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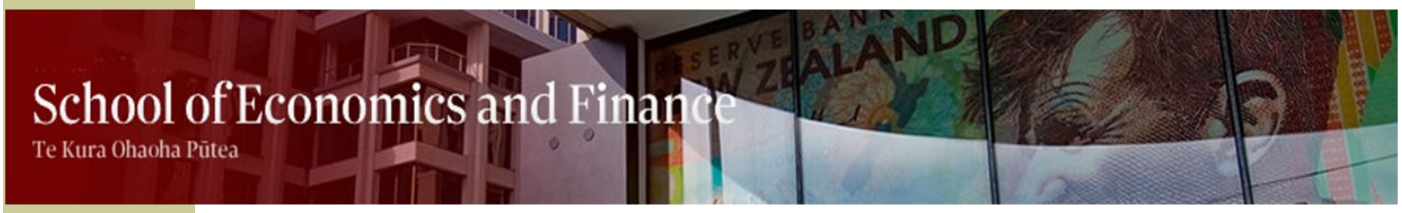

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Stylised Facts for New Zealand Business Cycles:

A Post-1987 Perspective

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Abstract

Key features of NZ business cycles were established for the period 1966q4 to 1990q1 by Kim, Buckle and Hall (1994) (KBH), but the conduct of fiscal, monetary and labour market policy and the behaviour of New Zealand's economy have changed considerably since then. Our results for the period 1987q2 to 2010q4 show a reduction in volatility and a rise in persistence for both the real economy and for price and monetary variables. Government sector, open economy, monetary and labour market results differ from those advanced in KBH. Overall, we establish a more credible set of benchmark regularities, to help underpin the construction and use of contemporary NZ macroeconomic models.

JEL Classification: E32, C54

Keywords: Business cycle stylised facts; New Zealand; Growth cycle analysis

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Stylised Facts for New Zealand Business Cycles:

A Post-1987 Perspective

1 Introduction

Over the past 60 years or so, the New Zealand economy and the international environment in which it operates have undergone major changes. Key features of New Zealand business cycles were established for the period 1966q4 to 1990q1 by Kim, Buckle, and Hall (1994) (KBH)[1], but a number of financial, fiscal, external sector, and labour market regularities had to remain unresolved in that study. Moreover, the conduct of fiscal, monetary and labour market policy in New Zealand and the behaviour of its economy have changed considerably since then. It is timely therefore to present a more contemporary set of stylised facts for New Zealand business cycles.

We use well-established univariate and bivariate growth cycle methodology to quantify volatility, persistence, and co-movements of aggregate output with the economy's salient macroeconomic variables, for the period from 1987q2 to 2010q4. Unlike many other comparable studies, we give particular attention to the extent to which volatility, and contemporaneous and non-contemporaneous cross-correlations have moved within our sample period[2]. Results are assessed in the context of KBH (1994), McCaw (2007), and Hall and McDermott (2011) (HMcD).

The stylised facts approach can be traced back at least as far as Lucas (1997, p 10) who stated that "with respect to the qualitative behaviour of co-movements among [economic time] series, business cycles are all alike". This claim implied the possibility of a unified explanation of business cycles grounded in the general laws governing market economies. The insights of Lucas led to increased emphasis on business cycle facts being the starting point for any macroeconomic theory and model which purported to explain and predict aggregate economic activity. So much so that nowadays, 'stylised facts' provide not only one important litmus test for existing macroeconomic models, but also a guide to the construction of new models.

In the late 1980s and early 1990s, a series of papers revisited the stylised facts for a number of industrialised economies. These studies included, influentially, Greenwald, Stiglitz, Hall, and Fischer (1988), Kydland and Prescott (1990), Backus and Kehoe (1992), and Backus, Kehoe, and Kydland (1994), among others. For some macroeconomic variables, these studies established consensus, for others diversity. Unfortunately, very few of these findings were directly portable to small open economies such as New Zealand and Australia, contrary to the general view expressed by Lucas (1977) that business cycles are all alike. For New Zealand, this limitation was responded to initially by Kim, Buckle and Hall (1994), and for Australia

[1] Prior to this study, there had been no systematic analysis of the properties of New Zealand business cycles since the work by Haywood (1972) and Haywood and Campbell (1976).
[2] Our results come from programs written in RATS by Dr Kunhong Kim.

by Crosby and Otto (1995) and by Fisher, Otto and Voss (1996). More recent results for Australia have been reported in Tawardros (2011).

In their examinations, KBH (1994) documented the volatility, autocorrelation, and cross-correlation with real GDP of a comprehensive set of macroeconomic variables. They established a number of key features of New Zealand growth cycles, including the exceptional volatility of the economy; the procyclicality of real variables, the countercyclical tendency of price fluctuations, and a number of robust labour market regularities. However, the scale of changes to the economy in the latter part of their sample period frustrated efforts to obtain credible regularities with respect to New Zealand's financial, fiscal, and open economy variables. Clarification of the uncertainties in these areas provided a major motivation for this study.

Since the KBH study, research into stylised facts of New Zealand business cycles has been limited. Sanyal and Ward (1995) investigated a number of bivariate regularities, although their analysis is preoccupied with the structural disturbances of the 1970s. McCaw (2007) utilised New Zealand's updated chain-volume data from 1987(2) to 2006(2) to examine relationships for an exhaustive set of macroeconomic variables. But the reporting of cross-correlation results for not only New Zealand's output gap, but also for its CPI and nontradables inflation gaps, and the 90-day interest rate gap, together with cross correlations of key New Zealand variables with those for Australia and the U.S. meant that the study did not have a primary focus on the fiscal, financial, and external sector uncertainties identified in KBH. Nonetheless, where relevant, we compare our findings with those of McCaw. Similarly where relevant, our results are compared with those reported for New Zealand unobserved components business cycles in Hall and McDermott (2011, Table 7) for the sample period 1983q2 to 2006q4.

The statistical results we report are motivated by the following key questions: To what extent have the volatility and persistence of New Zealand's business cycles decreased since KBH? Has real variable regularity been maintained? Does government expenditure exhibit a pro-, counter-, or acyclical relationship with output? Can one establish credible regularities for other fiscal variables, including for taxation, transfers and a public debt to GDP ratio? Has more recent data helped clarify the cyclical relationship between net exports and real output? Can one establish a sufficiently clear role for the terms-of-trade and the real aggregate exchange rate? Have a new set of monetary regularities emerged in the post-reform period? And how, if at all, have labour market regularities changed?

Our univariate and bivariate methodology is described succinctly in Section 2. Our stylised facts for New Zealand business cycles are reported and commented on in Section 3. Section 4 concludes.

2 Methodology

As documented in Appendix C, our raw data series have been sourced from Statistics New Zealand (SNZ), the Reserve Bank of New Zealand (RBNZ), and the New Zealand Treasury. Variables from the latter data set have been utilised previously in Claus et al (2006), Dungey and Fry (2009) and Hall and McDermott

(2011). Our sample size is restricted to the period from 1987q2 to 2010q4, to coincide with the start point of SNZ's chain-volume series based on the International System of National Accounts 1993.

The set of variables selected for analysis was largely guided by stylised facts which were either unresolved in KBH or may have changed significantly since then. This necessitated considering real GDP expenditure components, external variables, monetary variables, and labour market variables. Series were seasonally adjusted as required and then log transformed, with the exception of those containing negative observations (e.g. net exports) or those already expressed as a percentage (e.g. interest rates).

To achieve consistency with previous studies for New Zealand, the methodology of this paper is basically as utilised in KBH (1994) and McCaw (2007). This meant the adoption of growth cycle rather than classical cycle methodology, and as is well-known immediately raises the controversial issue of detrending.

An assessment of fluctuations about a trend in an observed economic variable (y_t), requires decomposition of its time series into a non-stationary trend component (g_t) and a stationary cyclical component (c_t):

$$y_t = g_t + c_t$$

A considerable number of de-trending procedures are possible, but we utilise the well-known algorithm developed by Hodrick & Prescott (1980) (HP). This HP filter has the considerable advantage of providing a simple, intuitive, and highly operational method of trend extraction. It generates an estimate of the secular and cyclical components according to the convex minimization problem

$$\min_{[g_t]_{t=1}^{T}} \left[\sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=2}^{T-1} ((g_{t+1} - g_t) - (g_t - g_{t-1}))^2 \right]$$

where $\lambda > 0$. Implicit in the above equation is a trade-off between the degree of fit and the smoothness of the trend component. The first term in the equation represents the sum of the squared deviations from trend and penalises the cyclical component. The second term is the sum of the squares of the trend component's second differences, and penalises variations in the trend growth rate. The arbitrarily chosen smoothing parameter, λ, determines the rate at which the latter is penalised relative to the former. As λ approaches zero, the trend component conforms more closely to the actual data series; while as λ tends to ∞, the trend component becomes linear. We adopt Hodrick and Prescott's (1980) recommended smoothing parameter of 1600 for quarterly data, as previously used successfully for New Zealand series reported in KBH (1994) and in Hall, Kim, and Buckle (1998). Adoption of this parameter value also facilitates direct comparisons with results from KBH (1994), McCaw (2007), and studies for many other countries.

However, use of the HP filter is not without controversy. In particular, it is argued that use of the standardised smoothing parameter has a tendency to generate spurious correlations by attributing medium to

long-run variations in the data to the cycle when in fact, they are part of the trend (Harvey and Jaeger, 1993). HP filters are also criticised for producing unusual cyclical components toward either end of the sample (Baxter & King, 1999). Such criticism provokes the consideration of alternative detrending methodologies. Prominent alternatives include the band-pass filter of Baxter and King (1999) (BK) and the unobserved components (UC) model of Harvey (1985, 1989) . For example, Choy (2011) has recently used BK and UC methodology to assess stylised facts for Singaporean business cycles, and Tawardros (2011) has used HP and UC methodology to re-examine Australia's stylised business cycle facts. Computation of results for New Zealand using UC methodology would be an avenue for further work and may or may not provide material insights additional to those reported here.

Following application of the HP filter, our detrended series are analysed to obtain their standard deviation, autocorrelations, and cross-correlations with output. These statistical measures are contained in Table 1 for key National Accounts real output and expenditure variables, Table 2 for New Zealand Treasury fiscal variables, Table 3 for price and monetary variables, and Table 4 for labour market variables, and. The standard deviation indicates the volatility of a particular series, while the first-order autocorrelation tells of its immediate persistence. These measures are supplemented by cross-correlations which convey the direction and strength of a variable's co-movement with output. The correlation coefficients may be described as either procyclical, countercyclical or acyclical.[3] Because the contemporaneous correlation is not always the most informative, the co-movement of each series with real GDP is computed initially as far as fifth-order leads and lags. Specifically, the cyclical component of the candidate variable at time $t + k$ (x_{t+k}) is associated with the cyclical component of real GDP at time t (y_t), for all $-5 \leq k \leq 5$. Under this approach, a maximum correlation at, for example, $k = 3$ indicates that the cyclical component of the candidate variable tends to lag the aggregate business cycle by three quarters.

The bivariate cross-correlation coefficient estimates presented in our Tables should be interpreted in the context of their statistical significance. To this end, the present paper follows the approach of KBH by reporting for each of the summary statistics Generalised Method of Moments standard errors, computed as explained in Christiano and Eichenbaum (1992).

The statistics in the Tables are also limited to the extent that they are full-sample averages. To assess the stability over time of these sample-average values, we adopt a 'moving windows' form of analysis, as utilised in KBH. Specifically, we plot a 21-quarter moving average of the standard deviations and cross-correlations with output for all variables. Due to the short size of the sample period relative to KBH, this analysis was also performed for both a 13-quarter and 29-quarter moving average. However, as the latter results were not materially different, they have not been reported. Further, unlike KBH and the results

[3] A variable will be said to be procyclical when its deviations from trend are *contemporaneously* correlated with those of output in a positive fashion; countercyclical when its deviations from trend are *contemporaneously* correlated with those of output in a negative fashion; and acyclical when its deviations from trend exhibit a *contemporaneous* correlation with output that is close to zero.

