Estimating New Zealand's Structural Budget Balance

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Abstract

Existing methodologies for estimating a government's structural budget balance are reviewed and applied to the case of New Zealand. Besides the conventional cyclical adjustment, an assessment is made of other possible non-structural elements to the budgetary position, including the terms of trade, asset prices and unbalanced growth. A key result is that the terms-of-trade boom, which began in the late 2000s, is associated with around 1% of GDP in tax revenues that may not be structural. Uncertainty surrounding cyclically-adjusted balance estimates is presented using fan charts.

JEL CLASSIFICATION E62 – Fiscal Policy
H62 – Budget Deficit; Surplus

KEYWORDS fiscal policy; business cycle; terms of trade; asset prices

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Estimating New Zealand’s Structural Budget Balance

1 Introduction

A common and useful analytical tool for fiscal policy is the structural budget balance, which is an attempt to distinguish between the cyclical and structural components of the government’s revenue and expenses. To illustrate, in 2009, New Zealand had a fiscal deficit for the first time in 15 years. Some of the deficit will be attributable to the automatic stabilisers which operate in response to an economic downturn. This cyclical component of the deficit can be expected to automatically unwind as the economy recovers to its potential. However, if a deficit position would exist even if the economy was operating at its potential, then there is a structural element.

In policy terms, the cyclical and structural components of the budget balance correspond to the automatic stabilisers and discretionary policy respectively. Estimating the magnitude of the structural component of a fiscal deficit tells policy makers how much active fiscal adjustment is required to restore the budget to balance. In good times, judgement about how much revenue is cyclical, and how much is structural, is critical to policy formation if fiscal policy is to avoid costly mistakes. Also, the change in the structural budget balance is indicative of whether discretionary fiscal policy is adding stimulus or withdrawing demand in the economy.

It is common practice internationally to estimate a cyclically-adjusted balance (CAB), which is the budget balance adjusted for the business cycle. The New Zealand Treasury has published estimates of the CAB since the 1980s. More recently, overseas experience suggests that other non-structural, or windfall, elements to the budget balance should be analysed. These include the terms of trade, asset prices and unbalanced growth.

This paper looks at the Treasury’s current indicator with the aim of achieving four objectives. First, the methodology is reviewed in light of lessons drawn from experience and international practice. Second, an assessment is made of further adjustments that could be made for other non-structural elements. This leads to the notion of a structural budget balance (SBB) which is the budget balance adjusted for both business cycle and other temporary effects. Third, uncertainty is explored through the use of sensitivity analysis and confidence intervals. Lastly, new results are presented of New Zealand’s structural fiscal position over history.

2 Business cycle effects

2.1 Overview of different approaches

The cyclically-adjusted balance is an unobservable variable. It is related to concepts of ‘equilibrium’, ‘potential’, or ‘natural’, rates of output and employment. There is no single, definitive means of estimating these unobservable variables.

The Treasury’s existing CAB indicator is based on a very similar approach to that used by the Organisation for Economic Cooperation and Development (OECD), International Monetary Fund (IMF) and European Commission.[1] The basic steps to this method are as follows. First, an output gap is estimated. Second, the cyclical component of the budget balance is found using an estimate of the sensitivity of revenues and expenses to the output gap. The CAB is then calculated by subtracting the cyclical component of revenue and expenses from the actual budget balance.

While the Treasury’s methodological approach is similar to the approaches adopted by the OECD and IMF, which produce their own estimates of New Zealand’s CAB, there will remain differences in the numerical estimates. This is because of choices about the accounting basis and reporting entity as well as different estimates of the output gap.

Although this broad approach is predominant amongst the international economic institutions, alternatives do exist. A simplified version of the method is to assume a constant relationship between the budget balance and the output gap. This approach is used by HM Treasury (Farrington *et al*, 2008). The advantage is that it is simple and transparent. However, it is unable to take account of changes in the composition of revenue and spending over time.

Another alternative, used by the European System of Central Banks, is to de-trend individual tax bases rather than assuming there is a constant relationship through time between tax bases and the output gap (Bouthevillain *et al*, 2001; Bezdek *et al*, 2003). This has the advantage of taking into account ‘unbalanced’ growth which may have significant fiscal implications if growth is temporarily skewed toward, or away from, tax-rich bases. However, there is no agreed theoretical foundation for the assumption that the components of demand, as opposed to aggregate output, have an identifiable equilibrium level. The implications of this method for New Zealand are investigated in section 3.4.

A fundamentally different approach is to use a structural vector autoregression method to empirically analyse the relationship between fiscal and economic shocks (Blanchard and Perotti, 2002). This method has been used previously by the New Zealand Treasury to empirically analyse the effect of fiscal policy on New Zealand business cycles (Claus *et al*, 2006). This approach has the advantage of being grounded within an economic model with behavioural foundations which allows for bi-directional feedbacks between fiscal policy and economic activity. The method is useful for analysing the dynamic effects of fiscal policy but does not lend itself to producing direct estimates of the structural budget balance. It is complementary to the analytical approach followed in this paper.

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[1] The Treasury’s CAB methodology is discussed in Tam and Kirkham (2001) and Kirker (2007). Other methods: OECD (Girouard and André, 2005), IMF (Hagemann, 1999), European Commission (European Commission, 2002).

2.2 Treasury's existing indicator methodology

The indicator is computed using a system of reduced-form equations. Formally, the main fiscal aggregates of revenue (R_t), expenses (E_t), and the operating balance (OB_t) in year t are decomposed into their cyclical and structural components (denoted by superscript s and c respectively):

$$R_t = R_t^S + R_t^C \qquad (1)$$

$$E_t = E_t^S + E_t^C \qquad (2)$$

$$OB_t^S = R_t^S - E_t^S \qquad (3)$$

$$OB_t^C = R_t^C - E_t^C \qquad (4)$$

$$OB_t = OB_t^S + OB_t^C \qquad (5)$$

The main sources of revenue are personal income tax, corporate income tax, indirect tax, investment income and sales of goods and services. For each revenue type, a cyclical adjustment is made which is a function of the output gap and specified elasticities:

$$R_{it}^S = R_{it}\left[\theta_i\left(\frac{Y_t^*}{Y_t}\right)^{\varepsilon_{R_i,YGAP}} + (1-\theta_i)\left(\frac{Y_{t-1}^*}{Y_{t-1}}\right)^{\varepsilon_{R_i,YGAP}}\right] \qquad (6)$$

$$R_t^S = \sum_i R_{it}^S \qquad (7)$$

where R_{it} is revenue from the ith source in year t, Y_t denotes the output level, Y_t^* is potential output, $\varepsilon_{R_i,YGAP}$ is the elasticity of revenue with respect to the output gap and θ_i is the lag weight.

On the expense side, only the unemployment benefit is treated as cyclical.

The structural rate of unemployment is estimated based on an assumed Okun's law relationship between unemployment and the output gap:

$$U_t^S = \beta(1 + YGAP_t)U_t \qquad (8)$$

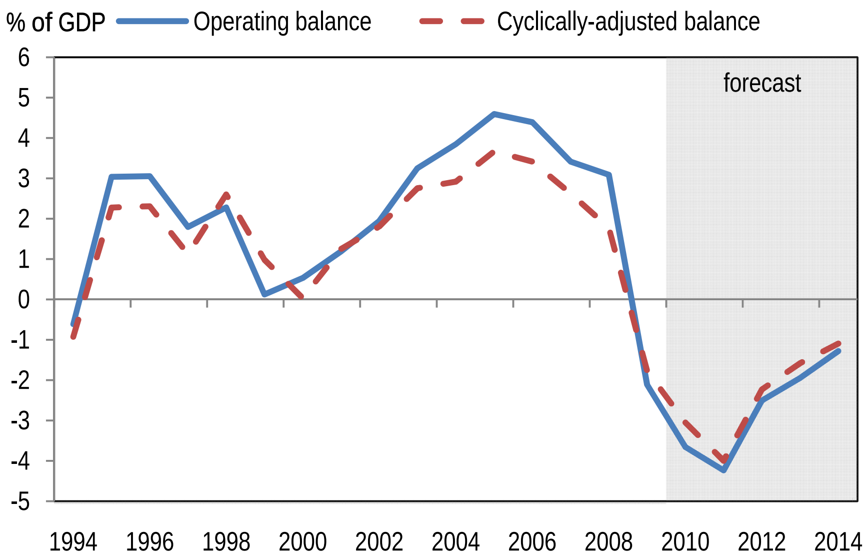
$$UE_t^S = \frac{U_t^S}{U_t}UE_t \qquad (9)$$

$$E_t^S = E_t + \left(UE_t^S - UE_t\right) \qquad (10)$$

where U_t^S is the structural rate of unemployment in year t, U_t is the actual rate of unemployment, β is the Okun coefficient, $YGAP_t$ is the output gap, UE_t^S is the structural level of unemployment benefit expenses and UE_t is the actual level of unemployment benefit expenses.

New Zealand's public finance legislation specifies the total Crown operating balance as the government's measure of the budget balance for which short-term intentions and long-term objectives must be publicly articulated (New Zealand Treasury, 2005). The CAB reported by the Treasury uses this measure (before gains and losses). The estimate published at the Budget in May 2010 is shown in Figure 1.

Figure 1 – Cyclically-adjusted balance published at Budget 2010



Source: The Treasury

Note: The measure of the fiscal balance is total Crown operating balance before gains and losses (OBEGAL). Note: all years in the paper are June years (fiscal years) unless otherwise stated.

2.3 Output gap

The output gap is the difference between actual output and its potential level, expressed as a percentage of potential output. It is a measure of the cyclical state of the economy.

Potential output, and hence the output gap, is unobservable and therefore a model or statistical filter is used to estimate it. There exists a range of possible estimation techniques which means a range of estimates are reasonable.

Estimates of New Zealand's output gap are made by a range of institutions including the Treasury, the Reserve Bank of New Zealand, the OECD and the IMF. Estimates do differ because of differences in estimation technique (including the frequency of data used).

