was in a low growth phase 37 percent of the time during the past fifty years, a higher percentage of time than it was in classical contractions. The majority of this time occurred between 1977 and 1991 and was the type of aberration period that policymakers should try to avoid or ameliorate where possible, in the future.

6. Conclusions

Key contributions of this paper are firstly, that we develop a new quarterly time series for New Zealand’s real GDP, covering the 60-year period 1946 to 2005, and present a new consistently derived set of Classical business cycle turning points. This enables us to utilise eight full (P-T-P) cycles, to establish representative classical business cycle properties. Secondly, we estimate our Markov-switching models by Gibbs-sampling, instead of by the more commonly used classical maximum likelihood method. Thirdly, we establish business cycle growth and volatility rate regimes for a considerably longer time horizon than those previously reported. Fourthly, we use our sets of turning points and growth rate regimes to establish business cycle asymmetries, volatility, diversity and degree of duration dependence, as well as mean growth rate and volatility regimes.

Specifically, we show that the New Zealand business cycle has asymmetries of duration, amplitude, cumulated gains or losses in real GDP, and excess gains or losses. There is also considerable diversity across individual cycles, and considerable volatility in durations and amplitudes. In addition, Brain-Shapiro and Ohn-Taylor-Pagan test statistics show that, for expansion phases, there is no evidence of duration dependence. New Zealand business cycle expansions over this period are therefore likely not to have died of old age, but rather to have been terminated by particular events.

Our regime-switching models reveal that the diversity in individual cycles comes from disruptions to the typical pattern of the business cycle, following terms of trade shocks such as the 1970s oil shocks and the loss of a major export market when the United Kingdom joined the EEC, and the major economic reforms of the mid-1980s through to the early 1990’s. Results also point to a return, since the early 1990s, to a
more rhythmic pattern of long expansions and short contractions. Ideally, these will provide the underpinning for a sustainable “new golden days” period, and for a next generation of cyclical growth models for New Zealand.

But more rhythmic patterns should not be mistaken for a predetermined pattern, as tests show that business cycle expansion phases do not age. This, together with the observation that rates of growth are not dissimilar across the more sustained expansion phases, implies that in order to enhance New Zealand’s prosperity, policies are required that extend business cycle expansions without allowing the excesses that undermine those expansions to build up. The inward looking policies that initially followed earlier decades’ adverse terms of trade shocks do not offer a sensible policy strategy, if New Zealand wishes to continue avoiding the type of low growth high volatility period, experienced from the late 1970s to the early 1990s.
Figure 1. New Zealand real GDP, 1946-2005 (millions of 1995/96 dollars). Classical recessions indicated by shading.

Figure 2. Business Cycle Expansion Phases.
New Zealand’s quarterly real GDP, 1946q1 to 2005q4
Table 1. Peaks and Troughs of New Zealand Post-WWII Business Cycles

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Bold dates represent preferred peak/trough. Differences in KBH, HMcD and BB turning points from the mid-1980s reflect successive data revisions by SNZ, most recently from chain-weighting. * Peak within (or immediately next to) Easton's Plateau range (1997, p 305, fn 2) ** Easton provides plateau ranges rather individual quarter peaks.
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Average: 20.63 4.00 21.1 -4.1 264.2 -9.8 0.5 -7.3
CV: 0.47 0.40 0.58 -0.78

Duration Dependence Tests†
Quarterly data (1946-2005)
- Brain-Shapiro: 0.218 0.268
- OTP SB: 0.054 0.015

Annual data (1860-2005)
- Brain-Shapiro: 0.359 --
- OTP SB: 0.078 --

Note: E denotes expansion phase; C is contraction phase; durations are in quarters; amplitudes are percentages; cumulated gains or losses are percentages of GDP in first quarter of the phase; excess area percentages show how much extra output is gained or lost relative to the economy growing at a constant rate; CV is the coefficient of variation. † denotes p-values.
Table 3. Gibbs-sampling Estimates and Diagnostic Statistics for Markov-switching Models, for New Zealand real GDP

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<td>$\sigma_2$</td>
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Implied annual growth rate in:
- State 1: 1.53
- State 2: 3.19

Note:
1. The implied annualized growth for state $j$ is computed as $4\mu_j$.
2. The standard errors are Newey-West based.
3. The Geweke (1992) and Gelman and Rubin (1992) tests are defined in the text.
References


