MPRA

Munich Personal RePEc Archive

What Goes Up Must Come Down (But Not Necessarily at the Same Rate): Testing for Asymmetry in New Zealand Time Series

Tedds, Lindsay

University of Victoria

1998

WHAT GOES UP MUST COME DOWN (BUT NOT NECESSARILY AT THE SAME RATE):

TESTING FOR ASYMMETRY IN NEW ZEALAND TIME SERIES[1]

Lindsay M. Tedds

Department of Economics, University of Victoria, Victoria, B.C., Canada

April, 1998

ABSTRACT

The notion that many macroeconomic variables fluctuate asymmetrically over time is not new to economic theory but it is relatively new to empirical economics. The most common empirical representations of aggregate time series are usually smooth and sluggish. This study employs the test for steepness and deepness to the cyclical component (extracted via the HP filter) of 8 New Zealand economic time series. We find that there is no evidence of asymmetry in the cycles of any of the series.

I   INTRODUCTION

The notion that the economy's speed of adjustment in response to positive and negative output gaps, more commonly referred to as peaks and troughs in the business cycle, proceeds asymmetrically is not new to economic theory. The idea was first credited to Mitchell (1913) and later encompassed by both Keynesian and Classical models in all their forms.[2] It essentially purports that economic expansions are longer but less dramatic than downturns. The most prevalent macroeconomic variable accredited with such behaviour is unemployment which is often argued to increase quickly in recessions but decline slowly during expansions.

While the notion of asymmetry has been prevalent in the theoretical literature for over eighty years, it has only recently received attention by applied economists who had previously not accounted for such a possibility in their work. There are, however, a number of empirical issues associated with the possibility of asymmetry. First and foremost, if an "...economic variable exhibits short-run asymmetry, does it occur systematically enough to be counted as part of the probability structure of the economic time series" (Neftçi, p.308). If it is systematic, then we need to develop theoretical and empirical models that can generate such behaviour endogenously. Second, if a non-linear problem is treated as a linear one, then the error term will contain too much information and, subsequently, the estimated coefficients will likely test to be significant when, in reality, they may not be. Cyclical asymmetry is, by definition, a non-linear phenomenon so it will tend not to be well represented by the standard linear time series models commonly used in the analysis of economic data, given that these typically assume Normal stochastic behaviour. Assuming Normality ignores the clear implication that, if a series displays asymmetric tendencies, there should then be significant skewness in the series frequency distribution. As such, if asymmetry does exist in some economic variables used in modelling, then any empirical model which accounts for this will have better predictive powers.

---

[2]For an excellent discussion of these models and their progeny, see Romer (1996).

The issue of asymmetry is, therefore, an important empirical one as its existence will necessitate an examination of many of our economic models. The purpose of this study then is to investigate possible asymmetries in the cycles of several major long-run aggregate series typically used in econometric modelling. The testing method employed in this paper will follow the approach developed by De Long and Summers (1986) and later popularized by Sichel (1993), Holly and Stannett (1995), and Giles (1997) which utilizes the HP filter (Hodrick and Prescott, 1980) to extract the stationary cyclical component of a series. This cyclical component is then sequentially tested for deepness and steepness using the coefficient of skewness. This method will be applied to several annual New Zealand time series (namely: exports, imports, interest rate, money supply, GDP, CPI, investment, and unemployment), most of which extend over a 70 to 100 year period. The sample size was chosen to allow for the possibility of both long and/or short term asymmetry in the series. This appears to be the first empirical examination of asymmetry issues using annual time series data over such a large sample period and selection of variables. All of the results were obtained using the SHAZAM (1993) package except that the trend term, acquired using the HP filter, was obtained using the TSP (1996) package.

II   DATA ISSUES

Our primary interest is in studying some of the characteristics of a number of series frequently included in more detailed macroeconomic models. The New Zealand time series examined in this study are exports, imports, interest rate, money supply, gross domestic product, consumer price index, investment, and unemployment, all of which are annual series.