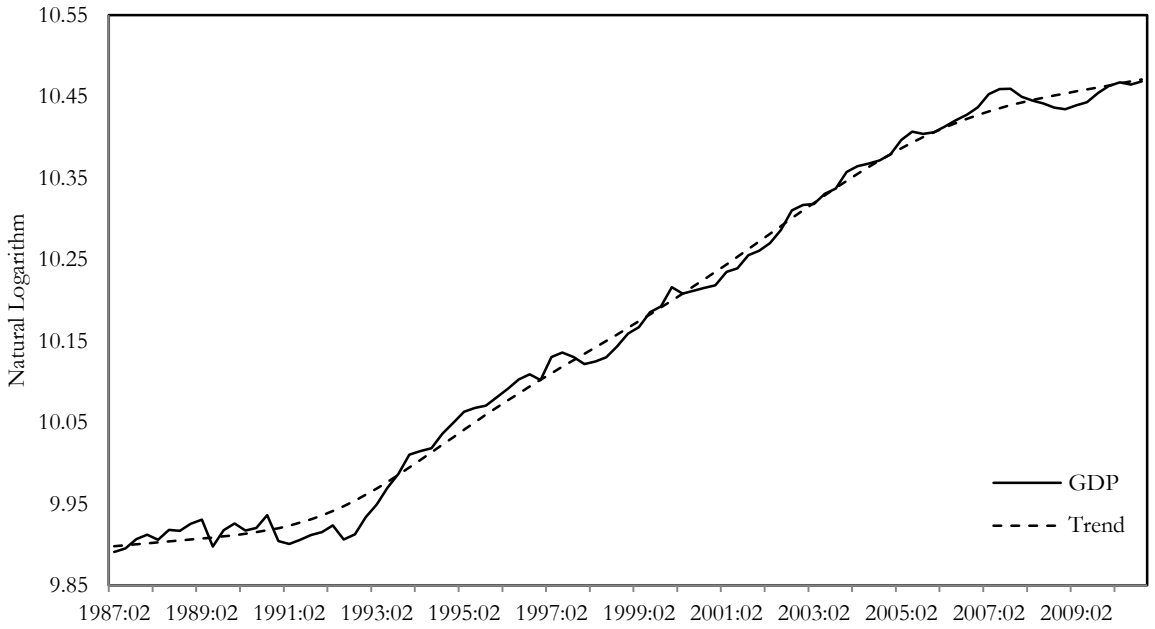
reported in most other studies, our stability over time analysis is extended beyond the contemporaneous correlations to the phase shift corresponding with the maximum cross-correlation which is statistically significant. For example, in the case of net exports, the moving windows analysis has been reported for both the contemporaneous correlation and the correlation at a lag of two quarters.

3 Business cycle regularities

Figure 1 shows movements in the logarithm of New Zealand's real expenditure-based Gross Domestic Product (GDP), for the period from 1987q2 to 2010q4. Also plotted is the HP filtered trend component for $\lambda = 1600$. Over this period, real GDP has grown to 178% of its original level. New Zealand's GDP has been characterised by a number of fluctuations about its long-term trend, the statistical properties of which can be used to describe, define and analyse that nature of New Zealand's business cycles.

Figure 1

Gross Domestic Product (Expenditure)
1987q2 - 2010q4



The most sizable fluctuations can be reconciled with macroeconomic events of historical significance[4]. Such events include the domestically-felt recession experienced simultaneously by the U.S. and Australia in the early 1990s; the relatively modest slowdown in 1998-1999 associated with the Asian financial crisis and New Zealand's successive summers of drought; the domestic boom of 2007 on the back of a buoyant housing market and strong consumer confidence; and most recently, the Great Recession from 2008 through to 2010.

[4] Descriptive accounts of New Zealand's business cycles over the period 1998 to 2011 can be found in Chetwin (2012), and of past recessions are available in Reddell and Sleeman (2008). Summary statistics for New Zealand's post-war business cycles can be found in Hall and McDermott (2009).

3.1 Volatility and Persistence

Virtually all aspects of the New Zealand economy, real and nominal, have undergone a significant reduction in volatility since the conclusion of the sample period in KBH (1994). Full sample measures of the standard deviation and relative standard deviation for New Zealand's key macroeconomic variables are presented in Tables 1 to 4. The relative standard deviation of macroeconomic variable x is its standard deviation relative to that of expenditure-based GDP (variable y). These statistical measures document the emergence of an inherently more stable economy.

Perhaps the most significant stylised fact to have emerged in this context is a marked reduction in the general volatility of the real economy. As illustrated in Table 1, the standard deviation of the cyclical component in real GDP has fallen from a remarkable 3.64% in KBH to only 1.41% in the updated sample period. Unsurprisingly, this fall has coincided with a rise in persistence, with the first-order autocorrelation of real GDP increasing from .31 in KBH to .77 in the present study. These broad facts are consistent with the findings of McCaw (2007), and the greater underlying stability of the New Zealand economy. It should be noted that, with a standard error of 0.10% for the volatility of real GDP, the full sample average disguises a degree of variability in the standard deviation itself, an observation that is reinforced by the changeable nature of the moving windows measure illustrated in Figure 2.

The decline in the volatility of real GDP has been mirrored to varying degrees throughout much of the real economy. Aggregate measures of consumption, investment, and government consumption expenditure have all witnessed a sizeable reduction in volatility. In light of such conformity, however, two expenditure components warrant particular attention: private non-residential fixed investment and government expenditure. Compared to the summary statistics obtained by KBH, the former is the only variable to experience an increase in its standard deviation, while the latter is the only real variable to exhibit a fall in its standard deviation relative to that of real output. The disconnectedness of these two variables echoes remarks made by KBH as to the relative independence of trend volatility in private fixed investment and government purchases. Such independence may reflect underlying differences in the determinants of these variables.

What explains the manifest decline in New Zealand's real variable volatility? At a proximate level, this trend may be associated with the stability of prices. As shown in Table 3, the standard deviation of the GDP deflator has fallen from 5.12% in KBH to a modest 1.20% in the present study.

It may also be associated with improved policy. For example, through the 1989 Reserve Bank Act, New Zealand became the first country to formally adopt inflation-targeting monetary policy. Two decades later, it appears the RBNZ has achieved considerable success in achieving its mandate "to formulate and implement monetary policy directed to the economic objective of achieving and maintaining stability in the general level of prices" (Reserve Bank of New Zealand Act 1989, s 8). Another policy-related catalyst for improved stability may be the more prudent use of fiscal policy, following on from enactment of the Fiscal

Responsibility Act 1994, and since incorporated into the Public Finance Amendment Act 2004. Despite criticism that the rapidity and sequencing of these and other reforms may have restrained long-term growth over the past 30 years, it appears that the measures have played an instrumental role in the reducing the volatility of New Zealand's business cycles – a feat which, of itself, may be conducive to growth in the long-run (Ramey & Ramey, 1995). Outside of the policy domain, a more stable external environment during much of the sample period is likely to have been a further significant contributing factor.

While measures of absolute volatility can promote an intriguing narrative, business cycle theorists can often be more interested in measures of relative volatility; such as the standard deviation of the candidate variable relative to that of real GDP. Of particular note here, is the fact that non-durables consumption is almost as volatile as real GDP, with a relative standard deviation of 0.95. On the other hand, consumption of durables is more than twice as volatile as GDP. Consistent with stylised facts for the majority of industrialised countries, investment is significantly more volatile than both consumption and real GDP. In fact, with a relative standard deviation of 5.29, investment exhibits substantially more volatility than in the United States, where it tends to be only about 3 times as volatile as output (King & Rebelo, 2000).

Results for taxation, transfers, net taxation and government debt to GDP variables were not reported in either KBH or McCaw. Notable from the measures reported in Table 2, however, are that all four variables have been volatile relative to GDP, with net taxation having been particularly so.

The volatility of New Zealand's external sector variables has also been notably lower since KBH (1994), with the exception of the real TWI. Not surprisingly for our sample period of fully flexible exchange rates, the real TWI has shown somewhat greater volatility, recording 6.06% relative to 5.03%. From a figure of 3.16%, the standard deviation of the net exports share has fallen to a new sample average of 1.63%, reflecting a reduction in the volatility of all subcomponents apart from service exports. Despite this improvement, the standard deviation of New Zealand's net export share remains above the median value of 1.06% obtained by Backus et al. (1994) for their sample of 11 OECD countries, and almost four times as large as the figure of 0.45% for United States.

The decline in net exports volatility was paralleled by an even larger reduction in the standard deviation of the terms-of-trade from 8.54% to 3.34%. This trend may be ascribed to increased external stability and some degree of diversification of New Zealand's export base. Indeed, upon surveying the moving windows analysis in KBH, it appears much of the accentuated volatility in that sample came during the early 1970s when oil prices were subject to severe shocks and New Zealand's primary-oriented export base faced volatile world prices. This trend of high volatility in the terms-of-trade seems to have re-emerged during the recent global financial crisis, reflected to some extent in Figure 4 by the rise in the moving standard deviation for that series.

This study also takes the opportunity to revisit the volatility of New Zealand's monetary variables in the wake of the extensive financial market deregulation that took place in the 1980s. KBH document a

substantial degree of volatility in New Zealand's monetary sector. The equivalent facts for the period from 1987q2 to 2010q4 depict a virtually unrecognisable economy in terms of its relative stability. Of particular note is the significant reduction in the standard deviation of the 90-day nominal interest rate from 16.2% in KBH to 1.37% in the updated sample period. This was accompanied by a much less dramatic reduction in the standard deviation of the real 90-day rate from 2.07% to 1.14%. These trends reflect the increased stability of inflation over the past 20 years, as well as the general trend of declining volatility in most other macroeconomic variables. Despite the fall in amplitude of both short-term and long-term interest rates, the short-term rates remain relatively the more volatile, as one would expect.

There has been no material increase in the volatility of labour market variables reported in Table 4, with all except (FTE) employment having been considerably less volatile than their KBH equivalents.

3.2 Real Variable Regularity

There is nothing particularly striking in the Table 1 cross-correlations between GDP and its major consumption and investment variables. Both consumption and investment, along with their disaggregated components, are strongly procyclical, with a magnitude of .76 for aggregate consumption and .79 for aggregate investment. Similarly, the correlation coefficients for the disaggregated components range from .58 for 'other' investment to .83 for durables consumption.[5] Of some note, though, is the magnitude of these coefficients, which evidence a much tighter correlation than was observed by KBH and bear a closer resemblance to the estimates reported by King and Rebelo (2000) for the United States. "Real variable regularity" has therefore been both confirmed and enhanced.

3.3 Fiscal Variables

Except in recent multivariate VAR and UC studies for New Zealand by Claus et al. (2006), Dungey and Fry (2009) and Hall and McDermott (2011), it has been common to investigate stylised facts solely for National Accounts government expenditure variables. However, even for these variables the stylised facts continue to be controversial. For example, have government expenditure variables been consistently pro-, counter- or a-cyclical, have there been robust lead or lag lengths, and what has been the degree of movement in these relationships over time? With the aim of shedding further light on each of these aspects, we first present results for the conventionally reported government expenditure variables, and then for the other fiscal variables published in HMcD (2011, Table 7).

3.3.1 *Government Expenditure*

In KBH, government expenditure variables displayed no systematic cyclical tendency (0.16 correlation for the aggregate and 0.14 for central government). The maximum statistically significant cross-correlation was 0.39 with fluctuations in government expenditure lagging fluctuations in real GDP by five

[5] 'Other' investment refers to all Private Gross Fixed Capital Formation that is not classified as either Residential or Non-Residential.

quarters. In this sense, government expenditures constituted an exception to the contemporaneous real variable regularities displayed by consumption, investment, exports, and imports. That acyclical behaviour of government spending was consistent with the finding of Backus and Kehoe (1992) that internationally, government purchases exhibit no systematic cyclical tendency.

The results we present for government expenditure variables in Tables 1 and 2 confirm both that aggregate government expenditure has been acyclical and that the maximum cross-correlation has been positive with a lag of five quarters. The magnitude of that maximum has, however, increased from the previous 0.39 to around 0.56, and the latter magnitude should be seen in the context of its variability over time, as illustrated in Figures 10 and 11. There, the 21-quarter moving average of the five-quarter lagged cross-correlation for aggregate government expenditure has fluctuated considerably, and has almost always exhibited quite pronounced positive co-movements. The key changes in direction of the aggregate government expenditure variable seem associated most strongly with those in its investment expenditure component.

What then might this relationship imply for the nature of fiscal policy in New Zealand? Subject of course to the bivariate nature of the measure, and having due regard to the interpretation of most recent movements being limited by end-point issues associated with moving windows methodology[6], the correlation is consistent with governments' following above trend movements in real GDP with often quite substantial above trend government expenditures.

3.3.2 *Other Fiscal Variables*

The net taxation variable has been consistently and significantly procyclical, centred around its sample average correlation of 0.57 and with considerable variability over time (Table 2 and Figure 7). Movements in taxation seem to have dominated those in transfer payments, as movements in taxation have been similarly positively correlated with a lag of one quarter (0.57). The maximum cross-correlation for transfers has been negative, with a lead of five quarters (-0.41)[7].

Movements in the gross government debt to GDP ratio have also been very variable over time, and have been primarily negatively correlated with a lag of three quarters (-0.60), i.e. above trend movements in real GDP have been associated most strongly with subsequent below trend movements in the government debt to GDP ratio (Table 2 and Figure 11).

3.4 Open Economy Variables

Among the industrialised countries of the world, the business cycle literature contains systematic evidence of a countercyclical trade balance. This stylised fact was reported by Backus and Kehoe (1992) for 10

[6] Further work is planned to address end-point issues.

[7] This result for transfers is in contrast to the statistically significant result reported in HMcD (2011, Table 7) of transfers being weakly contemporaneously countercyclical (-0.16). The HMcD sample period was 1983q2 to 2006q4.

industrialised countries. Nowadays, the assumption of a countercyclical trade balance is a commonplace feature of many DSGE models.