The Treasury's official measure of the output gap is derived from a potential output series which is estimated using a multivariate (MV) filter over history and a production function approach in the forecast period. The production function used is that of the New Zealand Treasury Model, a general equilibrium forecast model discussed in Ryan and Szeto (2009).

Figure 2 shows estimates of potential output using a variety of techniques: MV filter, Hodrick-Prescott (HP) filter, Kalman filter and a production function approach. The MV and HP filters are both statistical smoothing methods. Claus *et al* (2000) describe the MV filter as 'semi-structural' in that it incorporates information from macroeconomic relationships into the HP filter. The Kalman filter is based on structural economic relationships (strictly, these are smoothed estimates of the Kalman filter using the unobservable-components time-series technique). The production function approach uses a Cobb-Douglas production function in which hours worked per employee, the employment rate, the participation rate, and total factor productivity are all filtered using the HP filter. The potential output series estimated using the MV and HP filters display a much more cyclical pattern compared with the Kalman filter, which in this case has the characteristic of being a much stiffer estimate, similar to a long-run trend. The estimates are all affected by the 'end-point problem' to some degree, which means that estimates are sensitive to the last observations in the sample. Treasury's official measure attempts to address this issue partially by using forecast information. The Kalman filter estimate is particularly sensitive to both its starting and end points which may be highly problematic, particularly given the last observations in the sample (the 'end point') are in the aftermath of a recession.

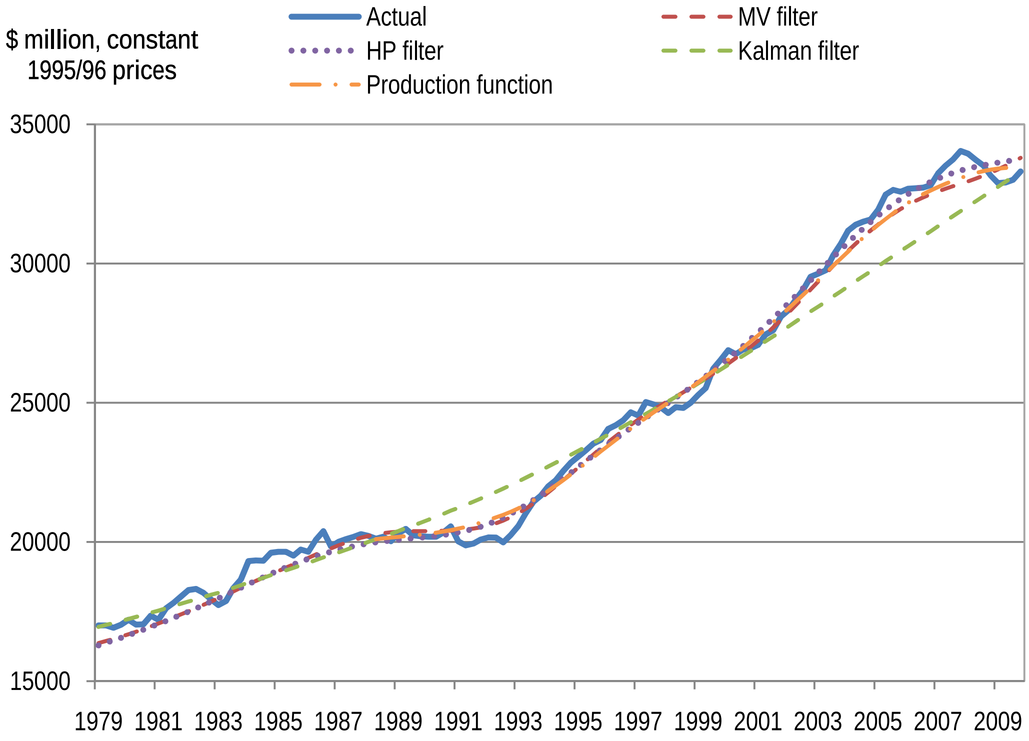
In selecting between the methods there is a trade off between attributing too much variation to cyclical factors (ie, demand-side shocks), and attributing too much variation to structural factors (ie, supply-side shocks). The statistical smoothing techniques appear to be show a high degree of cyclicality and may be overstating the amount of variation attributable to supply-side shocks. On the other hand, a stiff estimate risks attributing too much variation to the business cycle and thus underestimating structural change.

In considering the relative usefulness of the methods, it is useful to think about the purpose of the analysis. In attempting to bring a medium-term perspective to fiscal policy, to assess the sustainability of fiscal settings, it may be better to use a stiffer estimate. This is because short-lived supply-side shocks, while relevant when thinking about a short-term stabilisation objective, are ultimately temporary and therefore could lead to policymakers overestimating the degree of permanence in the fiscal position. Secondly, compared with monetary policy, fiscal policy tends to change at less frequent intervals, with longer lags in implementation, and it is harder to unwind policy loosening (ie, there is deficit bias induced by political economy). This may mean that, at least in boom times, it may be prudent to use the stiffer estimates so as to avoid the likelihood that potential growth has been overstated requiring difficult policy reversal later.

The resulting CAB estimates are presented in Figure 3 for both the MV and Kalman filters. The estimate made using the Kalman filter shows a less cyclical pattern since it ascribes much more of the growth over the 2000s as cyclical. Each estimate has technical merit. Ultimately, policymakers, and their advisors, need to make a judgement about the evolution of potential output based on the available evidence and the degree of conservativeness they wish to have in assessing potential growth.

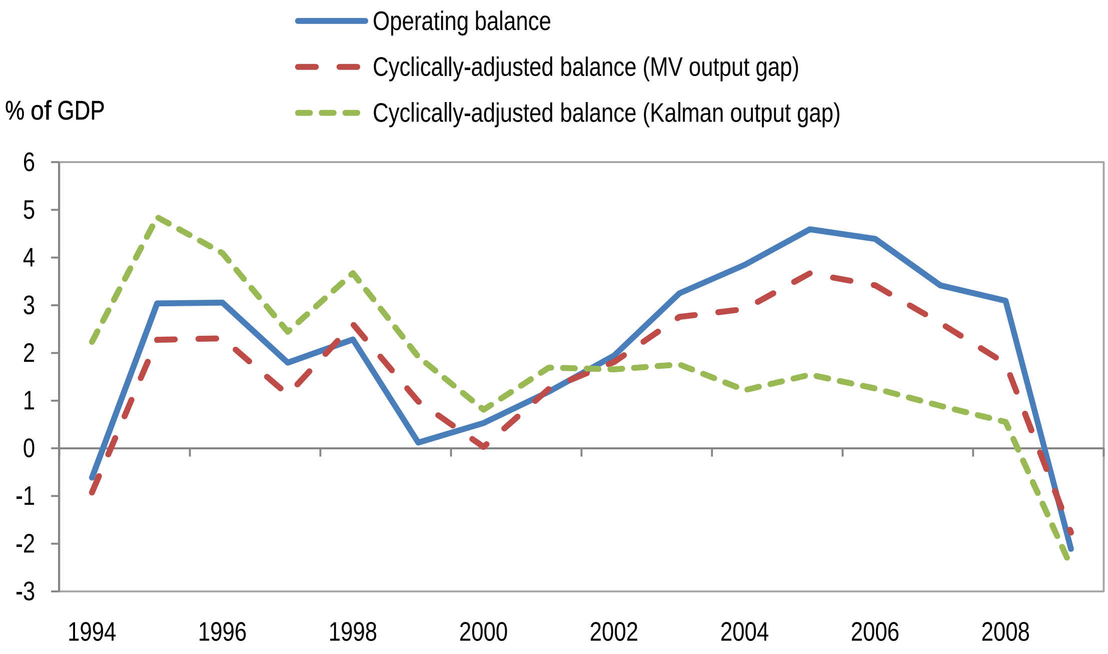
In Figure 4, cyclically-adjusted nominal revenue and expenses are shown. Consistent with the operating balance path, it shows that the margin between cyclically-adjusted revenue and expenses is much smaller when using the Kalman output gap. The cyclical adjustment indicates that over 2005 to 2008, the non-structural, or temporary, component of tax revenues was about $1 billion per annum using the MV gap and $3 billion per annum using the Kalman gap.

Figure 2 – Real GDP, actual and potential estimates



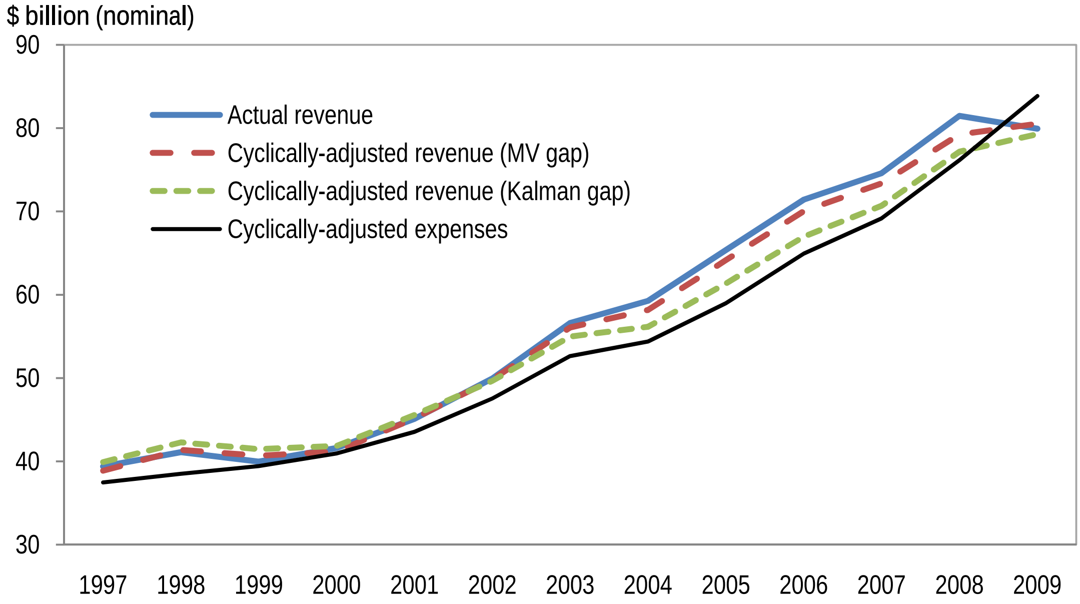
Sources: Statistics NZ, The Treasury

Figure 3 – Cyclically-adjusted balance with MV and Kalman output gaps



Sources: The Treasury, author's calculations

Figure 4 – Total revenue and expenses, actual and cyclically adjusted



Sources: The Treasury, author's calculations.