The unemployment series was obtained from *PCINFOS* Database of Statistics New Zealand (1993) and covers the sample period from 1953 to 1992. This is the shortest sample period used in this paper but in the case of New Zealand, it is not necessary to go back any further as the country experienced negligible

unemployment until 1967 (Easton and Thomson, 1982, p.6).

The rest of the series were obtained from the New Zealand Institute of Economic Research (Colgate, 1991). The series contained in this database were compiled with the intention of creating long historical time series for certain major macroeconomic variables. This involved linking series to various sources in New Zealand including *INFOS* data, New Zealand official yearbook data, official data from the Department of Statistics and the Reserve Bank, and private data from the Money and Finance Research Project on Financial Institutions at Victoria University at Wellington. Nominal[3] exports, imports, interest rates[4], and money supply cover the largest sample period in this study, from 1890 to 1990. Average new mortgage rates were used as a proxy for interest rates in this study as it is often argued that this affects peoples lending and savings rate more than any other interest rate series. M3 was used to measure the amount of money in the New Zealand economy, as is standard practice in economics today, where M3 is defined as the total money supply.[5]

The final three series are, first, nominal GDP which includes a stock valuation adjustment and covers the period from 1918 through to 1990. Gross fixed capital formation represents investment and ranges from 1944 to 1990. Finally, the consumer price index (CPI) used is an overall index weighted by and including

---

[3]While constructs of these series were available in real values, the deflator used to create the real GDP series, and hence real M3, contained in the database used in this study was determined to be unsuitable. As such, the author felt that definitional consistency of the variables used throughout this study was important as was maintaining the structure of the database and used nominal constructs of these series instead. In addition, Beveridge and Nelson (1981), Danthine and Girardin (1989), and Harvey and Jaeger (1993), all examined various nominal series in their studies.

[4]While interest rates were state controlled in part of the sample (in the mid to late 1970's), visual inspection of the data series does not suggest this caused any issue with the data. A plot of the level of the series showed a slight downward trend until 1950 and a non-linear upward trend from thereon.

[5] M3 includes notes and coin plus all deposits with trading banks, saving banks, stock and station agents, financial companies, and official money market lenders.

the data from all urban areas and all groups of goods, which measure begins in 1946 and continues until 1990. This series contained a missing observation in 1946 so, following the results of recent work by Ryan and Giles (1997), this gap was simply filled in with the recorded value for 1945.

All the above noted series, except interest rates, are examined in their natural logarithmic form, as is standard practice. Plots of the series show that each of these series has a strong upward trend which indicates the possibility that they are non-stationary, that they may have unit roots, and the author tests for this by applying both the Augmented Dickey-Fuller (ADF) test (Said and Dickey, 1984) and the KPSS test (Kwiatkowski, Phillips, Schmidt, and Shin, 1992) to the series. This is deemed to be an important step because in order for the HP filter to produce a stationary cyclical component, the series must be integrated of an order no greater than four (Harvey and Jaeger, 1993, p. 234).

III   DETRENDING AND THE HP FILTER

Following the above discussion, prior to conducting asymmetry tests on the data, the series must first be rendered stationary. There are a number of procedures which can be used to extract the non-stationary trend from an observable time series and the procedure which is used in this paper is the HP filter, the properties of which are discussed below.

The HP filter is premised on the assumption that a time series, y_t, can be expressed in the

$$y_t = \tau_t + c_t + \varepsilon_t \qquad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \qquad (1)$$

 form,

where τ_t is the non-stationary trend component, c_t is the stationary cyclical component, and ε_t is the usual white noise disturbance term. The HP filter obtains the trend series, τ_t, which solves the following

$$\min \sum{}_t \ [(\,y_t - \tau_t\,)^2 + \lambda[(1 - L\,)^2 \tau_t\,]^2] \qquad\qquad (2)$$

intertemporal optimization problem,

where L is the usual lag operator and λ can be interpreted as a Langrage Multiplier which, in this case, is a "smoothness" parameter (Giles, 1997, p.6) whose value is set in advance. Once τ_t is obtained, it is then straightforward to obtain the cyclical component. Given equation (1), the cyclical component is computed as y_t - τ_t .