In light of this empirical consensus, one of the more puzzling stylised facts to have emerged from KBH was the sample average acyclical nature of net exports (-0.09, not significant). This sample average value reflected substantial sub periods of both pro-and counter-cyclicality, ending with a period from (centred) 1983 onwards of strong procyclicality (.60). These observations were inconsistent with Backus, Kehoe, and Kydland's (1992) 11-country median contemporaneous correlation of -0.29, and provide a key justifications for this paper's reassessment of New Zealand's business cycle facts.

This paper finds a more robust countercyclical tendency in net exports for the period from 1987q2 to 2010q4. The contemporaneous cross-correlation of -.33 in Table 1 reveals a weakly countercyclical, yet statistically significant, relationship between the net exports share and real GDP. Despite a notable degree of variability in the moving windows of this correlation, it remains negative for almost the entire sample period. On this evidence, the behaviour of net exports more closely reflects the common experience of other OECD countries in the updated sample period.

In a proximate sense, the stronger counter-cyclicality of New Zealand's trade balance, relative to that found in KBH, can be attributed primarily to the relatively stronger procyclicality of imports. As can be seen from the relevant panels in Figure 6, imports determine not only the sign, but also the strength of the net exports share. In periods where imports and real GDP are closely correlated, above average output is more likely to result in a deterioration of the trade balance. The pivotal role of imports in the determination of the relationship between net exports and output can be reconciled with the strong income term assigned to import demand by empirical economists such as Krugman, Baldwin, Bosworth, and Hooper (1987).

But is the contemporaneous relation the strongest one? As in KBH, where net exports are negatively cross-correlated with a magnitude of -0.35 and a lag of two quarters, we report a markedly stronger maximum cross-correlation of -.52, also at a lag of two quarters. The six-month lag might in principle be explainable in terms of concepts underpinning a J-curve. For example, if the terms-of-trade are procyclical, then for an expansion phase of the aggregate business cycle net exports could fall below trend as quantities of imported goods also expand.[8] In New Zealand, however, a deterioration of the trade balance could be dampened in the short-run by the relative stickiness of trade quantities. When trade quantities are slow to adjust, the price effect of a rise in the terms-of-trade would operate to improve the trade balance, thereby partially offsetting the adverse quantity effect outlined above. This argument would not be inconsistent with a two-quarter lag in the negative co-movement of the trade balance. So, has New Zealand's terms of trade been procyclical or leading with a positive cross-correlation? The answer would be yes if one turned to the maximum cross-correlation for the terms of trade reported in HMcD (2011, Table 7) for the sample period 1983q2 to 2006q4.

[8] SNZ calculates the terms-of-trade as the price of exports relative to the price of imports. Accordingly, a rise in the terms-of-trade constitutes an improvement while a fall constitutes a deterioration. This explains why the abovementioned argument hinges upon a procyclical terms-of-trade as opposed to a countercyclical measure.

There, the terms of trade was statistically significant with value 0.33, and led by two quarters. However, as reported in our Table 3, this relationship is not sustained when observations are extended through to 20010q4. There is then no statistically significant contemporaneous relation, and the maximum cross-correlation of 0.28 for a lag of two or three quarters is puzzling.

A robust specific role for the terms of trade has clearly not yet emerged from our bivariate work. We have, however, not yet assessed the relationship between the cyclical component of net exports at time $t + k$ and the cyclical component of the terms-of-trade at time t, as encouraged by Backus et al. (1994), and some form of multivariate approach may be even more fruitful..

We have also considered the cyclical behaviour of both the real and nominal TWI. Both of these measures have been quite strongly procyclical (Table 3, 0.56), with magnitudes varying quite considerably over time (Figure 8). Not surprisingly, this is a considerably stronger result than the generally non-significant negatively correlated results obtained by KBH for their sample period which covered a series of different exchange rate regimes.

Disaggregated components of the trade balance also warrant brief discussion. Imports of services co-move positively with a two-period lag, contrasting with imports of goods which move procyclically. More interestingly, though, exports of services have a maximum cross-correlation of 0.48 at a lead of two quarters, and are the only major real output variable in our set to lead the aggregate cycle.

3.5 Monetary Variables

The study of KBH was unable to produce robust monetary variable results, due to major financial market deregulation during the sample period and changes to New Zealand's exchange rate regime. Our using a sample period from 1987q2 to 2010q4 enables us to reassess monetary sector stylised facts in the context of a more stable regulatory environment and a floating exchange rate regime.

As shown in Table 3, all interest rate variables are contemporaneously procyclical with output. However, the contemporaneous relationship between interest rates and output is not the most striking. Consistent with the findings of McCaw (2007), our interest rates tend to lag economic activity by approximately three quarters. For a phase shift of this nature, the correlation coefficients range from 0.57 for the nominal rate on five-year government bonds to 0.73 for the real 90-day rate. On the basis of these results, one might be tempted to infer that the response of monetary policy to detrended output tends to be reactive, rather than proactive[9]. However caution must be exercised when associating changes in the interest rate with changes in monetary policy; as it is entirely possible for the former to occur independently of the latter via changes in credit demand or other financial market factors. It may also mean, for a flexible inflation-targeting

[9] HMcD (2011, Table 7) report, for the period 1983q2 – 2006q4, a maximum statistically significant cross-correlation of -0.31 for a lead of nine quarters, which is consistent with weakly proactive monetary policy. However, in HMcD's multivariate UC results, this monetary policy variable was then not significant, and dominated by terms of trade, government expenditure and net migration variables.

central bank, that responses of output to interest rate movements may have been quite weak over the short- to medium-term.

To assess further this three-quarter lagged correlation, consider the representative case of the real 90-day interest rate. As illustrated in Figure 12, this has shown considerable stability over time, with the exception of a centred period between 2001q3 and 2005q2 during which it became close to acyclical. Nonetheless, one may posit an explanation grounded upon RBNZ's considerable focus on the housing boom during this period. In the context of an already tight domestic economy, the housing boom accentuated inflation but added little to the economy in terms of increased output . Accordingly, the RBNZ's interest rate response may have been less dependent on the deviations in output from trend, and more dependent upon the deviations from trend inflation.

There are several other distinctive observations for the cyclicality of monetary variables. The real interest rate displays a slightly stronger procyclical correlation than its nominal counterpart, short and long-term rates have broadly similar degrees of procyclicality, and results for the yield gap variable are consistent with those for the other interest rate variables. Finally, the two real monetary aggregate variables included in our data set – M3(r) and DC(r) – are basically acyclical, but their correlation with output climbs to 0.61 and 0.40 respectively at a lag of five quarters.

3.6 Prices

Cross correlations between fluctuations in aggregate price level and output variables can be consistent with a range of theoretical underpinnings and empirical interpretations. KBH report a relatively weak, but statistically significant countercyclical relationship between these two variables, but the moving average relationships showed considerable variability over time. For example, the CPI exhibited a period of sustained procyclicality for the centred period covering the late 1970s and early 1980s.

Three price level measures are used in this study: the All Groups Consumer Price Index (CPI); the CPI excluding food, fuel, and government charges; and the GDP deflator. Their respective contemporaneous cross-correlations of 0.04, -0.14 and .12 are not statistically significant and are consistent with fluctuations in the price level being acyclical (Table 3). However, when one considers the maximum co-movement at a lag of five quarters, the resulting coefficients offer evidence of a modest positive correlation with output for all three measures of prices (i.e., from 0.38 to 0.45)[10]. For example, when output is above trend at time t, one would expect the CPI to be somewhat above trend at time $t + 5$, a lagged relationship which is consistent with a degree of price stickiness at aggregate levels. Again not surprisingly, however, the lagged correlation has varied considerably over time, and has remained positive except for a short period centred in the early 2000s.

[10] There is somewhat less strong but statistically significant evidence that the aggregate price level is negatively cross-correlated with a lead of approximately five quarters (e.g. -0.35 (0.09) for the CPI).

3.7 Labour Market Variables

The greater part of our sample period post-dates passage of New Zealand's Employment Contracts Act and the subsequent Employment Relations Act, whereas the KBH sample pre-dated those Acts. So could one have expected materially different results for our contemporary sample period?

Key findings from KBH were that: aggregate employment fluctuations were positively correlated with output fluctuations with a lag of one quarter (0.40); aggregate labour productivity was strongly procyclical (0.79); and aggregate real average hourly compensation was very weakly procyclical (0.15 (0.10)), reflecting a lengthy period of procylicality and two short periods of centred countercyclicality. From a producer perspective, real private unit labour costs were consistently contemporaneously countercyclical for almost all of the period (-0.42), with this average having reflected contemporaneously procyclical real private labour costs (0.34) and their movements over time having been almost a mirror image of labour productivity movements.

Some interesting results emerge from our focus on the post-1987 sample period (Table 4). Perhaps least surprising is that (FTE) employment fluctuations have on average now been more strongly positively correlated with output fluctuations, but still with a lag of two quarters (0.59 relative to the KBH 0.40). Average procyclical (FTE) labour productivity is now shown to be less strongly correlated than the average (hourly) labour productivity reported in KBH (0.54 relative to 0.79), and is further reflected in more recent real unit labour costs having been more strongly countercyclical (-0.68 versus -0.42). But perhaps the most materially different results, which are also consistent with results presented in McCaw (2007), are those for our two real wage variables: firstly, real average hourly earnings are no longer weakly procyclical but significantly negatively correlated with output movements at a lag of two quarters (-0.32); and secondly, the KBH (private) real labour costs relationship of modest procyclicality (0.34) is in contrast to our post-ECA real labour costs variable being modestly negatively correlated with a lag of four quarters (-0.40).

4 Conclusion

Drawing on well-established univariate and bivariate growth cycle methodology, we have established a set of stylised facts for New Zealand business cycles for the period from 1987q2 to 2010q4. Our results, taken in conjunction with recent findings from McCaw (2007) and Hall and McDermott (2011), are benchmarked against those established by Kim, Buckle and Hall (1994) for the period 1966q4 to 1990q1, and suggest a number of new findings. Some of these findings challenge prior understandings, while others clarify previous uncertainties.

By way of broad perspective, our results show that for a sample period following the major economic reforms of the mid-1980s and early-1990s, fluctuations in New Zealand's aggregate business cycle have exhibited greater persistence than previously. Not surprisingly, this has been associated with reduced volatility for key macroeconomic variables, particularly so for government expenditure, nominal interest rates, net

exports, terms of trade, labour productivity, real wage and other price variables. Net taxation, government investment expenditure, and the components of private gross fixed capital formation have been volatile, relative to GDP.

Government sector, open economy, monetary and labour market cross correlation results differ in important respects from those established previously. In particular, monetary sector stylised facts are somewhat more robust. Information from non-contemporaneous cross-correlations is shown to be additionally important for some key variables, as is information from movements in cross-correlations over time.

More specifically, real variable regularity has been confirmed, and the procyclical co-movements for private consumption and investment have been stronger. Government expenditure has remained (contemporaneously) acyclical, and it continues to be the case that government expenditure has co-moved positively with a lag of five quarters. Fluctuations in real net taxation have been consistently contemporaneously procyclical, with considerable variability over time. Movements in the gross government debt to GDP ratio have also been very variable over time, and primarily negatively correlated with a lag of three quarters. Imports have now become convincingly more procyclical than exports, and as a result the net exports share has become both more strongly countercyclical and more strongly negatively cross correlated with a lag of two quarters. It has now also been established that real TWI movements have been quite strongly procyclical, with considerable variability over time. Interest rate variables have for the most part been weakly procyclical, but they have also exhibited a considerably stronger positive correlation with output at a lag of three quarters. These monetary sector regularities are of material significance, given the uncertainty that characterised the monetary sector during the KBH sample period. Finally, results for our labour market variables are preliminary in nature but suggest the possibility of considerably different stylised facts for labour productivity, real labour costs, real unit labour costs and real average hourly earnings.

Our univariate and bivariate stylised facts should not, of course, be used on their own as benchmarks for macroeconomic models. They can be further assessed against key findings from multivariate structural and reduced form approaches, with due regard for the fact that bivariate correlations provide statistical associations but not necessarily causative relations. The robustness of our underlying deviations from trend series could also be further verified, using an unobserved components approach to detrending.

Overall, however, a more credible set of benchmark regularities have been established, to help underpin the construction and use of contemporary New Zealand macroeconomic models.