2.4 Sensitivity of revenues to the cycle

The values used for the revenue elasticity parameters in Treasury's existing indicator are reported in Table 1. These are the same values used by the OECD, originally estimated in Girouard and André (2005). These estimates are the most recently made for New Zealand and, since they are used by the OECD, have the advantage of being validated by an independent, international body.

Table 1 – Revenue elasticities used for New Zealand in Budget 2010

Revenue category (i)	Revenue-to-output gap elasticity ($\varepsilon_{R,YGAP}$)	Revenue-to-base elasticity ($\varepsilon_{R,B}$)	Base-to-output gap elasticity ($\varepsilon_{B,YGAP}$)	Lag weight (θ_i)	Revenue share (%), 2009
Personal income tax	0.9	1.3	0.7	1.0	32
Corporate income tax	1.4	1.0	1.4	1.0	12
Other income tax	1.0	1.0	1.0	1.0	3
Goods and Services Tax (GST)	1.0	1.0	1.0	1.0	14
Other indirect tax	1.0	1.0	1.0	1.0	6
Investment income	0.0	-	0.0	-	4
Sales of goods and services, other	1.0	1.0	1.0	1.0	28
Tax revenues (weighted average)	1.0	1.1	0.9	1.0	68
Total revenues (weighted average)	1.0	1.1	0.9	1.0	100

Source: The Treasury

The elasticity of each revenue type with respect to the output gap can be decomposed into the product of an elasticity of revenue with respect to the relevant revenue base (eg, wages or profits) and an elasticity of the revenue base with respect to the output gap:

$$\varepsilon_{R_i,YGAP} = \varepsilon_{R_i,B_i} \times \varepsilon_{B_i,YGAP} \tag{11}$$

where B_i denotes the associated macroeconomic base for revenue type i.

The remainder of this section assesses each of these revenue elasticity estimates.

2.4.1 Sensitivity of tax revenues to changes in the base (ε_{R_i,B_i})

For personal income tax, the relevant base is the total wage bill. In Girouard and André (2005), the elasticity of personal income tax revenue with respect to the wage bill is found by computing the marginal and average tax rates of a representative household for several points in the earnings distribution. Per capita elasticity of income tax with respect to earnings can be evaluated as follows:

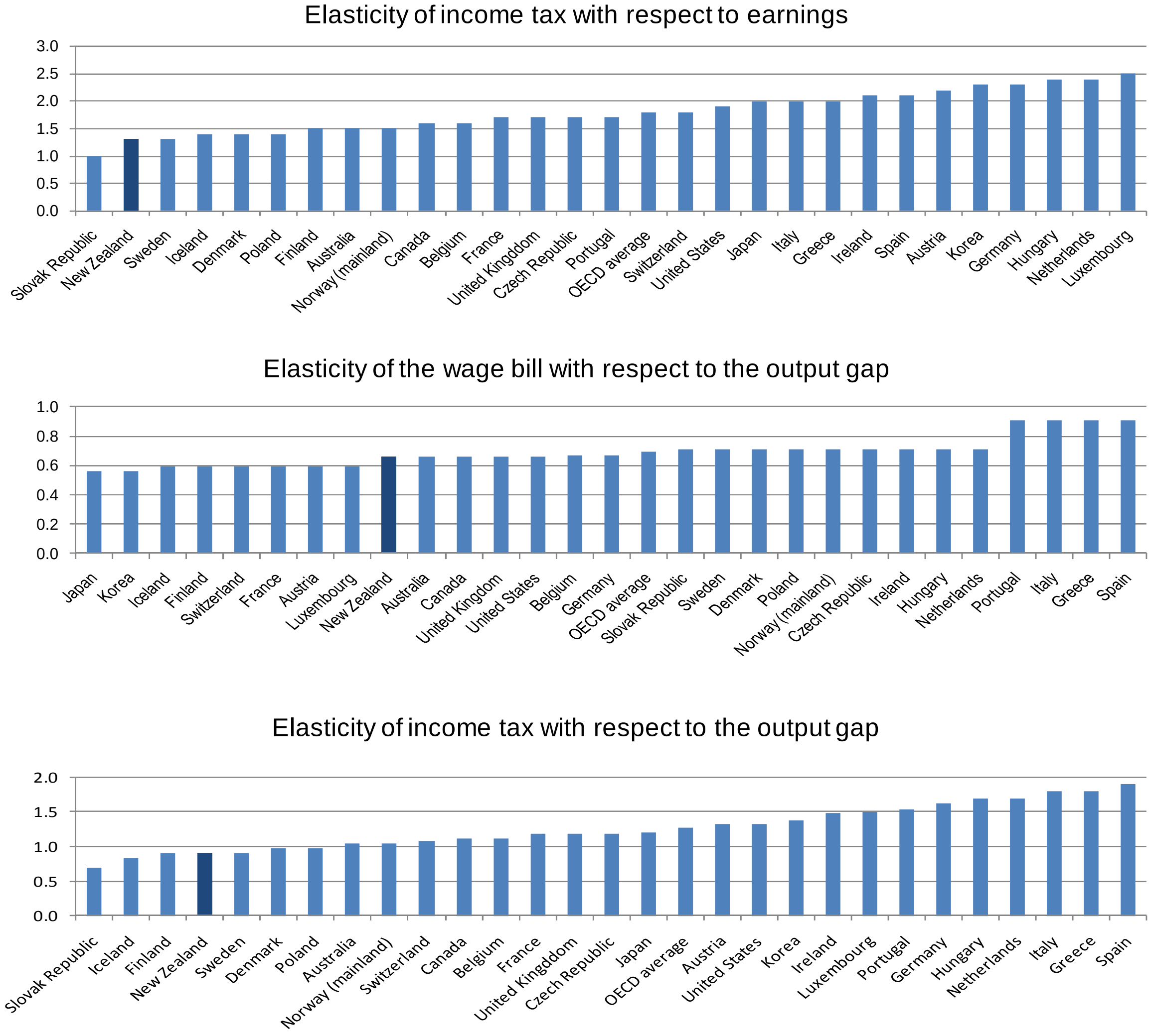
$$\varepsilon_{tax\ per\ worker,w} = \left(\sum_{i=1}^{n} \gamma_i MA_i\right) / \left(\sum_{i=1}^{n} \gamma_i AV_i\right) \tag{12}$$

With $\boldsymbol{\gamma_i}$ = weight of earnings-level $\boldsymbol{i}$ in total earnings, $\boldsymbol{MA_i}$ = marginal income tax rate at point $\boldsymbol{i}$ on the earnings distribution and $\boldsymbol{AV_i}$ = average income tax rate at point $\boldsymbol{i}$ on the earnings distribution.

The existing elasticity estimate is 1.3, which is estimated on the basis of the 2003 tax code and earnings distribution data from 1999 to 2001. This is at the bottom end of the range of estimates for OECD economies (see Figure 5). New Zealand's tax settings have changed since this time, including significant changes entering into effect from 1 October 2010. The range of estimates for the tax-to-base elasticity, based on this new tax code, is 1.33 to 1.40 (see Table 2). This is based on both the method of equation 12 and other microsimulation and econometric procedures.

The relevant bases for corporate income tax and indirect tax are corporate profits and taxable consumption respectively. The OECD assumes a tax-to-base elasticity of unity due to measurement difficulties and uncertainties, and there remains no obvious way of overcoming these issues.

Figure 5 – OECD estimates of income tax elasticities



Source: Girouard and André (2005)

Table 2 – Estimates of income tax-wage bill elasticity with 2010/11 tax code

Method	Data source	Estimate
Microsimulation model	Wage earning individuals, in 2010/11 tax year, with homogenous growth of 3.5% p.a. applied to incomes.	1.40
Time series model	IRD data for 2008/09 earnings, with growth to 2010/11 for each $5,000 income band based on average growth over previous 5 years for that band.	1.33 to 1.35
Individual income MTR ÷ ATR	IRD data on earnings distribution for 2008/09.	1.39

Source: Bell (2010)

2.4.2 Sensitivity of tax bases to the output gap ($\varepsilon_{B_i,YGAP}$)

For the personal income tax elasticity, Girouard and André (2005) econometrically estimate the elasticity of the wage bill with respect to the output gap. A pooled panel regression approach is used in which New Zealand is calibrated to a pool consisting of similar Anglo economies (United Kingdom, United States, Australia and Canada). The New Zealand time series is too short to give robust results. The estimated coefficient used is 0.66. This is near the median of OECD economies and there is minimal dispersion amongst countries, suggesting further attempts at refining this estimate would probably not have a high payoff.

For corporate income tax, the elasticity is derived from equation 13 by recognising that the corporate tax base (profits) is the reciprocal of the wage bill. The relationship is defined by:

$$\varepsilon_{B_c,YGAP} = \frac{1-(1-P)\varepsilon_{B_w,YGAP}}{P} \tag{13}$$

where $\varepsilon_{B_c,YGAP}$ is the elasticity of the corporate income tax base (ie, profits) with respect to the output gap, P is the profit share in GDP, and $\varepsilon_{B_w,ygap}$ is the elasticity of the wage bill with respect to the output gap. Because of the assumption that corporate income tax revenues change proportionally to the tax base, equation 13 also equals the overall elasticity of corporate tax with respect to the output gap. Girouard and André's data has a profit share of 44.8% for New Zealand, which combined with the wage bill-output gap elasticity of 0.66, means an estimated elasticity of 1.4 for corporate tax revenue with respect to the output gap. Profits, proxied by the gross operating surplus in the national accounts, have remained a relatively stable share of GDP since the early 1990s at around 45%. Thus this continues to be a robust estimate.