Given that λ represents the smoothness of the trend, the choice of its value affects the frequency of the oscillations that pass through the filter. If $\lambda \rightarrow \infty$, the sum of the squared-difference of τ_t must be zero, meaning that τ_t is an ordinary least squares linear trend. On the other extreme, if $\lambda = 0$, that is, the constraint is non-binding, then τ_t "...perfectly interpolates the time series y_t." (Sichel, 1993, p.235) In other words, $\tau_t = y_t$. While the choice of λ is, therefore, quite arbitrary[6], traditionally a value of $\lambda = 1600$ is imposed in the context of deseasonalized quarterly data (Giles, 1997, p.227) while for annual data a value of 100 is suggested by Kydland and Prescott (1990). Other choices for annual data include $\lambda = 4$ (Canova, 1994), Nelson and Plosser (1982) suggest values for λ in the range [1/6,1], and Baxter and King (1995) argue that λ=10 is the most appropriate value.[7] As there is no clear definitive choice for the value of λ, in this study we consider the sensitivity of our results to this choice by choosing λ= 100, 20, 4. In examining

---

[6]If equation (1) is believed to be the true model, then λ could be estimated by maximum likelihood, however, the whole reason for applying the HP filter is the belief that detrended data consist of something more than white noise. This is why a value of λ is imposed, rather than estimated.

[7]Baxter and King's support of a small values of the smoothing parameter lies in the facts that it is this value which leads to a similar cyclical component as that obtained by using a specific band-pass filter, their filter of choice. Any larger choice, they argue, results in severe "leakage" from low frequencies.

the plots of the cyclical component of each of the series, it readily became apparent that the choice of λ did not alter the results dramatically but larger values did amplify the characteristics of the cycles. As such, the author chose of focus on the cycle of the series obtained by applying the HP filter with $\lambda=100$ to test for deepness and steepness.

There are a number of advantages associated with employing the HP filter to extract the trend component of a series. Most importantly, this filter induces stationarity of the cyclical component regardless of whether the series is trend or difference stationary (Cogley and Nason, 1991).[8] This is a necessary outcome if we are to model or test with the cyclical component as only then can the usual asymptotics based on the standard central limit theorems be used to construct test statistics and confidence intervals. Secondly, it is an easy and flexible procedure to apply.

On the other hand, Cogley and Nason (1991) have found that when the HP filter is "...applied to a difference stationary series [it] strongly amplifies fluctuations in the series at business cycle frequencies." (Sichel, 1993, p.229) According to Giles (1997, p. 227) this may in fact be an advantage in the context of this paper, as such an amplification should make it easier to detect any asymmetries in the cyclical component. As noted previously, the HP filter is linear by construction so "...it cannot induce asymmetry in a series if none is present to begin with." (Sichel, 1993, p. 230) Further, in order to conduct the tests for deepness and steepness (discussed in further detail in section VII), we require not only the cyclical series, c_t, for the test for deepness but also its first difference, Δc_t, in order to conduct the test for steepness. The HP filter only extracts c_t and Δc_t is obtained by first differencing c_t. Sichel (1993) argues that by using this method to test for steepness, the test may not correctly identify actual steepness. He does not, however, provide, any empirical support for the statement. In light of the above discussion, the HP filter seems to be

---

[8] As was mentioned previously in this paper, provided that the series is integrated of an order no greater than four.

a very good choice for detrending the data for our study.

IV   TESTING FOR CYCLICAL ASYMMETRY

Once the cyclical component is extracted, we can proceed with testing for asymmetry. De Long and Summers (1986) suggested that if a series displays asymmetric tendencies, then there should be significant skewness in its frequency distribution. They suggested that the coefficient of skewness, which is defined as the ratio of the third centered moment to the cube of the standard deviation, be used to test for asymmetry. If the distribution is symmetric then the coefficient of skewness is zero.

Sichel (1993) extended this procedure by distinguishing between "deepness" and "steepness" in the cycle.[9] If a series exhibits deepness then it should be negatively skewed, that is, it should have fewer observations below its mean than above, but, the average deviation of observations below the mean should

$$D(c) = [\frac{(1/T)\sum_t (c_t - \bar{c})^3}{\underline{(c)}^3}] \qquad\qquad (3)$$

exceed the average deviation of observations above. The test for deepness then is represented as

where c_t is the cyclical component, $\bar{c}$ is the mean of c_t, and '(c) is the standard deviation of c_t.