A Tables

TABLE 1

Cyclical Behaviour of Key Output and Expenditure Variables

Quarterly Deviations from Trend: 1987(2)-2010(4), λ=1600

Variable x	Volatility SD%	Relative Volatility SD(x)%/SD(y)%	Auto-correlation	Cross-correlation of Real GDP (expenditure) with x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
GDP (production)	1.44%	1.02	0.86											
GDP (expenditure)	1.41%	1.00	0.77											
	(0.10%)													
Consumption	1.45%	1.03	0.81	0.03	0.10	0.31	0.49	0.62	**0.76**	0.71	0.65	0.58	0.49	0.36
	(0.09%)			(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	**(0.04)**	(0.06)	(0.08)	(0.08)	(0.09)	(0.09)
Non-durables	1.34%	0.95	0.64	-0.03	0.02	0.18	0.41	0.53	**0.60**	0.55	0.51	0.48	0.43	0.39
	(0.09%)			(0.10)	(0.09)	(0.09)	(0.09)	(0.08)	**(0.06)**	(0.08)	(0.09)	(0.09)	(0.09)	(0.10)
Durables	3.28%	2.33	0.77	0.09	0.26	0.44	0.56	0.69	**0.83**	0.72	0.60	0.50	0.34	0.22
	(0.29%)			(0.10)	(0.09)	(0.09)	(0.09)	(0.11)	**(0.03)**	(0.06)	(0.09)	(0.09)	(0.09)	(0.09)
Private gross fixed capital formation	7.46%	5.31	0.76	0.14	0.26	0.37	0.48	0.65	**0.79**	0.69	0.61	0.45	0.26	0.09
	(0.48%)			(0.13)	(0.12)	(0.10)	(0.09)	(0.08)	**(0.03)**	(0.07)	(0.10)	(0.09)	(0.09)	(0.10)
Residential	8.59%	6.11	0.76	0.00	0.11	0.28	0.47	0.62	**0.74**	0.66	0.53	0.29	0.13	-0.01
	(0.56%)			(0.11)	(0.11)	(0.09)	(0.08)	(0.06)	**(0.03)**	(0.06)	(0.07)	(0.08)	(0.09)	(0.10)
Non-residential	11.14%	7.92	0.74	0.22	0.31	0.39	0.49	0.53	**0.62**	0.54	0.56	0.55	0.45	0.36
	(0.84%)			(0.13)	(0.13)	(0.12)	(0.10)	(0.09)	**(0.07)**	(0.08)	(0.08)	(0.10)	(0.09)	(0.10)
Other	9.00%	6.40	0.57	0.16	0.25	0.28	0.28	0.45	**0.58**	0.48	0.43	0.31	0.14	-0.01
	(0.67%)			(0.14)	(0.10)	(0.10)	(0.10)	(0.08)	**(0.06)**	(0.08)	(0.11)	(0.09)	(0.09)	(0.09)
Government Expenditure	2.64%	1.88	0.54	-0.12	-0.15	-0.12	-0.01	0.05	0.14	0.15	0.24	0.28	0.34	**0.54**
	(0.23%)			(0.10)	(0.11)	(0.11)	(0.09)	(0.10)	(0.09)	(0.10)	(0.10)	(0.09)	(0.10)	**(0.09)**
Govt. Consumption	1.37%	0.97	0.43	-0.17	-0.18	-0.22	-0.13	-0.02	0.07	0.08	0.27	0.28	0.32	**0.50**
	(0.13%)			(0.11)	(0.12)	(0.10)	(0.09)	(0.10)	(0.09)	(0.10)	(0.10)	(0.09)	(0.09)	**(0.08)**
Govt. Investment	11.01%	7.83	0.62	-0.13	-0.15	-0.08	0.04	0.09	0.18	0.21	0.23	0.29	0.33	**0.48**
	(0.90%)			(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.12)	(0.11)	(0.10)	**(0.09)**
Net Exports Share	1.63%	1.16	0.67	0.10	0.02	-0.08	-0.14	-0.32	-0.33	-0.43	**-0.52**	-0.45	-0.34	-0.26
	(0.13%)			(0.11)	(0.12)	(0.10)	(0.09)	(0.08)	(0.07)	(0.08)	**(0.08)**	(0.09)	(0.09)	(0.09)
Exports of Goods and Services	2.49%	1.77	0.46	0.05	0.04	0.04	0.15	0.19	**0.31**	0.13	-0.04	-0.10	-0.16	-0.20
	(0.23%)			(0.12)	(0.11)	(0.10)	(0.11)	(0.11)	**(0.09)**	(0.12)	(0.11)	(0.10)	(0.10)	(0.09)
Exports of Goods	3.05%	2.17	0.33	-0.10	-0.15	-0.17	-0.06	0.03	**0.20**	0.05	-0.09	-0.10	-0.08	-0.06
	(0.32%)			(0.11)	(0.11)	(0.10)	(0.11)	(0.12)	**(0.10)**	(0.13)	(0.12)	(0.10)	(0.11)	(0.09)
Exports of Services	4.61%	3.28	0.76	0.39	0.47	0.47	**0.48**	0.43	0.33	0.27	0.13	0.00	-0.13	-0.29
	(0.36%)			(0.09)	(0.08)	(0.09)	**(0.08)**	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Imports of Goods and Services	4.88%	3.47	0.71	-0.05	0.05	0.15	0.27	0.47	0.52	0.54	**0.56**	0.44	0.30	0.21
	(0.32%)			(0.11)	(0.11)	(0.10)	(0.08)	(0.07)	(0.06)	(0.08)	**(0.08)**	(0.09)	(0.09)	(0.09)
Imports of Goods	5.76%	4.10	0.66	-0.04	0.07	0.17	0.25	0.47	**0.51**	0.51	0.51	0.39	0.24	0.18
	(0.37%)			(0.12)	(0.12)	(0.10)	(0.09)	(0.08)	**(0.06)**	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)
Imports of Services	4.56%	3.24	0.66	-0.04	-0.03	0.05	0.21	0.30	0.35	0.42	**0.47**	0.38	0.36	0.22
	(0.33%)			(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.07)	(0.08)	**(0.09)**	(0.09)	(0.09)	(0.10)

Notes: Numbers in parentheses are GMM standard errors; column 3 is a first order serial correlation

TABLE 2

Cyclical Behaviour of Key New Zealand Treasury Fiscal Variables

Quarterly Deviations from Trend: 1987(2)-2010(4)

Variablex	Volatility SD%	Relative Volatility SD(x)%/SD(y)%	Auto-correlation	Cross-correlation of Real GDP (expenditure) with x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
GDP (expenditure)	1.41%	1.00	0.77											
	(0.10%)													
Government Expenditure	2.45%	1.74	0.51	-0.20	-0.23	-0.21	-0.09	0.01	0.13	0.20	0.32	0.35	0.37	**0.57**
	(0.25%)			(0.10)	(0.11)	(0.11)	(0.10)	(0.11)	(0.09)	(0.09)	(0.10)	(0.09)	(0.11)	**(0.09)**
Govt. Consumption	1.51%	1.07	0.37	-0.16	-0.17	-0.21	-0.15	-0.04	0.03	0.02	0.22	0.22	0.25	**0.44**
	(0.15%)			(0.11)	(0.12)	(0.10)	(0.09)	(0.10)	(0.09)	(0.10)	(0.10)	(0.09)	(0.09)	**(0.09)**
Govt. Investment	11.60%	8.25	0.56	-0.24	-0.25	-0.17	-0.04	0.05	0.19	0.31	0.35	0.39	0.39	**0.50**
	(1.01%)			(0.09)	(0.10)	(0.10)	(0.10)	(0.11)	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	**(0.10)**
Net Govt. Expenditure/GDP	1.28%		0.40	-0.15	-0.30	-0.35	-0.45	**-0.52**	-0.51	-0.48	-0.40	-0.27	-0.13	0.04
(Govt. expend. - net tax)	(0.10%)			(0.10)	(0.10)	(0.10)	(0.09)	**(0.08)**	(0.08)	(0.09)	(0.09)	(0.10)	(0.11)	(0.11)
Government Revenue variables														
Taxation	3.92%	2.79	0.41	-0.04	0.10	0.18	0.36	0.49	0.55	**0.57**	0.53	0.41	0.31	0.20
	(0.31%)			(0.10)	(0.11)	(0.11)	(0.10)	(0.08)	(0.07)	**(0.08)**	(0.09)	(0.10)	(0.12)	(0.10)
Transfers	3.36%	2.39	0.50	**-0.41**	-0.38	-0.31	-0.21	-0.15	-0.12	-0.05	-0.02	-0.02	0.07	0.09
	(0.37%)			**(0.08)**	(0.09)	(0.11)	(0.11)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.09)
Net taxation	6.58%	4.68	0.46	0.08	0.22	0.28	0.42	0.53	**0.57**	0.56	0.51	0.39	0.26	0.16
(Taxation - transfers)	(0.48%)			(0.11)	(0.11)	(0.11)	(0.10)	(0.08)	**(0.07)**	(0.08)	(0.08)	(0.09)	(0.11)	(0.11)
Gross Govt. Debt/GDP	2.99%	2.13	0.79	0.26	0.10	-0.05	-0.15	-0.34	-0.45	-0.51	-0.54	**-0.60**	-0.50	-0.43
	(0.28%)			(0.10)	(0.11)	(0.11)	(0.11)	(0.09)	(0.07)	(0.08)	(0.10)	**(0.08)**	(0.08)	(0.08)

Notes: Numbers in parentheses are GMM standard errors; column 3 is a first order serial correlation

TABLE 3

Cyclicality of Key Price and Monetary Variables

Quarterly Deviations from Trend: 1987(2)-2010(4), λ=1600

X12 Seasonally Adjusted

Variable x	Volatility SD%	Auto-correlation	Cross-correlation of Real GDP (expenditure) with x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
Price Variables													
TOT	3.34%	0.73	-0.02	0.03	0.05	0.06	0.13	0.14	0.20	**0.28**	0.28	0.20	0.12
	(0.29%)		(0.10)	(0.10)	(0.10)	(0.09)	(0.08)	(0.09)	(0.10)	(0.10)	(0.09)	(0.09)	(0.07)
TWI	6.05%	0.84	-0.14	0.00	0.20	0.38	0.50	**0.56**	0.56	0.51	0.39	0.28	0.21
	(0.48%)		(0.08)	(0.08)	(0.08)	(0.07)	(0.06)	(0.05)	(0.06)	(0.07)	(0.08)	(0.09)	(0.11)
Real TWI	6.06%	0.83	-0.14	0.01	0.22	0.39	0.51	0.56	**0.57**	0.53	0.41	0.30	0.23
	(0.45%)		(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.05)	(0.06)	(0.08)	(0.08)	(0.09)	(0.11)
CPI	1.26%	0.70	-0.35	-0.29	-0.27	-0.23	-0.10	0.04	0.15	0.25	0.34	0.40	**0.43**
	(0.21%)		(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.08)	(0.09)	(0.10)	(0.11)
CPI less food, fuel, govt charges*	0.68%	0.70	-0.22	-0.24	-0.22	-0.11	-0.11	-0.14	0.01	0.15	0.23	0.34	**0.38**
	(0.08%)		(0.10)	(0.11)	(0.09)	(0.10)	(0.11)	(0.11)	(0.10)	(0.08)	(0.08)	(0.09)	(0.10)
GDP deflator	1.20%	0.69	-0.23	-0.15	-0.05	-0.02	0.02	0.12	0.13	0.27	0.39	0.41	**0.45**
	(0.09%)		(0.09)	(0.10)	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.09)	(0.08)	(0.09)	(0.09)
Monetary Variables													
90-day Bank Bill	1.37%	0.79	-0.19	-0.13	-0.04	0.06	0.20	0.37	0.51	0.61	**0.68**	0.61	0.48
	(0.09%)		(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.10)	(0.08)	(0.08)	(0.09)	(0.10)	(0.11)
5 yr Govt Bond	0.77%	0.77	-0.23	-0.17	-0.07	0.10	0.29	0.44	0.50	0.54	**0.57**	0.49	0.35
	(0.06%)		(0.10)	(0.11)	(0.11)	(0.11)	(0.11)	(0.09)	(0.07)	(0.08)	(0.09)	(0.11)	(0.13)
Floating first mortgage rate	1.12%	0.84	-0.24	-0.21	-0.16	-0.07	0.09	0.28	0.46	0.58	**0.69**	0.07	0.56
	(0.06%)		(0.09)	(0.10)	(0.10)	(0.11)	(0.11)	(0.10)	(0.08)	(0.08)	(0.08)	(0.10)	(0.11)
90-day yield gap	0.88%	0.66	-0.08	-0.05	0.00	0.00	0.06	0.18	0.35	0.47	**0.56**	0.52	0.43
	(0.07%)		(0.09)	(0.09)	(0.10)	(0.11)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Real 90-day Bank Bill**	1.14%	0.83	-0.24	-0.15	-0.05	0.07	0.23	0.39	0.54	0.66	**0.73**	0.66	0.53
	(0.07%)		(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.09)	(0.07)	(0.07)	(0.09)	(0.10)	(0.11)
M3(r)***	2.38%	0.82	-0.24	-0.20	-0.21	-0.09	0.03	0.19	0.29	0.38	0.45	0.55	**0.61**
	(0.14%)		(0.08)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
DC(r)***	2.09%	0.82	-0.25	-0.20	-0.20	-0.13	-0.02	0.05	0.13	0.19	0.28	0.37	**0.40**
	(0.15%)		(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.10)	(0.10)	(0.10)

Notes: Numbers in parentheses are GMM standard errors; Column 2 is a first-order Autocorrelation