Indirect taxes, including GST, are assumed to have unit elasticity with respect to their bases for all countries due to measurement difficulties.

2.4.3 Summary of evidence for tax revenue elasticities

The available evidence suggests that the OECD estimates remain reasonable values for the revenue elasticities. They are also widely accepted, used by the IMF and European Commission. Therefore there is sense in retaining the practice of using the OECD elasticity estimates.

It was noted that the estimate of the elasticity of personal income tax to the wage bill had increased slightly with the recent change in tax settings (increasing from about 1.3 to about 1.4). This is not large enough in magnitude to change the revenue-to-output gap elasticity value without introducing spurious precision (since $1.3 \times 0.66 \cong 0.9$ and $1.4 \times 0.66 \cong 0.9$).

2.4.4 Sensitivity of non-tax revenues to the cycle

Non-tax revenues make up a significant share of total Crown revenue (32% in 2009).

Investment income is not cyclically adjusted. Although financial returns will have some relationship with the cycle, the covariance will be specific to the nature of the financial instrument and the growth shock. Given the difficulties inherent in estimating these reliably, no cyclical adjustment is made to either investment income or financing costs. In any case, examining the primary balance (which is the fiscal balance excluding net finance costs) enables analysis which is not sensitive to this assumption.

Table 3 – Non-tax revenues, 2009

	Elasticity ($\varepsilon_{R,YGAP}$)	$ billion, 2009	% of total revenue
Sales of goods and services	1.0	15	19
Levies and fines	1.0	4	5
Other non-tax revenues	1.0	3	4
Investment income	0.0	3	4
Total		26	32

Source: The Treasury

The existing Treasury indicator treats the sales of goods and services and other revenue (including levies and fines) as sensitive to the cycle (with an assumed elasticity of unity). There is not sufficient data to estimate the elasticity. The Crown derives much of its sales revenue from low-volatility industries (predominantly in the energy sector), where it seems likely that both revenue and expenses would tend to co-vary over the business cycle. Therefore net profit, which impacts the operating balance, would have a relatively small cyclical component. This would also hold for levies and fines, which typically reflect expenses. Thus, it appears advisable to remove the cyclical adjustment for all non-tax revenue. This is consistent with the OECD's approach, which does not cyclically-adjust the profits of state-owned enterprises. The quantitative difference arising from this methodological change would be material but not large: in the existing approach, an output gap of one percentage point is associated with a cyclical adjustment of 0.2% of GDP.

2.4.5 Unemployment-related expenditures

The existing Treasury indicator uses an Okun's law relationship to derive a structural rate of unemployment. The Okun coefficient is assumed to be 0.5, meaning that an output gap of 1% of GDP is associated with the actual unemployment rate differing from its structural rate by 0.5 percentage points.

As a rule of thumb, 0.5 is broadly consistent with the established literature looking at major economies such as the United States. Harris and Silverstone (2000) investigate the Okun coefficient using New Zealand data from 1979 to 1999. Using an OLS regression, they found an estimate of 0.4. Using the same methodology on data over the period 1988 to 2009 also produces an estimate of 0.4. Harris and Silverstone also found that a standard estimate of the Okun's coefficient is likely to be understated due to misspecification of the adjustment process. Specifically, they found that expansions and contractions in output have an asymmetric relationship with unemployment.

The key advantage of using an Okun's law relationship is that it ensures consistency between the output gap and structural unemployment assumptions. However, while the empirical relationship holds on average over time, there may well be significant divergences at any particular point in time. An alternate approach to the Okun's law relationship would be use a direct estimate of the NAIRU. The Treasury's preferred method is a time-varying estimate using a Kalman filter (Szeto and Guy, 2004). This estimate of the NAIRU has a much less cyclical pattern than the rate implied by Okun's law.

The use of Kalman filter estimate of the NAIRU is more consistent with a medium-term perspective and is consistent with the Treasury's general equilibrium forecasting model. However, in scenarios which use a different output gap from the official forecast, it would be necessary to decide whether to use an alternative NAIRU estimate (in which case, the Okun's law relationship could be employed as a rule of thumb).

The actual difference in structural unemployment rates is bounded by 2 percentage points using data from 1994 until 2014 (the end of the Budget 2010 forecast horizon). Unemployment expenses currently make up only about 1% of total Crown expenses. Thus, even with a divergence in the estimated structural rate of unemployment of 2 percentage points, the total difference to the CAB would only be 0.1% of GDP.

3 Other structural factors

3.1 Candidate factors

The term CAB is sometimes used synonymously with the structural budget balance (SBB). However, a number of studies have pointed to factors which may be considered to have a transitory, or windfall, impact on the fiscal balance in addition to the fluctuations caused by the business cycle.

The following key areas merit investigation because they have been identified as issues by others:

- the terms of trade;
- asset prices; and
- output composition.

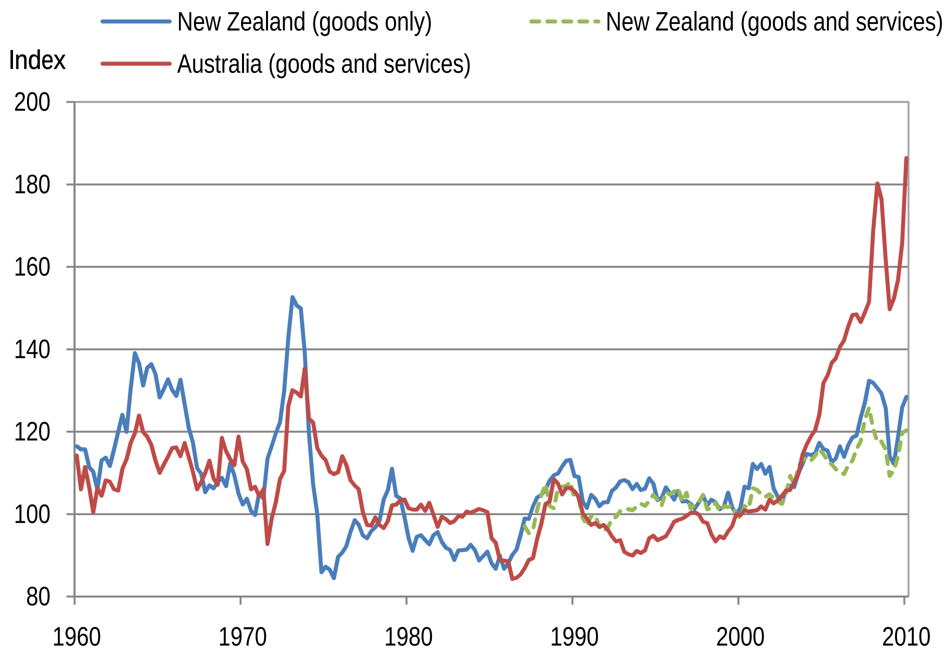
Each is considered in turn, looking at the implications for New Zealand.

3.2 Terms of trade effects

The terms of trade could be expected to have a material influence on fiscal revenues, particularly for economies with a significant commodity-exporting sector. Some revenues may not be permanent if, for example, commodity prices reach levels which are above some notion of long-run equilibrium. In some countries, this link is direct. Chile, for example, has an independent fiscal authority which makes a judgement about how much of the revenues from the state-owned copper mines should be considered as structural. Norway has a formula which guides decisions about how much of the state's oil revenues should be used for current expenditure. These examples are less relevant for New Zealand as resource rents are not a material part of the government's revenues. However, windfall taxes will flow to the government during a terms-of-trade boom since it will lift nominal incomes (Rozhkov, 2006; Turner, 2006). This is a relevant consideration since New Zealand's terms of trade, driven by strong commodity price growth, is elevated relative to historical levels, albeit not to the extent observed in Australia (see Figure 6).

Several studies have developed practical methods for adjusting the fiscal balance for the terms of trade, each applied to Australia. The OECD uses the method developed in Turner (2006) based on a real income gap concept, discussed and applied to New Zealand below. The Australian Treasury uses the method outlined in McDonald *et al* (2010), which requires the construction of a measure of potential nominal GDP. It is substantively similar to the Turner (2006) method. A substantively different approach is discussed in Rozhkov (2006), which uses econometric estimates of the relationship between commodity prices and tax revenues.

Figure 6 – Terms of trade (index, 2000Q1=100)



Sources: Statistics New Zealand, Reserve Bank of Australia

The Turner (2006) methodology is conceptually similar to the conventional CAB indicator, but instead of using the output gap, it uses a measure of the divergence in real incomes from equilibrium. The distinction arises because terms-of-trade movements are treated as a purely price phenomenon in the national accounts, which means that changes affect nominal GDP but not real GDP (except indirectly by inducing changes in the volume of production). Thus, in the national accounts, real GDP (RGDP) and real gross domestic income (RGDI) have the following relationship:

$$\begin{aligned} RGDI &= RGDP + x(TT - 1) \\ &= RGDP + \text{trading gain/loss} \end{aligned} \quad (14)$$

where x is the export share of GDP and TT is the terms of trade.

This terms-of-trade effect can lead to a material divergence between RGDP and RGDI. Indeed, this appears to be the case over the 2000s for New Zealand and other OECD economies such as Australia, Norway, Canada, South Korea and Ireland (see Figure 7). The methodology requires a real income gap, the RGDI analogue of the output gap. By making an assumption about the equilibrium level terms of trade, a potential RGDI measure is constructed as follows:

$$RGDI^* = RGDP^* + x(TT^* - 1) \quad (15)$$

where $RGDP^*$ is potential RGDP and TT^* is the equilibrium terms of trade.