On the other hand, if a series exhibits steepness, then its first difference should display negative skewness. That is, the sharp decreases in the series should be larger, but less frequent, than the more moderate increases in the series. As such, we can test for steepness by replacing c with the first difference of the series, $\Delta c = c_t - c_{t-1}$, in equation (3) so that it examines whether rates of change in c_t are asymmetric around their mean;

---

[9]He also presents a graphical representation of these characteristics (p. 226).

$$ST(\Delta c) = [\frac{(1/T)\sum_t(\Delta c_t - \overline{\Delta c})^3}{\_(\Delta c)^3}]$$ (4)

Both of these equations provide point estimates.

In order to test the significance of the estimates obtained from equations (3) and (4), we need to estimate the sampling variability of our cyclical series. The observations on c_t, however, are sure to be serially correlated so that the formula for the usual asymptotic standard error is unsuitable. Instead, the estimate suggested by Newey-West (1987), should be used. Following Sichel (1993), given the measure in

$$z_t = \frac{(c_t - \overline{c})^3}{\_(c)^3}$$ (5)

equation (3), we construct a variable where the tth observation is given by,

For the measure in (4) we simply replace c with Δc in equation (5). We then regress this variable on a constant and obtain the Newey-West standard error by using the AUTCOV=1 option on the OLS command in SHAZAM. The estimate of the constant in this regression is equal to the deepness estimate given by (3) (or the steepness estimate given by (4) if Δc is substituted in equation (5)). By employing this method, the constant divided by its standard error is asymptotically normal so conventional critical values can be used to test the significance of D(c) and ST(Δc).

V   RESULTS

As was mentioned previously, we know that the HP filter results in a stationary cyclical series if the original series is integrated of an order no greater than 4 (i.e. I(4)). While, by convention, aggregate annual macroeconomic time series conform to this condition, the author argues that, because stationarity is an

important result, it is necessary to confirm this characteristic. To be conservative, we applied both the ADF and KPSS tests for stationarity and applied these tests at a 10% significance level. The author chose a 10% significance level as these tests are known to have low power and this choice attempts to increase their power, albeit arbitrarily. Both these tests are fairly well known so they will not be discussed in detail.

The ADF test was chosen over the Dickey-Fuller (DF) test (Dickey and Fuller, 1979) to allow for autocorrelation in the error term. Given that we are working with time series data, the error terms in the integrating regression could easily be correlated so we can account for this by augmenting the DF integrating regression with lags of the dependent variable to mop up any autocorrelation in the residuals. The number of augmentation terms is chosen by employing the "general to specific" approach.[10] The approach is as follow: choose an arbitrary q=qmax (usually 10 for annual data as suggested by Said and Dickey (1984)); estimate the ADF integrating regression with q=qmax; test the significance of the last included lag via an asymptotic normal test; if the coefficient attached to this lag is not significant, then rerun the regression with one less lag and continue until the last lag tests significant.

The KPSS test, opposite to the ADF test, considers a null of stationarity versus an alternative of non-stationarity. The reversal of the nulls is important because our classical approach to hypothesis testing is to support the null until the evidence is extreme enough to believe otherwise. Approaching the tests from both sides, as the adoption of these two tests achieves, adds credibility to the results. These tests are usually employed so that they test downwards. In the case of the ADF test, this means that we initially test the null that the series is I(4) against the alternative that the series is at most I(3) (in the case of the KPSS test, this

---

[10]There are a number of other, and arguably better, approaches to chose the number of augmentation terms including using the COINT command in SHAZAM but this is argued to be an ineffective approach for samples larger than 50 (Dods and Giles, 1995) and adding in augmentation terms until there are no significant ACF/PACF values for residuals. Given that, for the purpose of this paper, we are only interested in ensuring our series are I(4) or less and our extracted cyclical component is I(0), and we will not be modelling with the series themselves, the general to specific approach is a suitable method for the purposes of this paper.

is equivalent to testing the null of the series being at most I(3) versus the alterative that the series is I(4))
and if this results in a rejection of the null hypothesis in favour of the alternative, the next step is the test the
null hypothesis of the series being I(3) against the alternative that the series is at most I(2) (for the KPSS
test, if we support the null then we test that the series is at most I(2) versus the alterative I(3)) and so on
until there is enough evidence to support the null (alternative) hypothesis.