* Observations available from 1989(1) to 2010(4) only

** Observations available from 1987(3) to 2010(4) only

*** Observations available from 1988(2) to 2010(4) only

TABLE 4

Cyclical Behaviour of Key New Zealand Labour Market Variables

Quarterly Deviations from Trend: 1987(2)-2010(4),1600

Variable x	Volatility SD%	Relative Volatility SD(x)%/SD(y)%	Auto-correlation	Cross-correlation of Real GDP (expenditure) with										
				x_{t-5}	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}	x_{t+5}
GDP (expenditure)	1.41%	1.00	0.77											
	(0.10%)													
Employment	1.27%	0.90	0.88	0.18	0.28	0.35	0.45	0.53	0.57	0.58	**0.59**	0.56	0.50	0.42
	(0.08%)			(0.11)	(0.11)	(0.10)	(0.08)	(0.07)	(0.07)	(0.08)	**(0.09)**	(0.09)	(0.09)	(0.09)
Unemployment	0.70%	0.50	0.88	-0.24	-0.35	-0.42	-0.53	-0.62	-0.67	**-0.68**	-0.62	-0.54	-0.43	-0.32
	(0.05%)			(0.13)	(0.12)	(0.11)	(0.08)	(0.06)	(0.05)	**(0.07)**	(0.09)	(0.10)	(0.10)	(0.10)
Labour Productivity	1.08%	0.77	0.65	-0.01	-0.01	0.12	0.24	0.39	**0.54**	0.36	0.18	0.02	-0.12	-0.25
	(0.08%)			(0.10)	(0.09)	(0.09)	(0.09)	(0.10)	**(0.07)**	(0.08)	(0.09)	(0.10)	(0.10)	(0.12)
Real Average Weekly Earnings†	0.88%	0.63	0.41	-0.08	-0.04	0.01	0.00	-0.03	-0.10	-0.26	**-0.32**	-0.27	-0.22	-0.20
	(0.06%)			(0.11)	(0.11)	(0.11)	(0.11)	(0.10)	(0.11)	(0.10)	**(0.09)**	(0.10)	(0.11)	(0.11)
Real Average Hourly Earnings†	0.88%	0.63	0.65	-0.24	-0.26	-0.23	-0.27	-0.29	-0.32	-0.39	**-0.45**	-0.38	-0.25	-0.14
	(0.06%)			(0.09)	(0.09)	(0.10)	(0.10)	(0.09)	(0.09)	(0.08)	**(0.07)**	(0.09)	(0.09)	(0.10)
Real Labour Cost††	0.99%	0.70	0.62	0.03	0.00	-0.01	0.00	0.00	-0.09	-0.12	-0.27	-0.37	**-0.40**	-0.37
	(0.07%)			(0.10)	(0.10)	(0.09)	(0.09)	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	**(0.12)**	(0.11)
Real Unit Labour Cost††	1.76%	1.25	0.77	0.07	0.00	-0.13	-0.31	-0.48	**-0.68**	-0.59	-0.56	0.50	-0.40	0.25
	(0.12%)			(0.10)	(0.10)	(0.09)	(0.08)	(0.07)	**(0.05)**	(0.09)	(0.11)	(0.11)	(0.11)	(0.10)

Notes: Numbers in parentheses are GMM standard errors; column 3 is a first order serial correlation

† Sample period 1989(1)-2010(4)

†† Sample period 1992(4)-2010(4)

B Figures

Figure 2

Moving Percentage Standard Deviations from Trend: Real Variables

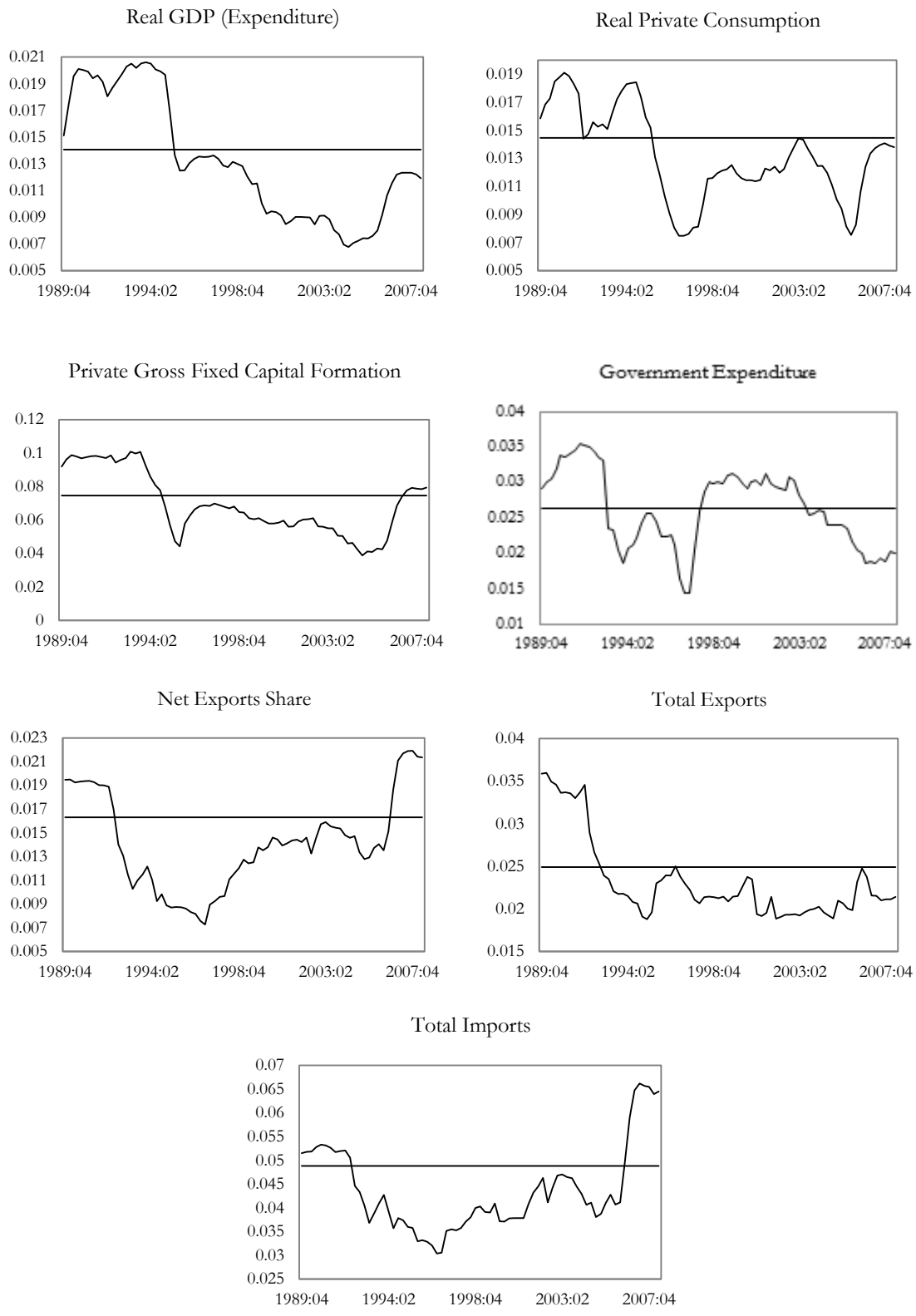
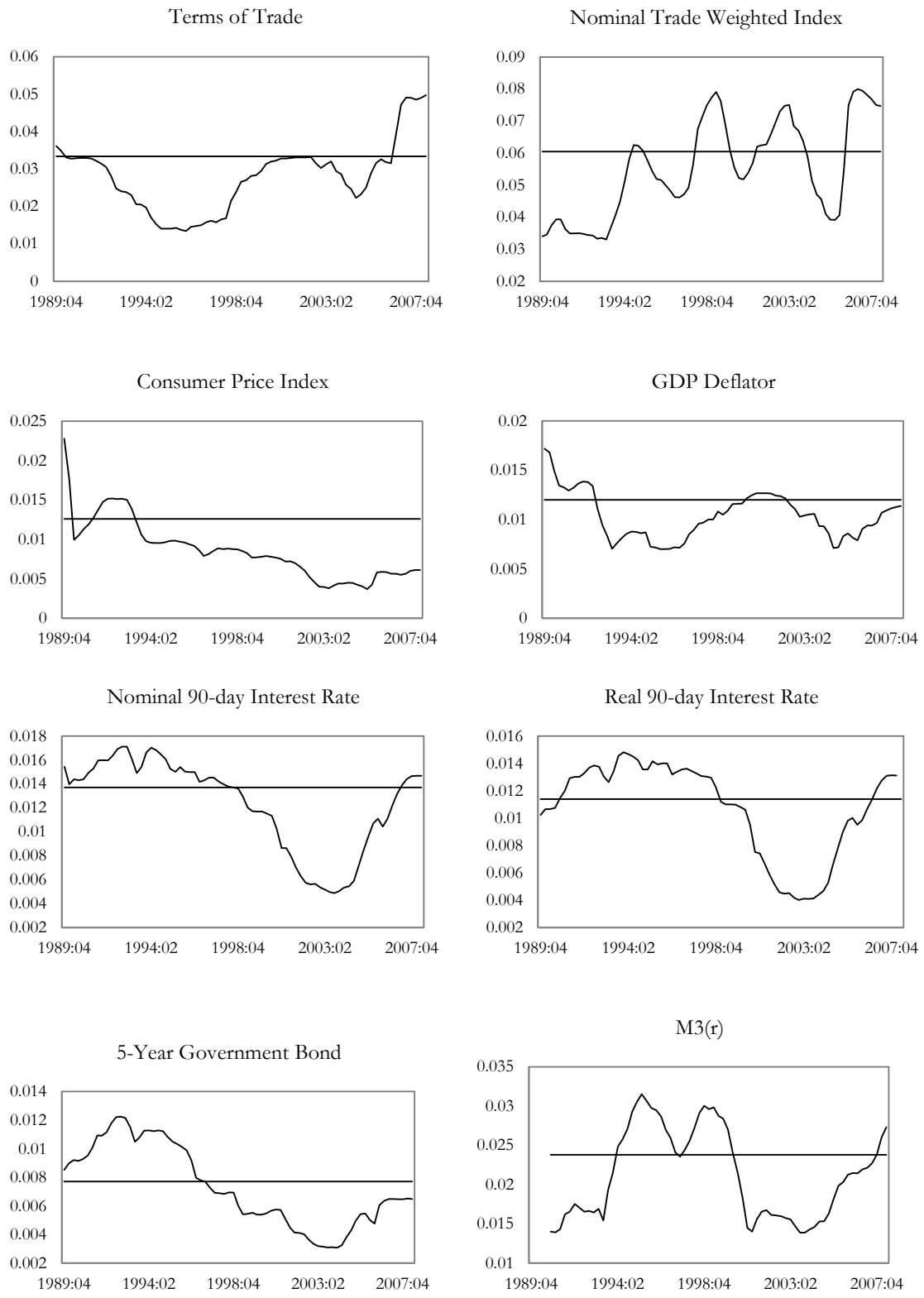


Figure 3

Moving Percentage Standard Deviations from Trend: New Zealand Treasury Fiscal Variables

Figure 4

Moving Percentage Standard Deviations from Trend: Prices and Monetary Variables



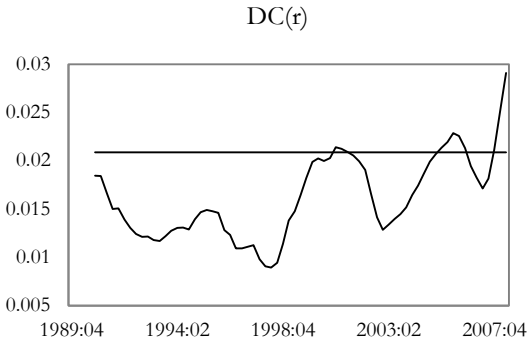
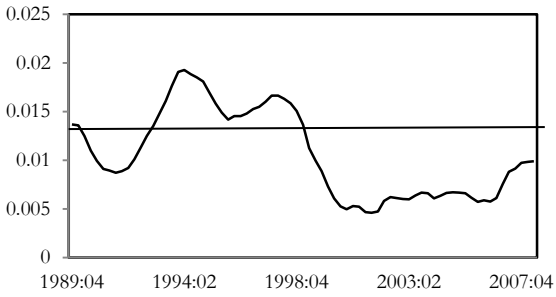