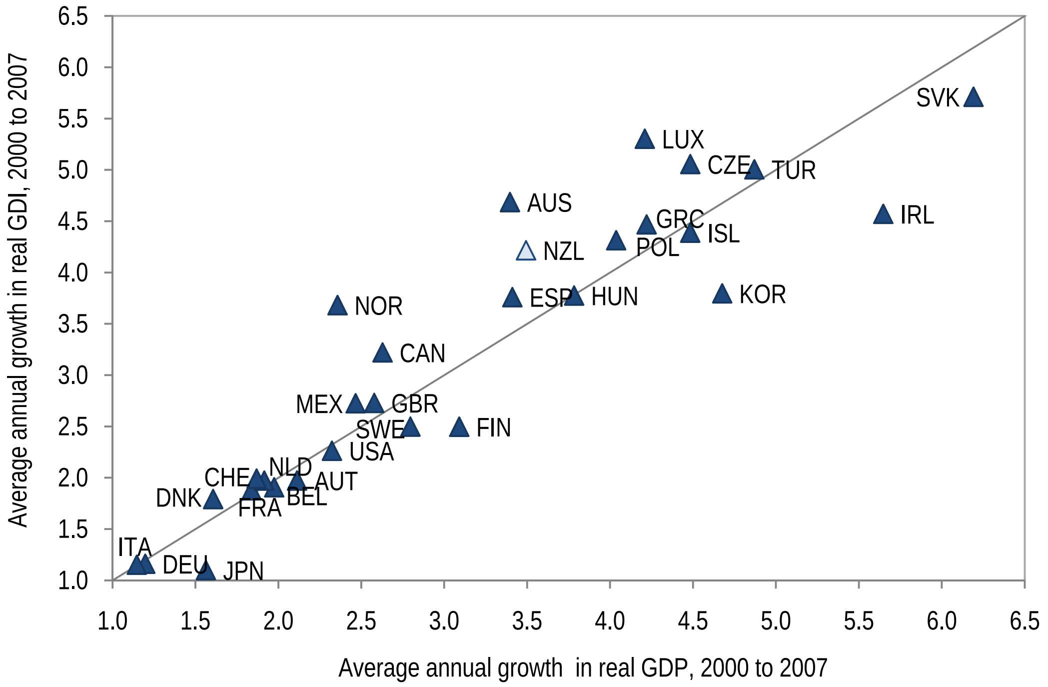
The real income gap is defined as:

$$\text{Real income gap} = \text{Output gap} + x(TT - TT^*) \quad (16)$$

The very existence of terms-of-trade cycles, and hence some notion of long-run equilibrium, is not clear cut. Borkin (2006) used standard statistical tests to find that there was no evidence of structural breaks in the terms-of-trade data over 1900 to 2005;

however a sub-sample of the last 30 years suggested an increasing trend. Looking ahead, it is arguable that New Zealand's terms of trade may have reached a sustainably higher level than that of the 1980s and 1990s due to global demand shifts (NZIER, 2009). An alternative view is that high commodity prices should eventually induce a supply response leading to windfall gains being competed away. A deeper understanding of the relevant structural economic forces would complement this analysis.

Figure 7 – Real GDI and real GDP growth in the OECD



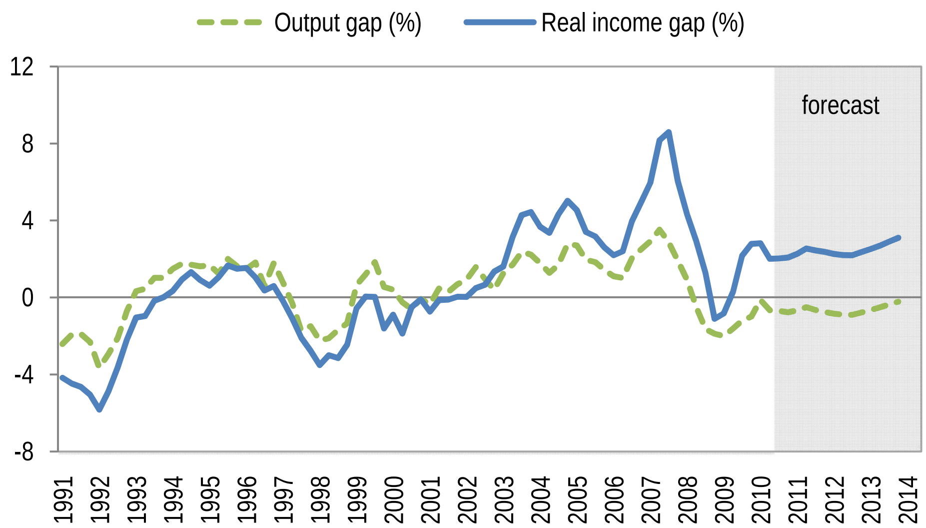
Source: OECD

To compute the real income gap, a value for the structural level of the terms of trade is required. An arbitrary choice is to use a historical average: the OECD uses the 40-year average. For New Zealand, the 20-, 30-, 40- and 50-year averages are within 5% of each other. The Australian Treasury has used a medium-term forecasting approach to estimate a structural terms-of-trade level which is 20% above its 30-year average (McDonald *et al*, 2010). An alternate specification for the trend, which would lead to smaller deviations, would be to use a moving average (or similar statistical filter).

It is worth noting that this estimate for the structural level of the terms of trade does not feature in the Treasury's central forecasts (unlike potential GDP). Therefore, a terms-of-trade adjustment to the fiscal balance should be seen as an exercise in seeing what the fiscal position would be under a different assumption (ie, a scenario), rather than necessarily being a central view. This decoupling of structural indicators from central forecasts should not be seen as an inconsistency. Rather, it is using a wider array of information to make judgements about the fiscal position from a medium-term perspective, without compromising the forecasts' role of estimating the most likely near-term outcome.

The real income gap is plotted in Figure 8. The real income and output gaps begin to diverge from about 2003, reflecting the rise in the terms of trade to levels above the historical average. The peak difference between the output gap and real income gap is around 6 percentage points in the first quarter of 2008. If the HP filter had been used to de-trend the terms of trade, the peak difference would still be material at around 2 percentage points.

Figure 8 – Output and real income gaps



Sources: The Treasury, Statistics New Zealand, author's calculations

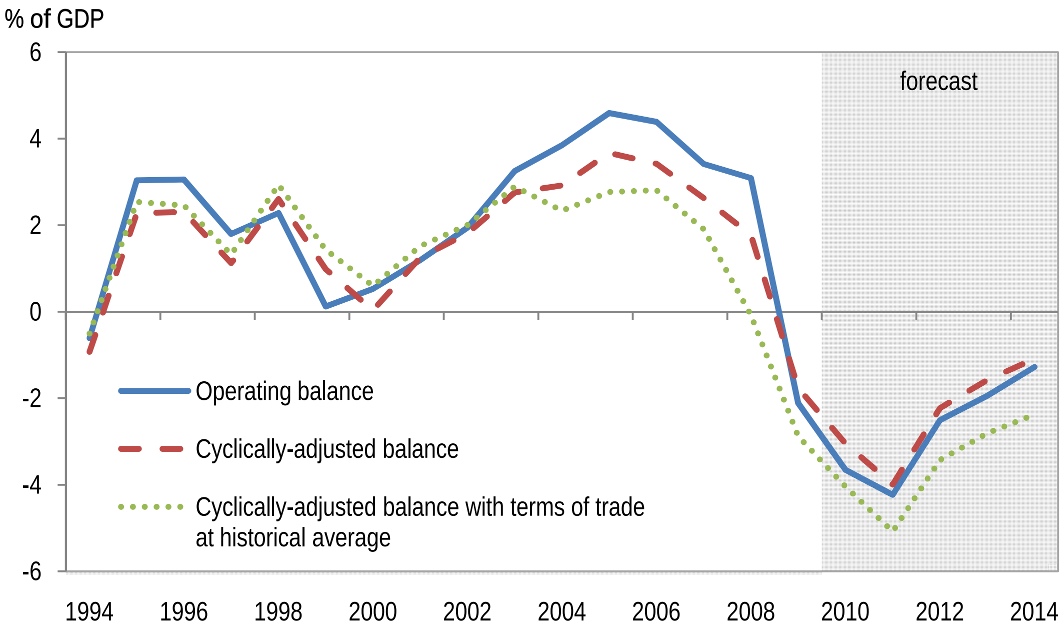
Note: The output gap series used is the official Treasury estimate at Budget 2010. The real income gap uses an assumption that the terms of trade equilibrium is the 50-year historical average.

To make an adjustment to the fiscal balance, an estimate or assumption is required for the sensitivity of revenue to the terms of trade. Structural breaks in the data have prevented robust econometric relationships for New Zealand (Kirker, 2007). A reasonable assumption, used by the OECD, is to apply the same elasticity values that are used for the regular cyclical adjustment (ie, with respect to the output gap). The reasonableness will depend on how differently the average terms-of-trade shock effects tax bases compared with the average output shock. Turner (2006) estimates the parameters for Australia, finding that corporate income tax is more sensitive to the terms of trade relative to personal income tax. This relationship perhaps may not hold in New Zealand because of differences in the ownership structure of the export sector. In any case, the results are not likely to be distorted much by using the same elasticity parameters as for the output gap. The total adjustment to tax revenues is in practice likely to be of a similar magnitude using either approach since the higher corporate tax elasticity offsets the lower personal tax elasticity. A ±50% change to personal and corporate tax elasticities, where the change is of opposite sign so that the average of the elasticities is preserved, is associated with a ±10% change in the terms of trade adjustment (ie, about 0.1% of GDP in the case of a 1% of GDP adjustment to the structural budget balance).

The resulting adjustment to New Zealand's cyclically-adjusted balance is shown in Figure 9. The results suggest the underlying fiscal position may have been overstated by an average of 1% of GDP over the period 2004 to 2009 because of the high terms of trade.

This measure is different from the conventionally estimated cyclically-adjusted balance and therefore should be seen as a complement rather than substitute to that indicator.