In testing the logarithms of the series in question, we found them all to be less than I(4). The results
of the ADF test and KPSS test on the actual series are summarized in table 1 and table 2 respectively. The
results concerning the order of integration reported in these tables for each of the variables represents the
number of times the series needs to be differenced in order to render it stationary, according to the test
employed. For instance, in testing the export series with the ADF test with the drift and trend term in the
integrating regression and by testing downwards starting with I(4) as the initial null hypothesis, we find that
we fail to reject the null that the series is I(2) (testing against the alternative that the series is at most I(1)).
The integrating regression for this test included ten (10) augmentation terms and produced a test statistic of
-3.05 compared to a critical values of -3.15. While each of the two tests, and variations there in, all
produced different results as to the specific order of integration of each of the series, it is of no concern here
and actually shows an additional benefit of using the HP filter over differencing. In order to difference the
data to produce a stationary series, we must know its exact order of integration otherwise future tests with
the differenced stationary component may be biased and conventional asymptotic results may not apply.
This is not an issue with the filtering technique employed in this study. Applying the same tests to the
cyclical series, we found them to be stationary in every case and this result holds regardless of the choice of
λ, although only the results for $\lambda=100$ are shown.

Table 3 presents the main results from this study. There we see the outcomes of the tests for
asymmetry in the cycles of each of the series being considered over four different sample periods. Over the

full period, the two-sided p-values provide clear evidence that there exists no significant deepness or steepness in any of the cycles over the long run. The author also chose to examine this issue over three other sample periods in order to test the hypothesis that asymmetry may be a short-run occurrence. The other sample sizes chosen are: pre-1950[11], 1950-1970[12] to account for economic effects of the Korean War, and 1970-1990 which signified common market entry for New Zealand. The results, however, were unaffected in each of these cases.

VI   CONCLUDING REMARKS

In this study, we have been unable to detect any evidence of asymmetry in the cyclical component, extracted by the HP filter, of any of the series examined. The results lead us to conclude that there is no evidence to support the notion that most macroeconomic variables adjust asymmetrically. As such, there is, as yet, no call for applied economists to adjust the assumptions made in their econometric models

New Zealand, however, is a small country which only recently experienced economic diversification and open trade. As such, the evidence presented in this study cannot be used to conclude that asymmetry assumptions no longer have a role in theoretical and empirical studies. Rather, this paper serves three purposes. One is to serve as a caution to economists modelling with economic time series to ensure that their data does, in fact, conform to the specifications of their model (i.e. Normality). Second is to suggest the need for more studies on this topic, perhaps using quarterly data given that annual data may be predisposed towards the absence of asymmetry. While this would be a more challenging exercise, due to seasonal adjustment and cycle dating issues, it may lead to more concrete evidence towards the existence

---

[11]The investment and unemployment series were excluded from this sample size because these series sample begin in 1947 and 1953 respectively.

[12]1953-1970 for the unemployment series.

(or lack therefore) of asymmetry. And finally, to suggest one step beyond this paper and actually investigate possible asymmetries in the real New Zealand business cycle.

REFERENCES

Baxter, Marianne and King, R.G. (1995), "Measuring Business Cycles Approximate Band-pass Filter for Economic Time Series", NBER Working Paper 5022.

Canova, F. (1994), "Detrending and Turning Points", *European Economic Review*, 38, 614-623.

Cogley, T. and Nason, J. (1991), "Effects of the Hodrick-Prescott Filter on Integrated Time Series", mimeo.

Colgate, P. (1991), *Databases for Taxation Modelling: Report to the Inland Revenue Department*, New Zealand Institute of Economic Research, Wellington.