DC(r)
0.03
0.025
0.02
0.015
0.01
0.005
1989:04
1994:02
1998:04
2003:02
2007:04

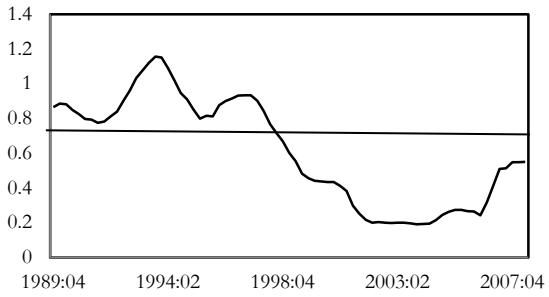
Figure 5

Moving Percentage Standard Deviations from Trend: Labour Market Variables

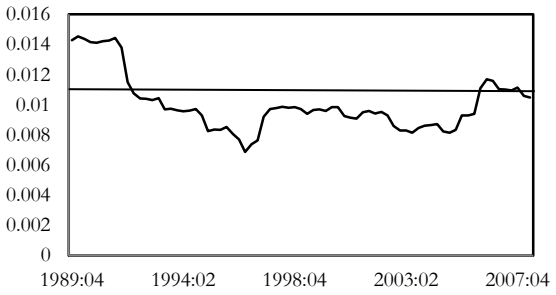
Employment



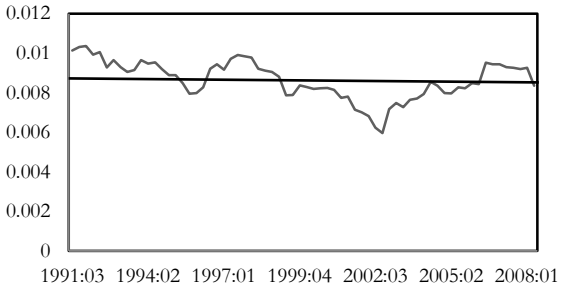
Unemployment



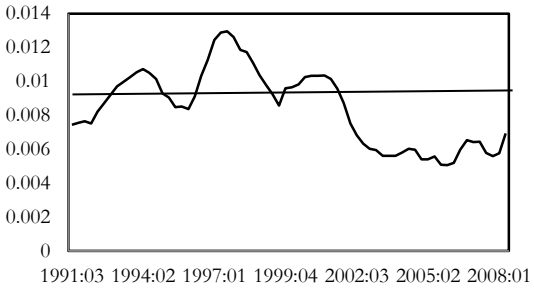
Labour Productivity



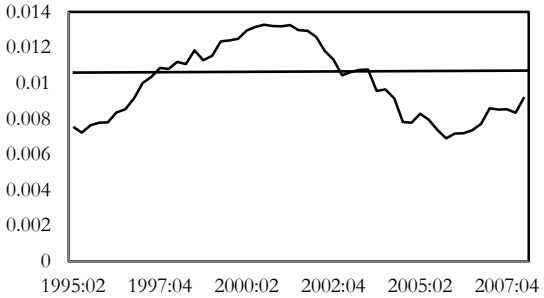
Real Average Weekly Earnings



Real Average Hourly Earnings



Real Labour Cost



Real Unit Labour Cost

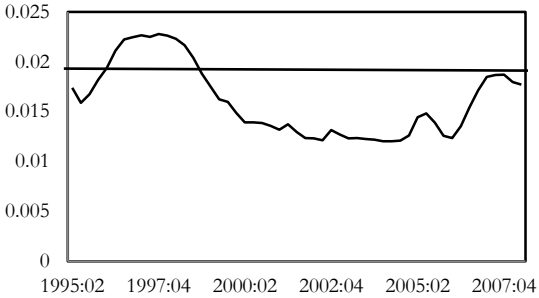


Figure 6

Moving Contemporaneous Cross Correlations with Real GDP: Real Variables

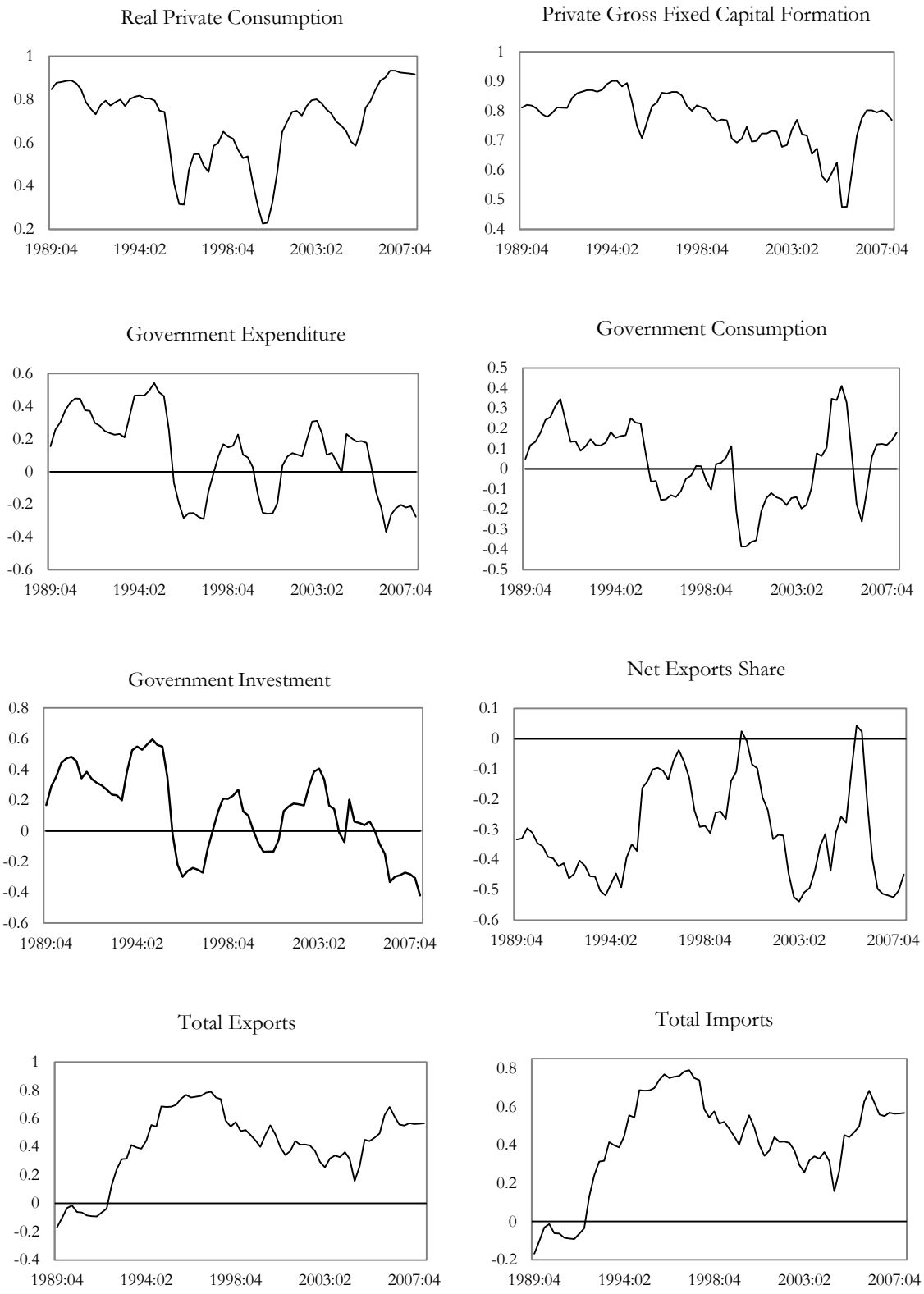


Figure 7

Moving Contemporaneous Cross Correlations with Real GDP: New Zealand Treasury Fiscal Variables

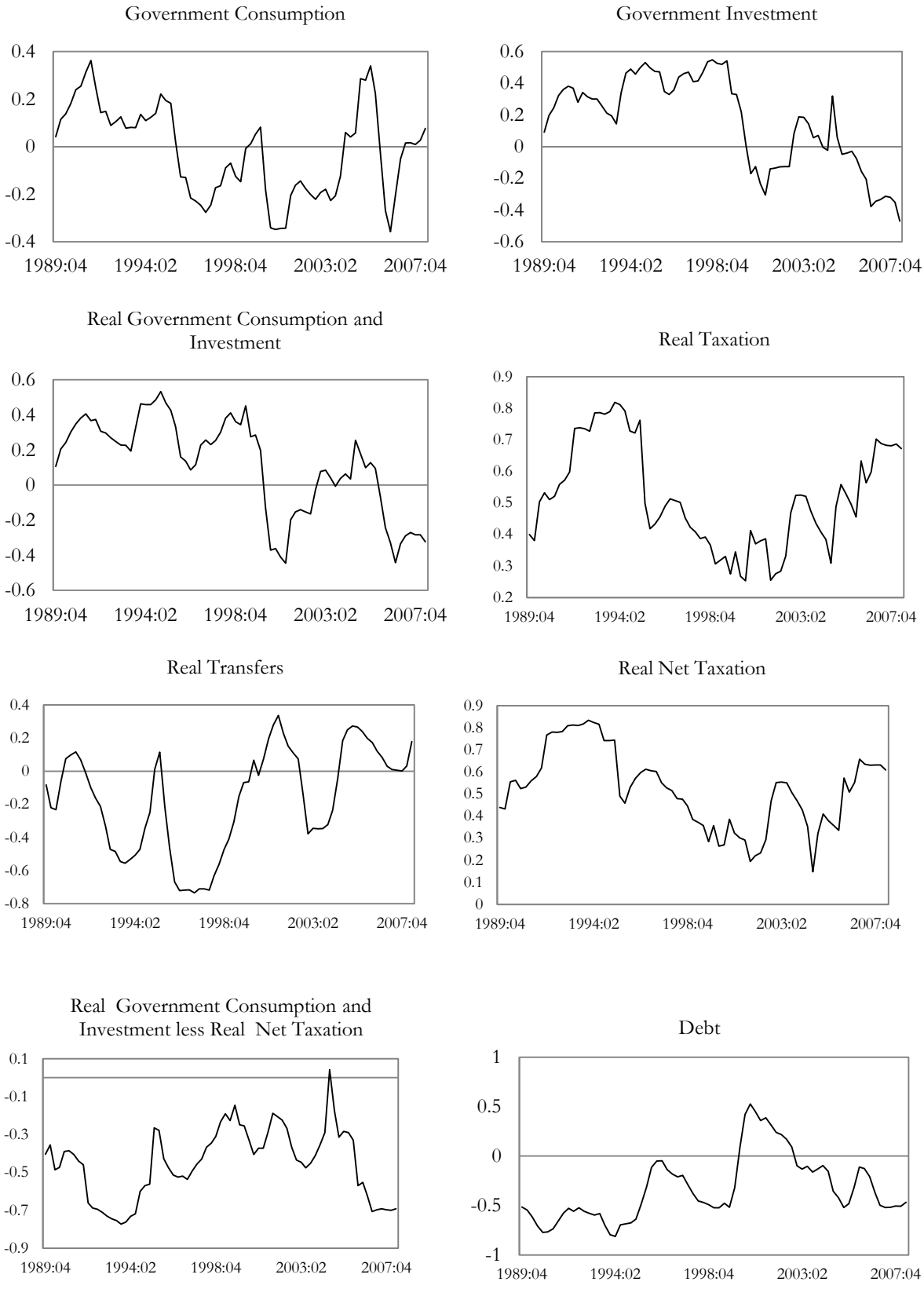
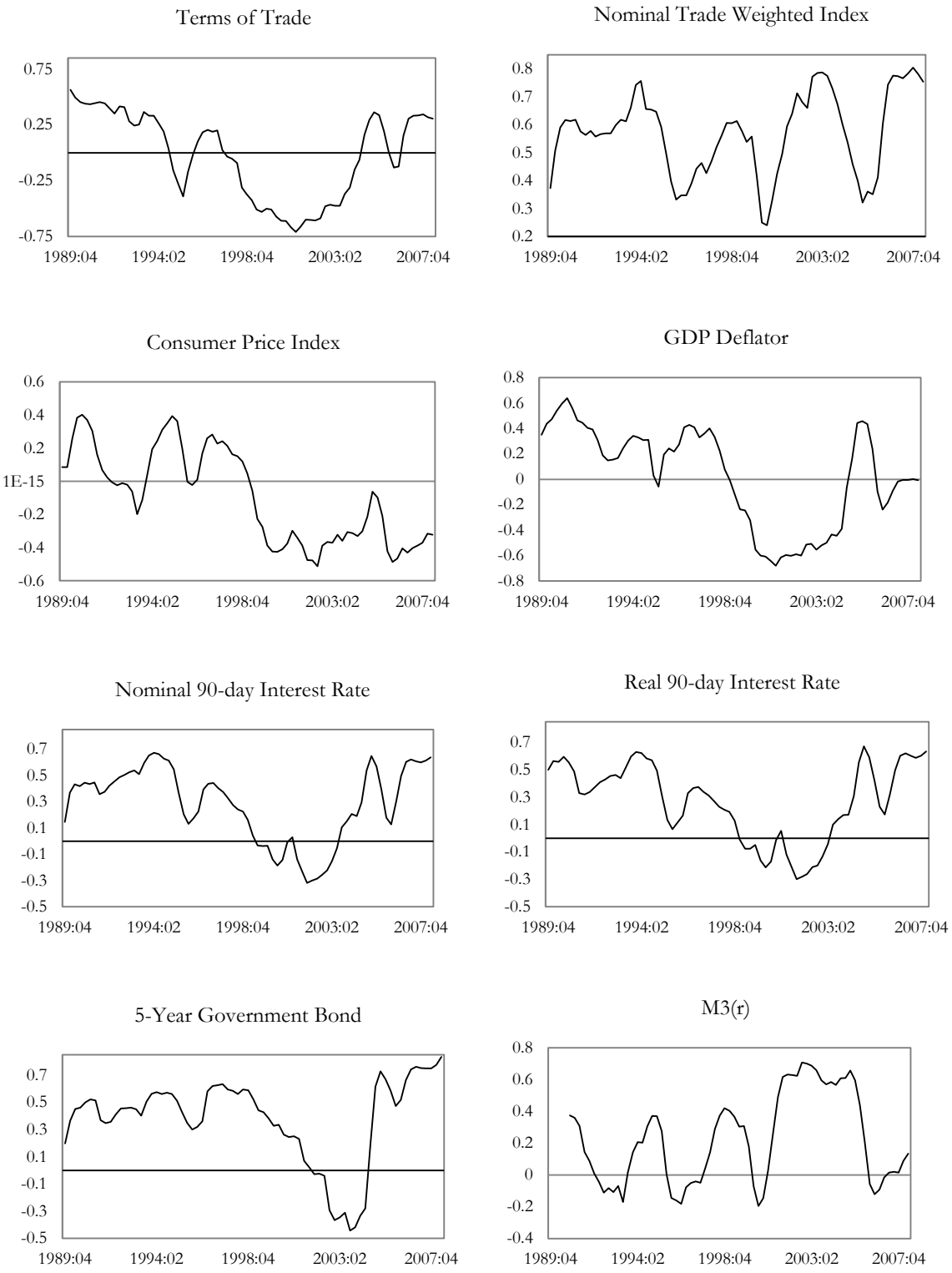