Figure 9 –Cyclically-adjusted balance with terms of trade adjustment



Sources: The Treasury, author's calculations

3.3 Asset prices

The role of asset prices in fiscal revenues is an issue that has gained increasing attention from institutions which conduct fiscal surveillance (such as the IMF, OECD and European Commission). The reason for looking at asset prices in the context of structural budget balances is that price movements may be treated as structural (reflecting shifts in profits, productivity or risk premia) when in fact they may have a transitory (bubble) component (Price and Dang, 2010). This is particularly so from the vantage point of 2010, following a period where equity and real estate bubbles have masked underlying fiscal performance in some economies (eg, see Kanda [2010] for the case of Ireland).

Asset price movements are transmitted to fiscal revenues through two main channels:

- indirectly, if there are wealth effects on economic behaviour which lead to changes in the size of tax bases; and
- directly, if asset prices are themselves a tax base, such as taxes on capital gains or transactions.

With respect to the first channel, the existence of wealth affects is well established in the literature although there is uncertainty about the consistency of effects across counties and asset types (Davis, 2010). In a New Zealand context, De Veirman and Dunstan (2008) study the relationship between wealth and consumption, and in particular find that housing wealth has a large impact on consumption spending relative to those found in studies of other economies (since housing assets are a larger share of household wealth in New Zealand).

A complication in the analysis of indirect transmission effects is that asset price boom and bust phases tend to be associated with persistent expansions and contractions in economic activity (Jaeger and Schuknecht, 2004). Therefore cyclical turning points are harder to forecast and the margins of error for output gap estimates can be large (because output may not return to trend as quickly as it might in 'normal' times). Consequently, estimates of structural fiscal balances are subject to greater margins of error during asset boom and bust phases.

A number of studies looking at OECD economies have attempted to test whether asset price movements are found empirically to explain hitherto unexplained changes in revenues which would otherwise be assumed to be structural (Eschenbach and Schuknecht, 2002; Girouard and Price, 2004; Morris and Schuknecht, 2007; Price and Dang, 2010; Kanda, 2010). These effects are found to be significant in countries with asset-based taxes. Morris and Schuknecht (2007) estimate that for the Euro area, a 10% asset price change is associated with a change of ½% of GDP in the fiscal position.

There is no widely accepted method for making adjustments to the structural fiscal balance for the asset price cycle. Some authors argue that, while *ex post* revisions to structural balance indicators would be possible, the difficulties inherent in distinguishing between temporary and permanent asset price movements *ex ante* make forward-looking adjustments fruitless. Others argue that the known limitations of existing structural balance indicators provide good reason to make adjustments for other factors so as to reduce the chances that indicators provide a misleading picture of movements in the underlying fiscal position.

New Zealand does not currently have specific asset-based taxes, such as capital gains or transaction taxes. However, asset prices may have some link to tax because trading gains form part of taxable income.

The empirical question is whether transitory asset price movements are causing movements in the structural budget balance. This question can be approached empirically by testing whether revenue surprises can be explained by deviations in asset prices from some benchmark. The general approach of Barrios and Rizza (2010) is followed so as to construct a measure of revenue surprises based on forecast errors, which are then regressed against deviations of asset prices from some trend level, controlling for an estimate of economic growth surprises.

The measurement of tax revenue surprises and GDP growth surprises are estimated using one-year-ahead Budget forecasts made by the Treasury over 1991 to 2009. The asset prices used are domestic real estate prices and New Zealand and US equity prices. Theory offers little practical guidance about the structural component of asset prices. A Hodrick-Prescott (HP) statistical filter or a linear growth rate is used to find a trend which fits the data. Further detail about the data, methodology and results are in Annex 1.

The bivariate sample correlation coefficients are shown in Table 4. As would be expected, GDP growth surprises have a strong correlation with revenue surprises. The correlation coefficient is 0.83 which is statistically significant at the 1% level. Of the other asset prices, only New Zealand equity prices have a significant correlation with revenue surprises, which is to be expected since economic growth surprises are positively correlated with New Zealand equity valuations.

The regression analysis shows that asset price deviations do not provide explanatory power additional to what can be explained by economic growth surprises (reported in Annex 2). The tests were robust to different specifications of the lag structure, forecast horizon and tax type.

Table 4 – Sample correlation coefficients

	Revenue surprises	Growth surprises	Real estate price gap	NZ equity price gap
Growth surprises	0.83***			
Real estate price gap	0.20	0.31		
NZ equity price gap	0.50**	0.48**	0.47**	
US equity price gap	-0.06	0.17	0.19	0.39*

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

The results are unsurprising. Since New Zealand does not have asset price-related taxes, the transmission between asset prices and revenue surprises is likely to be intermediated by wealth effects on economic activity. Thus, in contrast to economies with reliance on asset-based taxes, there is no reason to make adjustments to New Zealand's structural budget balance to account for asset price movements. This is not an argument to ignore asset prices in the context of structural revenues. Rather the focus of analysis needs to be on the output gap, and potential output, and the role that asset prices could play in their evolution.

3.4 Output composition

Composition effects can arise because different macroeconomic bases attract different tax treatment. For example, growth oriented toward domestic consumption rather than exports would likely attract higher levels of tax revenue, holding all else constant. For New Zealand, wages and salaries are the most tax-rich base, followed by profits and consumption expenditure.

As discussed in section 2.1, an alternative approach to using the output gap for cyclical adjustment is to de-trend individual tax bases (advocated in Bouthevillain *et al*). As noted, this alternative method has less theoretical foundation (because there is no equivalent to an output gap for individual tax bases in economic theory), but it is nevertheless worth investigating in parallel to other methods because it may enrich analysis by providing complementary information. This will be particularly so if policymakers have supplementary judgements about what constitutes balanced growth. This is a policy relevant consideration given recent concerns about imbalances in the New Zealand economy (New Zealand Treasury, 2009; Schule, 2010).

To implement the approach, each revenue type is adjusted with respect to the deviation from some reference macroeconomic base:

$$R_{it}^{S} = R_{it}\left(\frac{V_{it}^{S}}{V_{it}}\right)^{\varepsilon_{Ri,Vj}} \tag{17}$$

where R_{it} denotes revenue of type i in year t, V_{it} is the relevant macroeconomic base, superscript s denotes the structural level and $\varepsilon_{Ri,Vj}$ is the elasticity of revenue with respect to the relevant base.

The tax bases and elasticity values used in this analysis are shown in Table 5. The tax-to-base elasticity parameters reflect the discussion in section 2.4.1. These are only proxies for the true revenue base which is taxable income or taxable expenditure. A Hodrick-Prescott filter is used to estimate the trend level of each base (where each base is converted into real terms).

Table 5 – Tax bases

Tax type	Macroeconomic base	Tax-to-base elasticity	Tax-to-base ratio (%)
Personal income tax	Compensation of employees plus entrepreneurial income	1.35	27
Corporate income tax	Gross operating surplus	1.0	18
GST and other indirect tax	Private consumption plus residential investment	1.0	14
Other revenue	N/A	N/A	N/A

In Figure 10, the gap between each macroeconomic base and its trend level are shown (bars). Also plotted is the output gap and the equivalent output gap implied by using this disaggregated method (essentially a weighted average of the component base gaps).[2]

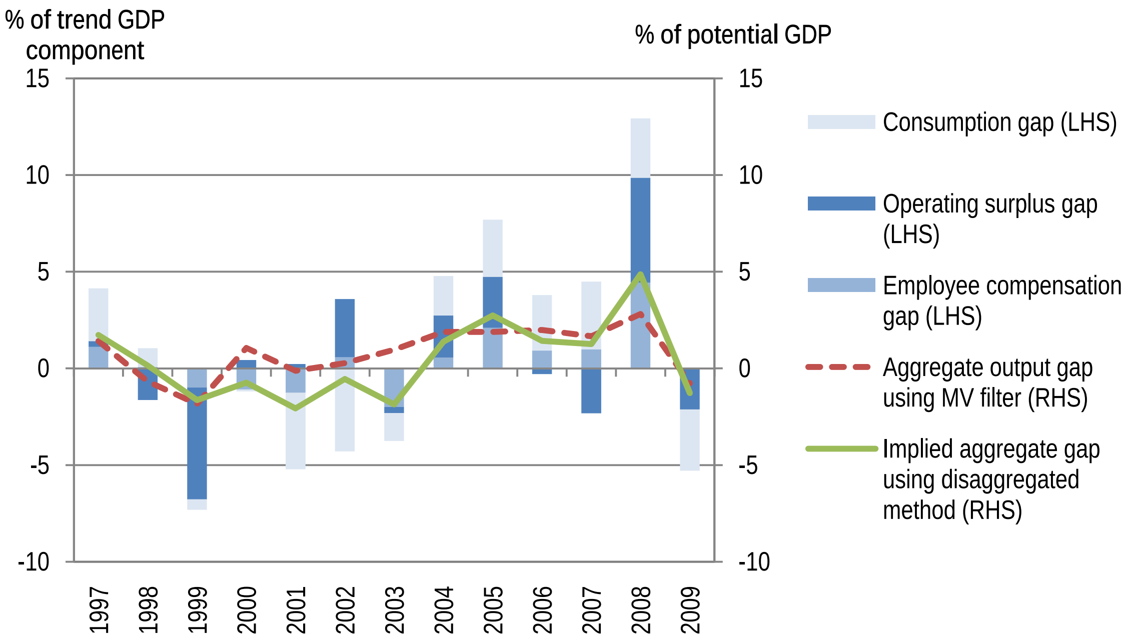
The disaggregated method provides a plausible estimate for the cyclical adjustment in the sense that the implied output gap displays a similar sign and slope as the conventionally estimated output gap. The difference between the output gap and the gap implied by the disaggregated method can be thought of as owing to composition effects. By these estimates, in the early 2000s, the composition effect was about -1.5% of GDP, reflecting a period of below-trend consumption, despite the near zero output gap. Then from 2005 to 2008 this reversed with the composition effect averaging +2.5% of GDP due to strong employee compensation and consumption levels.