De Long, B. and Summers, L. (1986), "Are Business Cycles Symmetrical", in R.J. Gordon (ed.), *American Business Cycles: Continuity and Change*, University of Chicago Press, Chicago, 166-179.

Dickey, D.A. and Fuller, W.A. (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistics Association*, 74, 227-231.

Dods, J.L., and Giles, D.E.A. (1995), "Alternative Strategies for 'Augmenting' the Dickey-Fuller Test: Size Robustness in the Face of Pre-Testing", *Journal of Statistical Computation and Simulation*, 53, 243-258.

Easton, B. and Thomson, N. (1982), *An Introduction to the New Zealand Economy*, University of Queensland Press, St. Lucia.

Giles, D.E.A. (1997), "Testing for Asymmetry in the Measured and Underground Business Cycles in New Zealand", *Economic Record*, 225-232.

Harvey, A.C. and Jaeger, A. (1993), "Detrending, Stylized Facts and the Business Cycle", *Journal of Applied Econometrics*, 8, 231-247.

Hodrick, R.J. and Prescott, E.C. (1980), "Postwar U.S. Business Cycles: An Empirical Investigation", Discussion Paper No. 451, Department of Economics, Carnegie-Mellon University.

Holly, S. And Stannett, M. (1995), "Are There Asymmetries in U.K. Consumption? A Time Series Analysis", *Applied Economics*, 27, 767-772.

Kwiatkowski, D. P.C.B. Phillips, P. Schmidt, and Y. Shin (1992), "Testing the null hypothesis of stationarity against the alternative of a unit root", *Journal of Econometrics*, 54, 159-178.

Kydland, F.F. and Prescott, E.C. (1990), "Business Cycles: Real Fact and Monetary Myth", *Federal Reserve Bank of Minneapolis Quarterly Review*, 14, 3-18.

Mackinnon, J.G. (1991), "Critical Values for Cointegration Tests", in R.F. Engles and E.W.J. Granger

(eds.) *Long-Run Economic Relationships*, Oxford University Press, Oxford, 267-276.

Mitchell, W.C. (1913), *Business Cycles*, University of California Press, Berkely.

Neftçi, S. (1984), "Are Economic Time-Series Asymmetric Over the Business Cycle?", *Journal of Political Economy*, 92, 307-328.

Nelson, C.R. and Plosser, C. (1982), "Trends and Ransom Walks in Macroeconomic Time-Series", *Journal of Monetary Economics*, 10, 139-162.

Newey, W. and West, K. (1987), "A Simple Positive-Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix", *Econometrica*, 55, 703-708.

Romer, D. (1996), *Advanced Macroeconomics*, The McGraw-Hill Companies Inc., New York.

Ryan, K.F. and Giles, D.E.A. (1998), "Testing for Unit Roots in Economic Time-Series With Missing Observations", to appear in T.B. Fomby and R.C. Hill (eds.), *Advances in Econometrics*, 13, JAI Press, Greenwich.

Said, S.E. and Dickey, D.A. (1984), "Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order", *Econometrica*, 71, 599-607.

SHAZAM (1993), *SHAZAM Econometrics Computer Program: User's Reference Manual Version 7.0*, McGraw-Hill, New York.

Sichel, D.E. (1993), "Business Cycle Asymmetry: A Deeper Look", *Economic Inquiry*, XXXI, 224-236.

Statistics New Zealand (1993), *PCINFOS Database*, New Zealand, Wellington, April release.

TSP (1996), *TSP Econometrics Computer Program Version 4.2*, TSP International, Palo Alto.