Figure 8

Moving Contemporaneous Cross Correlations with Real GDP: Prices and Monetary Variables



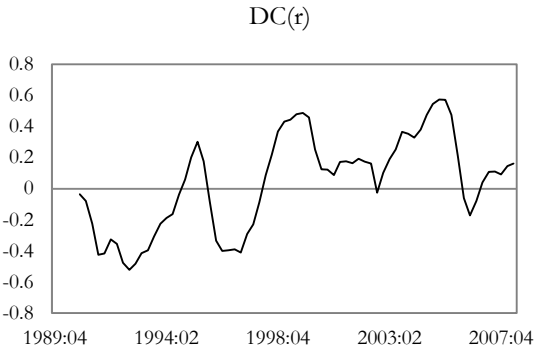
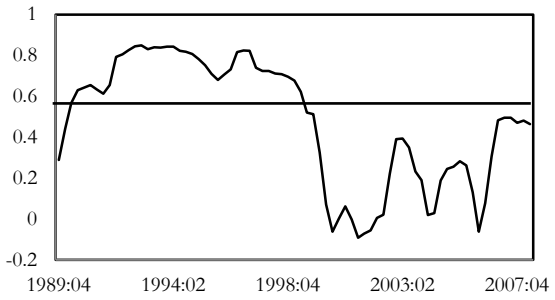

DC(r)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
1989:04
1994:02
1998:04
2003:02
2007:04

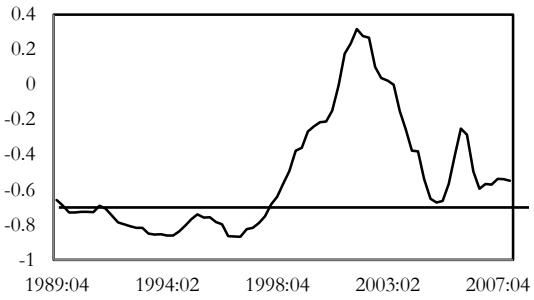
Figure 9

Moving Contemporaneous Cross Correlations with Real GDP: Labour Market Variables

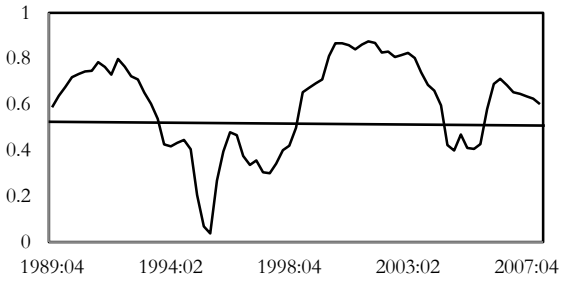
Employment



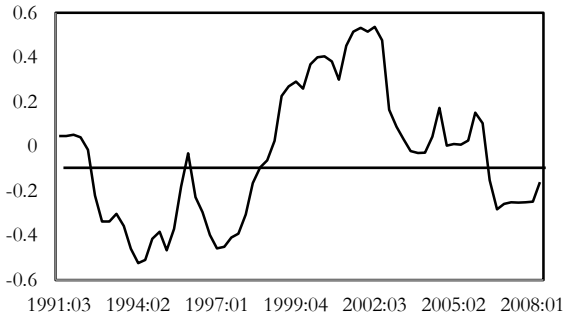
Unemployment



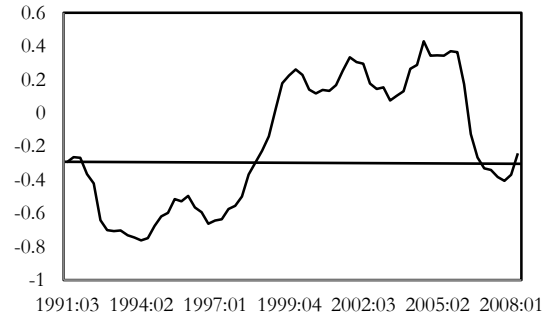
Labour Productivity



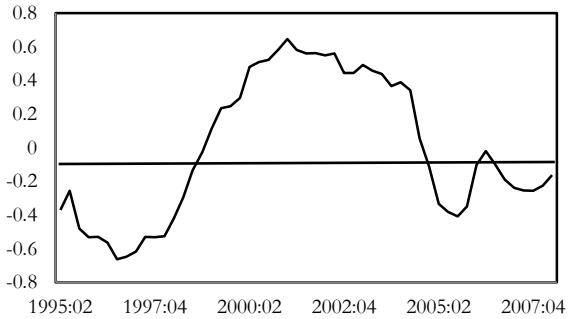
Real Average Weekly Earnings



Real Average Hourly Earnings



Real Labour Cost



Real Unit Labour Cost

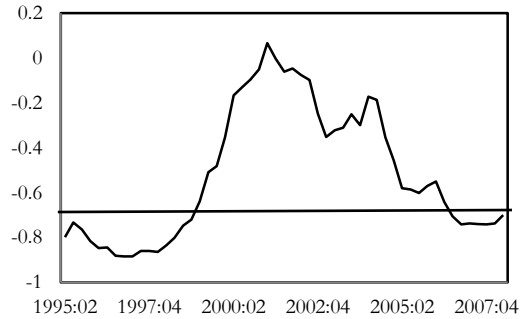
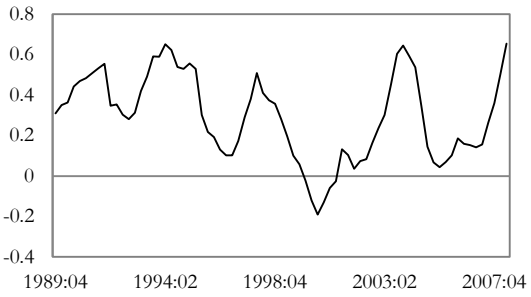


Figure 10

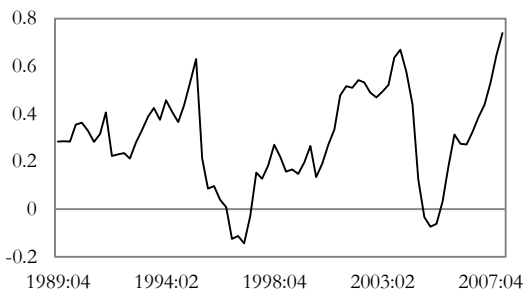
Moving Cross Correlations with Real GDP: Real Variables

Computed for the Phase Shift Exhibiting the Maximum Correlation

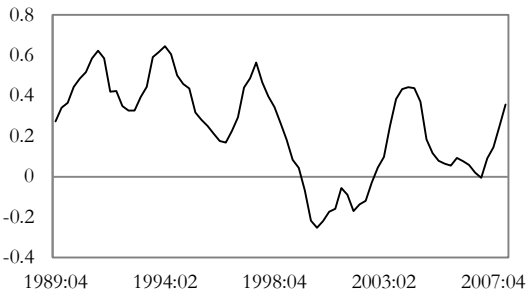
Government Expenditure : *t+5*



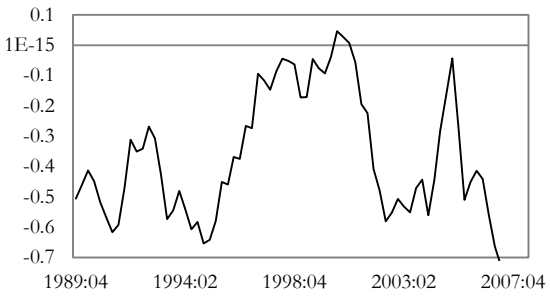
Government Consumption: *t+5*



Government Investment: *t+5*



Net Exports Share: t+2



Total Imports: t+2

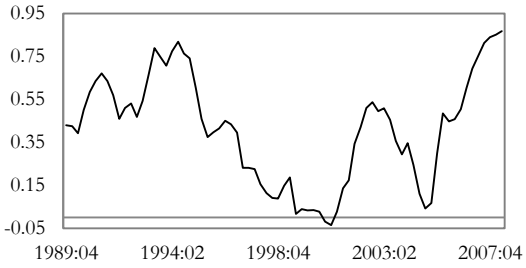
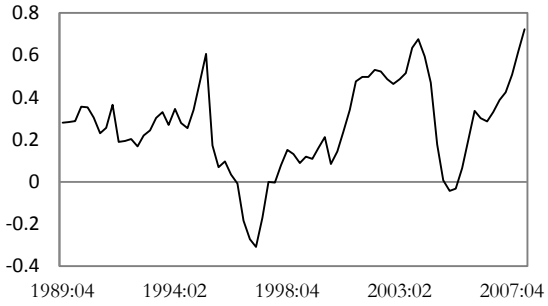


Figure 11

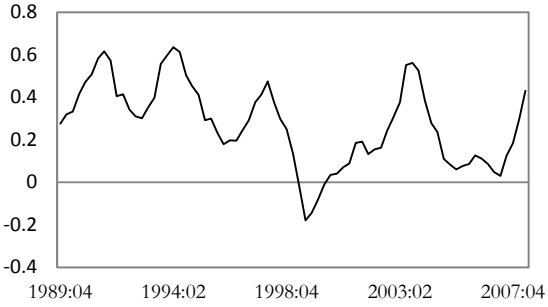
Moving Contemporaneous Cross Correlations with Real GDP: New Zealand Treasury Fiscal Variables

Computed for the Phase Shift Exhibiting the Maximum Correlation

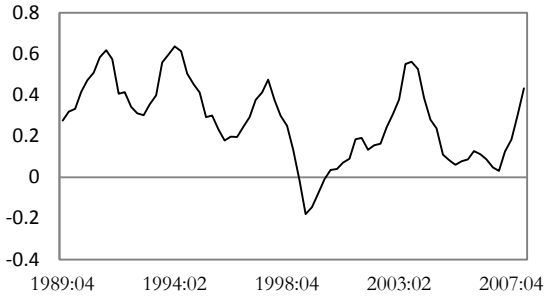
Government Consumption: t+5



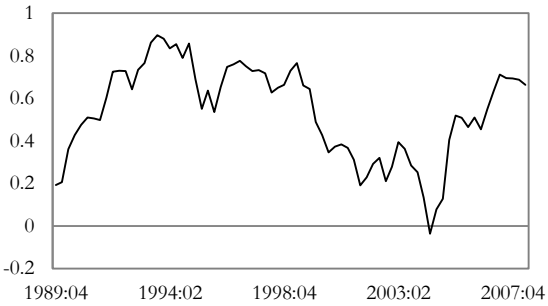
Government Investment: t+5



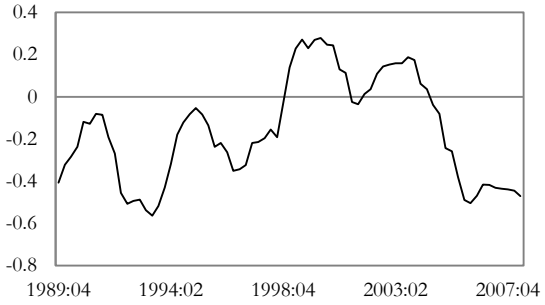
Real Government Consumption and Investment: t+5