In Figure 11, the structural budget balance using this alternative method is shown, which is strongly correlated with the estimate using the conventional method.

Theoretical concerns and measurement uncertainty mean this method is unsuitable as the primary tool for cyclical adjustment. Nonetheless, this method provides complementary information and could be used as a means of further sensitivity analysis.

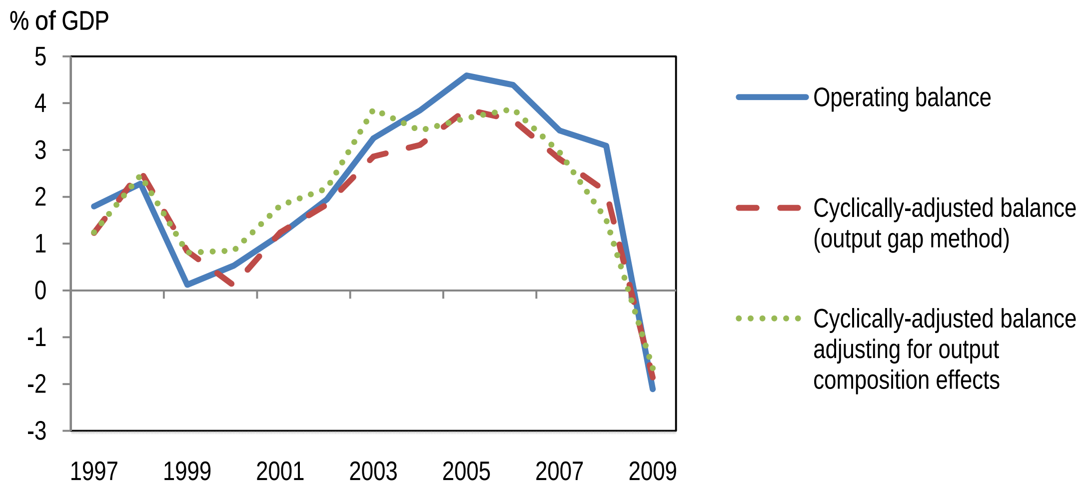
2 Strictly, the implied output gap is found by solving for the output gap in the aggregate CAB indicator which would yield the same cyclical adjustment as found in the disaggregated case. It thus captures both the compositional effect as well as error in the base-to-output gap elasticity estimate used in the aggregate CAB indicator.

Figure 10 – Gap between actual and trend for output components and implied aggregate gap using disaggregated method



Sources: Statistics NZ, The Treasury, author's calculations

Figure 11 – Cyclically-adjusted balance adjusting for output composition effects



Sources: The Treasury, author's calculations

4 Uncertainty

4.1 The need to address uncertainty

Cyclically-adjusted balance estimates have been found to be unreliable in real time, primarily due to the uncertainty surrounding real-time output gap estimates (Hallet *et al*, 2009). This suggests that the indicator should be used with caution, as one amongst many different indicators of the fiscal position. It also suggests real-time use of a cyclically-adjusted balance indicator demands an analysis of uncertainty.

There are two principal means of addressing uncertainty. One important way is to test sensitivity of results to the key input variables and parameters. Sensitivity analysis is limited in that it cannot attribute probabilities to various outcomes. One way to address this is through the construction of confidence intervals, which are developed next and presented using fan charts.

4.2 Confidence intervals

Confidence intervals for key fiscal variables can be estimated using historical data of forecast errors and revisions (eg, see Congressional Budget Office [2003] and Office for Budget Responsibility [2010]).

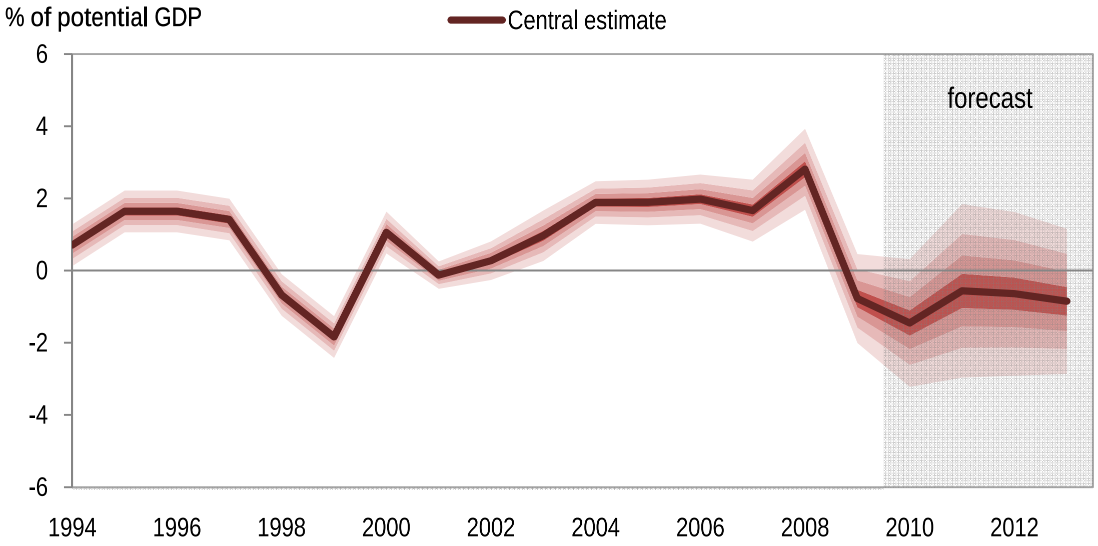
Confidence intervals for New Zealand's cyclically-adjusted balance can be constructed using Treasury's historical errors and revisions to real-time estimates and forecasts for government revenues, expenses, nominal GDP growth, output gap, unemployment rate as well as estimates of the uncertainty around the elasticity parameter values. Other assumptions are required: in particular it is assumed that errors are normally distributed with constant cross-sectional correlation and no serial correlation. Errors are adjusted for policy changes which occurred after the forecasts were finalised so that the results attempt to capture the likely range of outcomes conditional on constant policy settings. Annex 2 provides further detail on the data and methodology employed. Given the need to make assumptions about the distributions of future errors and that the limited data available, the numerical results should be seen as indicative rather than robust estimates of uncertainty.

Figure 12 shows the output gap with an 80% confidence interval. This is based on the variance of the official Treasury estimate with respect to the latest estimate. It is therefore limited because (i) there exists no "true" output gap from which to measure error and (ii) the Treasury has changed its estimation method over time, which will be the cause of some portion of the error. The confidence bands should also be viewed as being conditional on the output gap estimation technique used, rather than capturing the uncertainty introduced by the wide range of estimation techniques available (in this case, an MV filter over history and production function for the forecast horizon).

The fan chart for the cyclically-adjusted balance is shown in Figure 13, which is again conditional on using the official Treasury output gap estimation technique. The 80% confidence interval for the one-year-ahead estimate is ±2% of GDP, thus the 2011 deficit (forecast, at Budget 2010, to be 4.0% of GDP) appears to be structural with a high degree of confidence.

As noted, alternative output gap estimation techniques have not been incorporated into this analysis, nor the terms of trade. One approach for further investigation may be to assign subjective probabilities to different possibilities for the key structural parameters (eg, potential output model specification, structural terms of trade) which could assist with making finely balanced policy judgements in real time (ie, a decision-making under uncertainty framework). Another avenue would be to conduct simulations on real-time data using different indicator specifications or drawing on a wider literature, such as on output gap uncertainty (eg, Orphanides and van Norden, 2002).

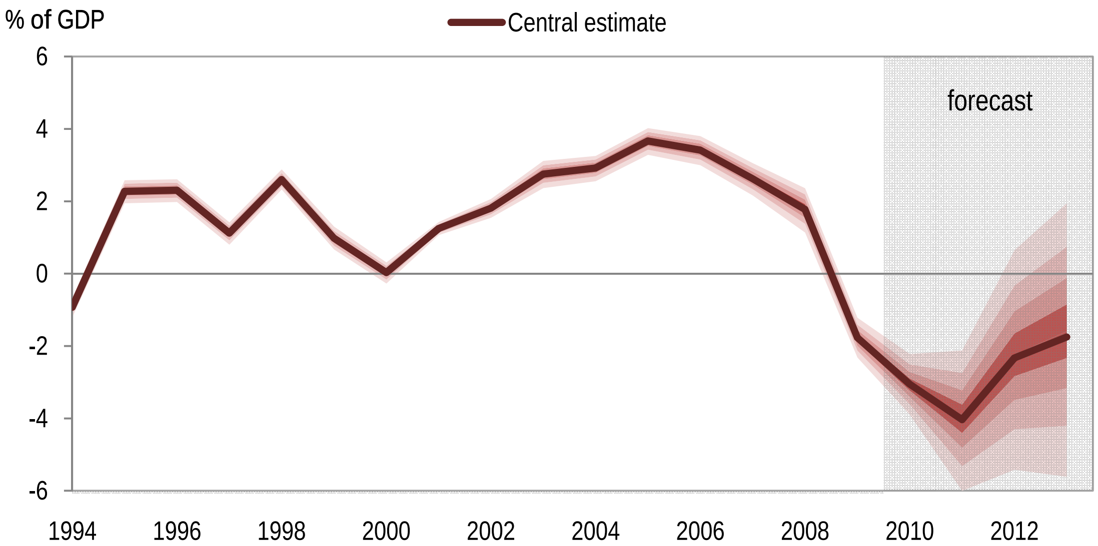
Figure 12 – Output gap fan chart (using official Treasury output gap measure)



Sources: The Treasury, author's calculations

Note: There are four bands on each side of the mean each representing sequential deciles such that the range of the fan represents the boundary of the 80% confidence interval around the central projection.

Figure 13 – Cyclically-adjusted balance fan chart (using official Treasury output gap measure)



Sources: The Treasury, author's calculations

Note: There are four bands on each side of the mean each representing sequential deciles such that the range of the fan represents the boundary of the 80% confidence interval around the central projection.