TABLE 1

Augmented Dickey-Fuller Unit Root Test

SERIES[1]		WITH DRIFT & TREND[2]				WITH DRIFT, NO TREND[3]				NO DRIFT, NO TREND[4]			
		q^5_{dt}	t_{dt}	CV^6_{dt}	Result$_{dt}$	q_d	t_d	CV_d	Result$_d$	q	t	CV	Result
Exports	Actual	10	-3.05	-3.16	I(2)	2	2.28	-2.58	I(1)	2	5.62	-1.62	I(1)
	Cycle[7]	1	-7.30	-3.15	I(0)	1	-7.34	-2.58	I(0)	1	-7.38	-1.62	I(0)
Imports	Actual	2	-0.87	-3.16	I(1)	2	1.44	-2.58	I(1)	2	4.62	-1.62	I(1)
	Cycle	1	-8.04	-3.15	I(0)	1	-8.08	-2.58	I(0)	1	-8.12	-1.62	I(0)
Interest Rates	Actual	10	-0.80	-3.16	I(1)	6	-2.07	-2.58	I(2)	6	-1.87	-1.62	I(1)
	Cycle	3	-4.42	-3.15	I(0)	3	-4.44	-2.58	I(0)	3	-4.47	-1.62	I(0)
Money Supply	Actual	10	-0.28	-3.16	I(1)	10	-2.32	-2.58	I(2)	7	-0.35	-1.62	I(2)
	Cycle	3	-5.81	-3.15	I(0)	3	-5.84	-2.58	I(0)	3	-5.87	-1.62	I(0)
GDP	Actual	1	-2.70	-3.16	I(1)	1	1.45	-2.59	I(1)	6	-0.65	-1.62	I(2)
	Cycle	1	-4.88	-3.16	I(0)	1	-4.91	-2.59	I(0)	1	-4.96	-1.62	I(0)
CPI	Actual	7	-2.89	-3.18	I(2)	0	-2.48	-2.59	I(2)	3	-0.48	-1.62	I(2)
	Cycle	1	-4.56	-3.17	I(0)	1	-4.57	-2.59	I(0)	1	-4.61	-1.62	I(0)
Investment	Actual	8	-2.25	-3.21	I(2)	8	-0.97	-2.62	I(2)	8	-0.04	-1.62	I(2)
	Cycle	1	-4.06	-3.19	I(0)	1	-4.09	-2.61	I(0)	1	-4.13	-1.62	I(0)
Unemp.	Actual[8]	5	-3.34	-3.22	I(0)	9	0.26	-2.62	I(1)	10	-0.73	-1.62	I(2)
	Cycle	1	-4.82	-3.20	I(0)	1	-4.86	-2.61	I(0)	1	-4.93	-1.62	I(0)

[1] All variables are examined in their logarithmic form except interest rates which is examined in its level form
[2] Denotes the use of the drift and trend terms in the ADF integrating regression
[3] Denotes the use of the drift term but not the trend term in the ADF integrating regression
[4] Denotes the absence of both the drift and trend term in the ADF integrating regression
[5] Denotes the Degree of Augmentation determined by using general to specific approach as discussed in text
[6] Asymptotic Critical Values obtained from MacKinnon (1991) and are for a 10% significance level
[7] Cycle evaluated with λ=100 but cycle obtained with λ=20 & λ=4 also produced a stationary cyclical series
[8] Results unchanged over the sample period 1966-1992 (when unemployment significant in New Zealand) except for no drift, no trend which changed to I(2)

TABLE 2

KPSS UNIT ROOT TEST

SERIES[1]		l[2]	TREND _	CV[3]	Results	LEVEL _	CV[3]	Results
Exports	Actual	4	0.40	0.12	I(1)	0.56	0.35	I(2)
	Cycle[4]	4	0.02	0.12	I(0)	0.02	0.35	I(0)
Imports	Actual	4	0.38	0.12	I(1)	2.00	0.35	I(1)
	Cycle	4	0.02	0.12	I(0)	0.02	0.35	I(0)
Interest Rates	Actual	4	0.39	0.12	I(1)	0.44	0.35	I(2)
	Cycle	4	0.03	0.12	I(0)	0.03	0.35	I(0)
Money Supply	Actual	4	0.40	0.12	I(1)	0.91	0.35	I(2)
	Cycle	4	0.02	0.12	I(0)	0.02	0.35	I(0)
GDP	Actual	4	0.32	0.12	I(1)	0.52	0.35	I(2)
	Cycle	4	0.03	0.12	I(0)	0.03	0.35	I(0)
CPI	Actual	4	0.31	0.12	I(1)	0.94	0.35	I(2)
	Cycle	4	0.04	0.12	I(0)	0.04	0.35	I(0)
Investment	Actual	3	0.18	0.12	I(1)	0.97	0.35	I(1)
	Cycle	3	0.05	0.12	I(0)	0.05	0.35	I(0)
Unemp.	Actual[5]	3	0.07	0.12	I(0)	0.89	0.35	I(1)
	Cycle	3	0.04	0.12	I(0)	0.04	0.35	I(0)