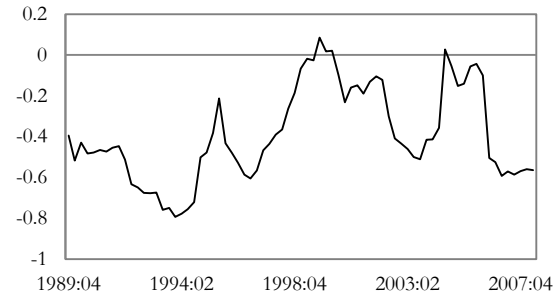
Real Taxation: t+1



Real Transfers: t-5



Real Government Consumption and Investment Less Real Net Taxation: t-1



Debt: t+3

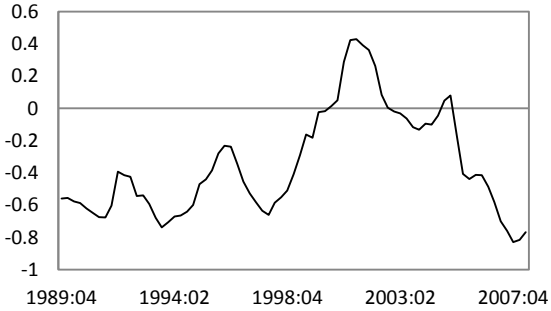


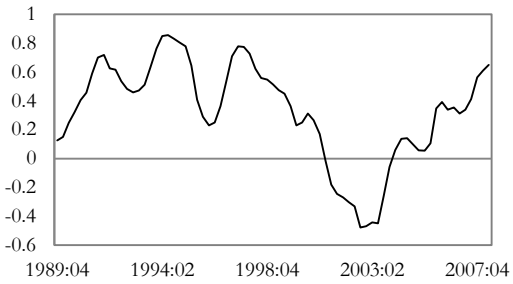
Figure 12

Moving Cross Correlations with Real GDP: Prices and Monetary Variables

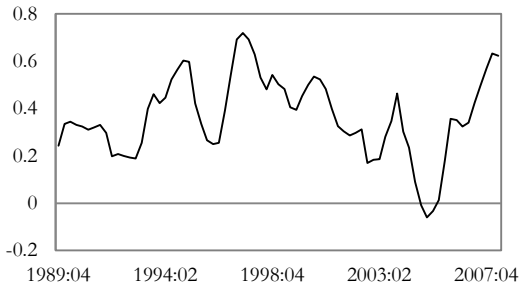
Computed for the Phase Shift Exhibiting the Maximum Correlation

Terms of Trade: t+3

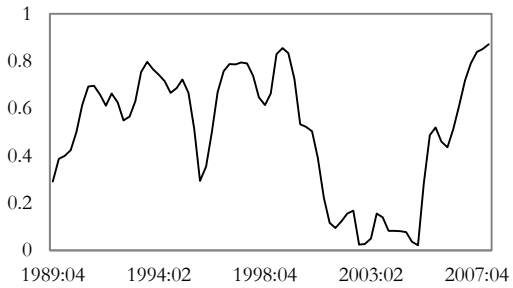
Consumer Price Index: t+5



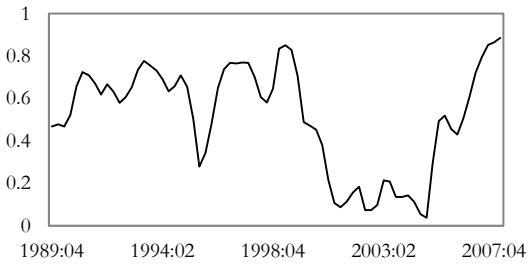
GDP Deflator: t+5



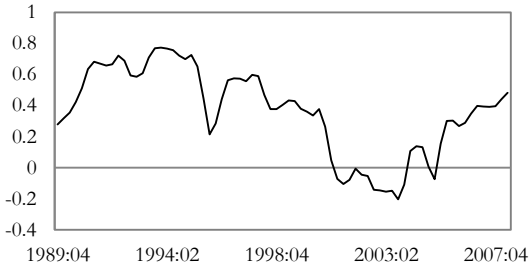
Nominal 90-day Interest Rate: t+3



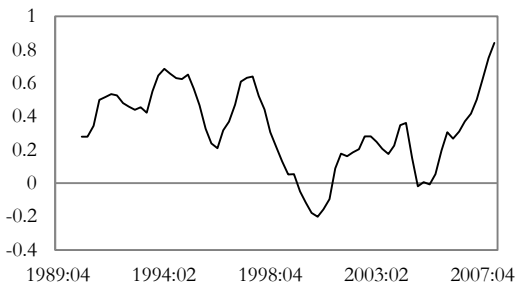
Real 90-day Interest Rate: t+3



5-Year Government Bond: t+3



M3(r): t+5



DC(r): t+5

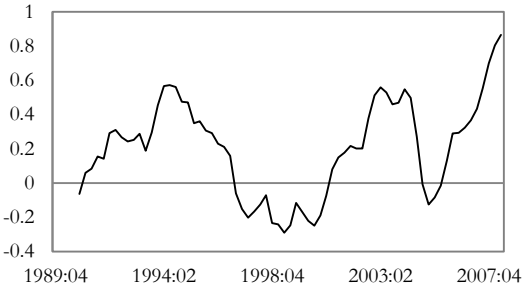
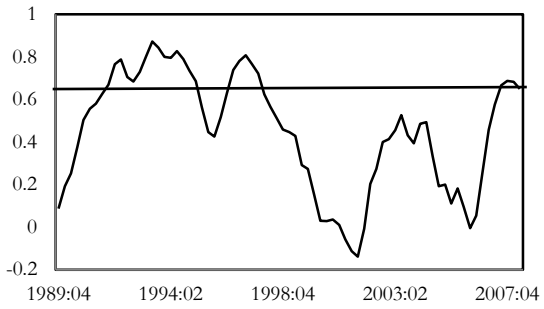


Figure 13

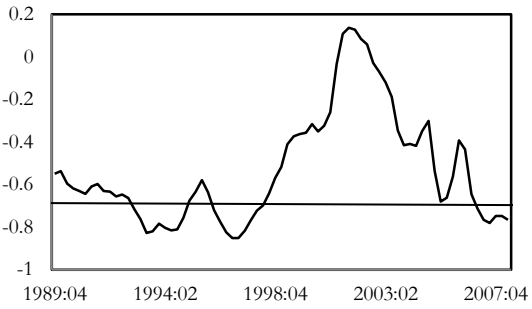
Moving Contemporaneous Cross Correlations with Real GDP: Labour Market Variables

Computed for the Phase Shift Exhibiting the Maximum Correlation

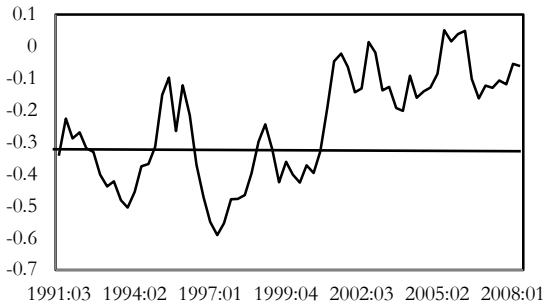
Employment: t+2



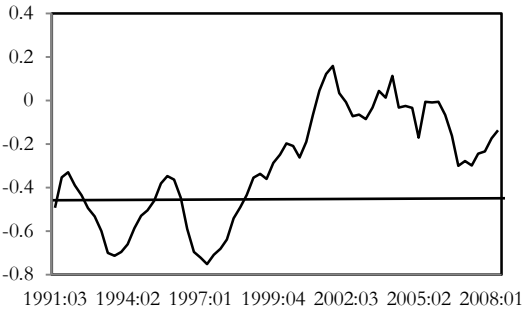
Unemployment: t+1



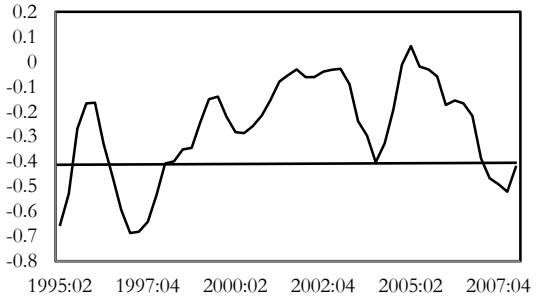
Real Average Weekly Earnings: t+2



Real Average Hourly Earnings: t+2



Real Labour Cost: t+4



C Variables and their Sources

All series were obtained from SNZ's *Infoshare* website, except for those containing the source reference 'RBNZ', and except for fiscal variables sourced from the New Zealand Treasury's fiscal data set for the time period 1982q2 to 2010q4. Where appropriate, notes are included on the calculation of variables that were not directly available in raw data form.

SA = seasonally adjusted, Log = Log transformed

Output and expenditure variables

1. Gross Domestic Product – Expenditure Measure
   Prodn A/C, GDP & GDE, Constant Prices, SA, Qrtly ($Millions) [Log]

2. Private Non Profit Organisations and Households Combined
   Use of Inc, Final Consumption Exp. Govt/Pvte Sectors, Constant Prices, SA, Qrtly ($Millions) [Log]

3. Non Durable Goods
   Use of Inc, Final Consumption Exp. by HH Item Type, Constant Prices, SA, Qrtly ($Millions) [Log]

4. Durable Goods
   Use of Inc, Final Consumption Exp. by HH Item Type, Constant Prices, SA, Qrtly ($Millions) [Log]

5. Private Gross Fixed Capital Formation
   Capital A/C, Gross Fixed Cap. Form. by Sect/O'ship, Constant Prices, SA, Qtrly ($Millions) [Log]

6. Residential Buildings
   Capital A/C, Gross Fixed Capital Formation by Asset, Constant Prices, SA, Qtrly ($Millions) [Log]

7. Non Residential Buildings
   Capital A/C, Gross Fixed Capital Formation by Asset, Constant Prices, SA, Qtrly ($Millions) [Log]

8. Other
   [Private Gross Fixed Capital Formation – (Residential Buildings + Non Residential Buildings)] ($Millions) [Log]

9. Government Expenditure
   [Government Consumption + Government Investment] ($Millions) [Log]

10. Government Consumption
    Use of Inc, Final Consumption Exp. by Govt/Pvte Sectors, Constant Prices, SA, Qrtly ($Millions) [Log]
    Note: Excludes the purchase of Frigates in 1997(2) and 1999(4)

11. Government Gross Fixed Capital Formation (Government Investment)
    Capital A/C, Gross Fixed Cap. Form. by Sect/O'ship, Constant Prices, SA, Qrtly ($Millions) [Log]

12. Net Exports
    [Total Exports – Total Imports] ($Millions) [Expressed as a share of GDP]

13. Total Exports
    Components of External Transactions Account, Constant Prices, SA, Qrtly ($Millions) [Log]

14. Exports of Goods
    Components of External Transactions Account, Constant Prices, SA, Qrtly ($Millions) [Log]

15. Exports of Services
    Components of External Transactions Account, Constant Prices, SA, Qrtly ($Millions) [Log]

16. Total Imports
    Components of External Transactions Account, Constant Prices, SA, Qrtly ($Millions) [Log]

17. Imports of Goods
    Components of External Transactions Account, Constant Prices, SA, Qrtly ($Millions) [Log]

18. Imports of Services
    Components of External Transactions Account, Constant Prices, SA, Qrtly ($Millions) [Log]

Price and monetary variables

19. Terms of Trade
    Overseas Trade Indexes, All Countries, Qrtly [Log]

20. Nominal Trade Weighted Index
    Nominal and Real TWI, Figure 8b, RBNZ [Log]

21. Real Trade Weighted Index
    Nominal and Real TWI, Figure 8b, RBNZ [Log]

22. Consumer Price Index (CPIXGST)
    CPI All Groups for New Zealand, Qrtly, (Re-indexed to reflect GST-exclusive inflation rates) [Log]

23. Consumer Price Index Excluding Food, Fuel, and Government Purchases
    Incomes and Prices, A3 Historical Series, RBNZ, Qrtly [Log]

24. GDP (expenditure) Deflator
    Incomes and Prices, A3 Historical Series, RBNZ, Qrtly [Log]

25. Nominal 90-day Interest Rate
    Interest rates, B2 Historical Series, RBNZ [Quarterly average]

26. Real 90-day Interest Rate
    [((1+Nominal 90-day Interest Rate)/(1+Two-Year Ahead Inflation Expectation))*100]
    Two-Year Ahead Inflation Expectation sourced from RBNZ

27. 5-Year Government Bond
    Interest Rates, B2 Historical Series, RBNZ [Quarterly average]

28. 90-day Yield Gap
    [Nominal 90-day Interest Rate – 5-Year Government Bond]

29. Floating First Mortgage New Customer Housing Rate
    Interest Rates, B3 Historical Series, RBNZ [Quarterly average]

30. M3(r)
    Money and Credit Aggregates, C1 Historical Series, RBNZ [Log]

31. DC(r)
    Money and Credit Aggregates, C2 Historical Series, RBNZ [Log]

Other fiscal variables

All sourced from the New Zealand Treasury's fiscal data set, as previously used in Claus et al.(2006), Dungey and Fry (2009), and Hall and McDermott (2011).

32. – 37. Real government expenditure, real government consumption expenditure, real taxation, real transfers, nominal gross government debt

Labour market variables

38. Employment
    SNZ HLFS Persons employed in labour force ('000), SA [Log]

39. Unemployment rate
    SNZ HLFS Unemployment rate (%), Total, SA

40. Labour productivity
    Production based real GDP/Employment [Log]

41. Real average weekly earnings
    SNZ All industries total (ordinary time + overtime) average weekly earnings (FTE), deflated by CPIXGST [Log]

42. Real average hourly earnings
    RBNZ average hourly earnings (total), deflated by CPIXGST [Log]

43. Real labour cost
    RBNZ Labour cost index (June 2009 = 1000), deflated by GDP deflator [Log]

44. Real unit labour cost
    Real labour cost/production based real GDP [Log]

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