[1] All variables are examined in their logarithmic form except interest rates which is examined in its level form

[2] The author employed the l_4 rule as suggested by Kwiakowski, Phillips, Schmidt, and Shin (1992) in order to chose an appropriate test statistic given the sample size (T). The rule is represented as

$$\ell = \text{int}[\,4(T/100)^{1/4}\,]$$

and is the same for both trend and level regressions.

[3] Asymptotic Critical Values obtained from KPSS (1992) and are for a 10% significance level

[4] Cycle evaluated with λ=100 but cycle obtained with λ=20 & λ=4 also produced a stationary cyclical series

[5] Results unchanged over the sample period 1966-1992 (when unemployment significant in New Zealand)

TABLE 3
Testing for Asymmetry of the Cycles (λ=100)

SERIES	SAMPLE	D(c)	a.s.e.	P-VALUE		ST(ΔC)	a.s.e.	P-VALUE
Exports	1890-1990	-0.16	0.47	0.81	0.71	0.94	0.45	
	1890-1950	-0.03	0.54	0.95	0.76	1.17	0.52	
	1950-1970	0.49	1.07	0.65	0.37	0.44	0.40	
	1970-1990	-0.89	1.15	0.44	0.45	1.13	0.69	
Imports	1890-1990	0.02	0.63	0.98	-0.01	0.62	0.99	
	1890-1950	0.00	0.72	0.99	0.11	0.76	0.87	
	1950-1970	0.55	0.96	0.56	-1.02	0.90	0.26	
	1970-1990	0.08	0.59	0.88	0.59	0.68	0.39	
Interest Rates	1890-1990	0.17	1.34	0.90	-1.00	2.58	0.70	
	1890-1950	-0.03	0.41	0.94	0.08	0.50	0.88	
	1950-1970	-1.83	2.02	0.36	-2.32	2.35	0.32	
	1970-1990	0.06	0.68	0.94	-0.33	1.20	0.79	
Money Supply	1890-1990	0.52	0.68	0.44	-0.19	0.51	0.71	
	1890-1950	0.56	0.91	0.54	-1.14	0.79	0.86	
	1950-1970	-0.15	0.55	0.79	0.13	0.43	0.76	
	1970-1990	0.49	0.70	0.48	-0.38	0.61	0.54	
GDP	1918-1990	-1.31	1.06	0.22	0.06	0.85	0.94	
	1918-1950	-0.93	0.80	0.24	-0.28	0.85	0.74	
	1950-1970	-0.26	0.68	0.71	2.08	2.20	0.34	
	1970-1990	-0.30	0.69	0.66	0.08	0.40	0.84	
CPI	1926-1990	-0.41	0.54	0.45	-0.37	0.44	0.40	
	1926-1950	-0.38	0.67	0.37	-0.61	0.64	0.34	
	1950-1970	-0.11	0.58	0.84	0.71	0.97	0.46	
	1970-1990	0.13	0.61	0.83	-0.34	0.44	0.44	
Investment	1947-1990	-0.41	0.56	0.45	-0.13	0.60	0.83	
	1950-1970	-0.87	1.03	0.39	-0.34	0.56	0.54	
	1970-1990	-0.28	0.50	0.57	0.02	0.77	0.98	
Unemp.	1953-1990	-0.27	0.69	0.69	0.74	0.79	0.35	
	1953-1970	0.08	0.54	0.88	0.94	0.89	0.28	
	1970-1990	-1.34	1.58	0.40	-0.07	0.82	0.93	

Note: "a.s.e." denotes robust asymptotic standard error as defined by Newey-West (1987), p-value denotes an asymptotic standard normal two-sided value, D(c) and ST(Δc) are defined by equations (3) and (4) respectively