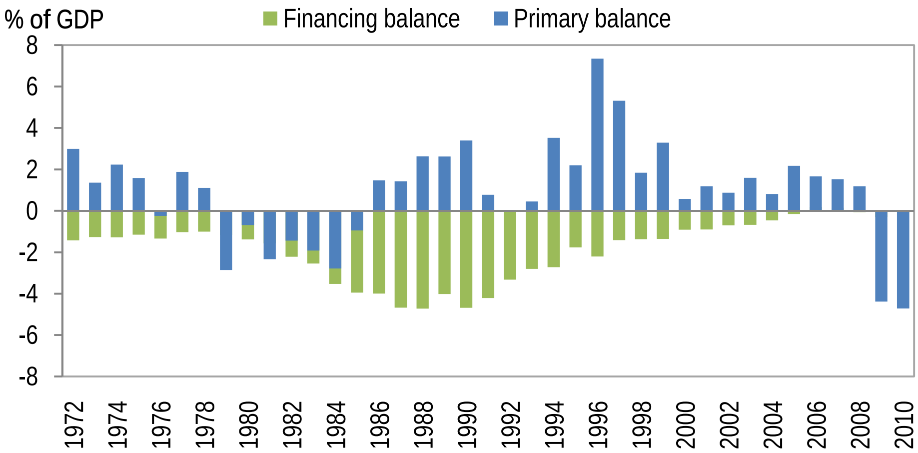
5 New Zealand's fiscal policy over history

5.1 A consistent data series

As well as informing policy judgements in real time, the techniques discussed in this paper can shed light on the evolution of fiscal policy in the past and put the more recent fiscal developments in historical context. Results in this paper have been presented using data only dating back to 1994 since this was when the New Zealand government moved from cash to accrual accounting. To gain a comparable picture of the fiscal balance from the 1970s to the present, a measure of the cash balance can be used.

The pre-1994 adjusted financial balance is spliced with the post-1994 core Crown residual cash balance.[3] Both are cash balances with a broadly similar reporting entity. This new series is plotted in Figure 14, decomposed into its primary and financing components. Of note is the sustained period of primary surpluses from 1986 to 2008. These primary surpluses eventually led to the elimination of net financing costs. Secondly, the magnitude of the 2009 and 2010 deficits stand out, particularly so given that net financing costs are almost nil.

Figure 14 – Primary and financing cash balance



Source: The Treasury

5.2 Cyclical adjustment

A very simple cyclical adjustment can be applied to the primary cash balance – by adjusting tax receipts in proportion to the output gap. This method is only very approximate because it does not take into account changing tax regimes, nor the cyclicality of expenses. Nevertheless, it should produce results which have the right order of magnitude given the relative insensitivity of results to the elasticity parameters. Results are plotted in Figure 15.

It is interesting to note that fiscal policy in the mid 1980s achieved a very significant consolidation with a structural improvement in the budget balance of around 7% of GDP, slightly larger than the consolidation following the 1991 Budget. A second interesting part of the story is that the weak cyclical state of the economy in the early 1990s meant that

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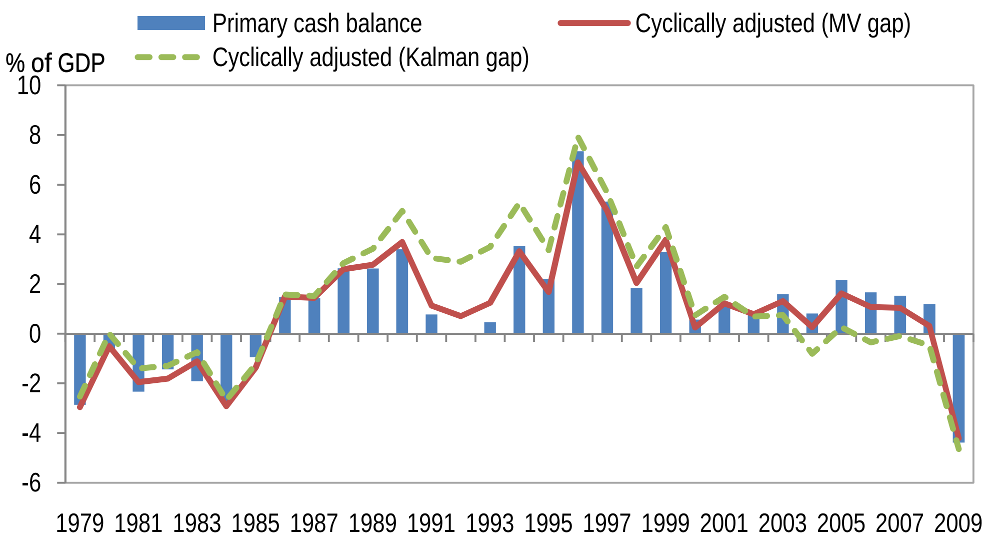
3 Both series can be found on the Treasury website at http://www.treasury.govt.nz/government/data.

the underlying budget position was probably much stronger than the headline deficits indicated. However, there is an endogeneity issue lurking in the background: the fiscal consolidation was part of a set of policy reforms which likely contributed to stronger potential growth in subsequent years.

Figure 15 – Cyclically-adjusted primary cash balance

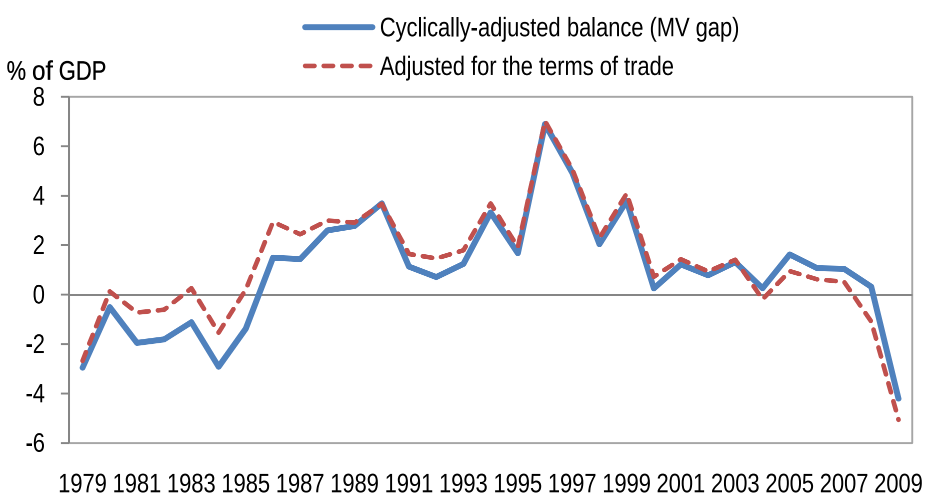


Source: The Treasury, author's estimates

The pattern of consolidation reversed in the late 1990s, mainly driven by significant tax cuts. The 2000s saw the structural primary balance initially stabilise at a modest or zero level (depending on the view taken about the cyclicality of growth over this period). Policy easing in the 2008 Budget led to a rapid and significant deterioration in the structural fiscal position, resulting in the largest structural deficit and largest deterioration in any one year over this time period.

A terms-of-trade perspective can also be applied. A terms-of-trade adjustment is made using the method discussed earlier in this paper, shown in Figure 16. It suggests that, relative to the unadjusted indicator, the underlying fiscal position was stronger in the 1980s, but weaker in the 2000s.

Figure 16 – Cyclical and terms-of-trade adjusted primary cash balance



Source: The Treasury, author's estimates

6 Conclusion

This paper has looked at a range of methodological issues relating to the cyclically-adjusted balance. Suggestions for the future use of CAB and SBB indicators are briefly summarised here.

The broad indicator structure used by the New Zealand Treasury is sound and internationally accepted. The OECD's revenue elasticity estimates should continue to be used. It is suggested that a cyclical adjustment is no longer made to revenue from sales, levies and fines.

A very important choice is the output gap estimate. For the purposes of medium-term fiscal analysis, there is a case for using a much stiffer filter than might be used with a shorter-term macroeconomic stabilisation objective in mind. In general, sensitivity to different estimation techniques should be analysed.

There is an emerging literature looking at non-structural factors, besides the business cycle. The terms of trade is highly relevant for New Zealand. An adjustment can be calculated which provides complementary information to the regular cyclical adjustment.

Asset prices have important linkages to structural economic phenomena, but do not explain revenue surprises in a New Zealand context. This would need to be re-visited if a significant asset-based tax (eg, capital gains tax) is introduced in the future.

While lacking some robustness, a method which adjusts for output composition effects could play a useful role as a means of sensitivity analysis.

Uncertainty is an important consideration. Sensitivity analysis for the key parameters is one way to address this in this framework. Different output gap estimation techniques, in particular, provide a range of estimates with varying economic interpretations requiring judgement and tradeoffs about which type of error to minimise. Furthermore, analysis should be complemented by the computation of confidence intervals, which have the benefit of indicating the likelihood of different outcomes (albeit imperfectly).

These indicators should be seen as the starting pointing for analysis, not the end point. Policy makers, and their advisors, should not attempt to supplant judgement with a single model. Nevertheless, the indicators discussed in this paper should be a valuable part of any suite of information used for thinking about fiscal settings and whether revenues are structural or cyclical.

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Appendix 1: Econometric analysis of revenue windfalls and asset prices

Approach

The hypothesis that asset price deviations have explanatory power for revenue surprises, controlling for growth surprises, is tested using the following regression specification:

$$RS_t = \beta_0 + \beta_1 G_t + \beta_2 RE_t + \beta_3 DE_t + \beta_4 GE_t + \varepsilon_t$$

where:

RS_t = nominal revenue surprise

G_t = nominal GDP growth surprise

RE_t = real estate price “gap” (deviation from benchmark)

DE_t = domestic equity price “gap” (deviation from benchmark)

GE_t = global equity price “gap” (deviation from benchmark)

ε_t = residual error term

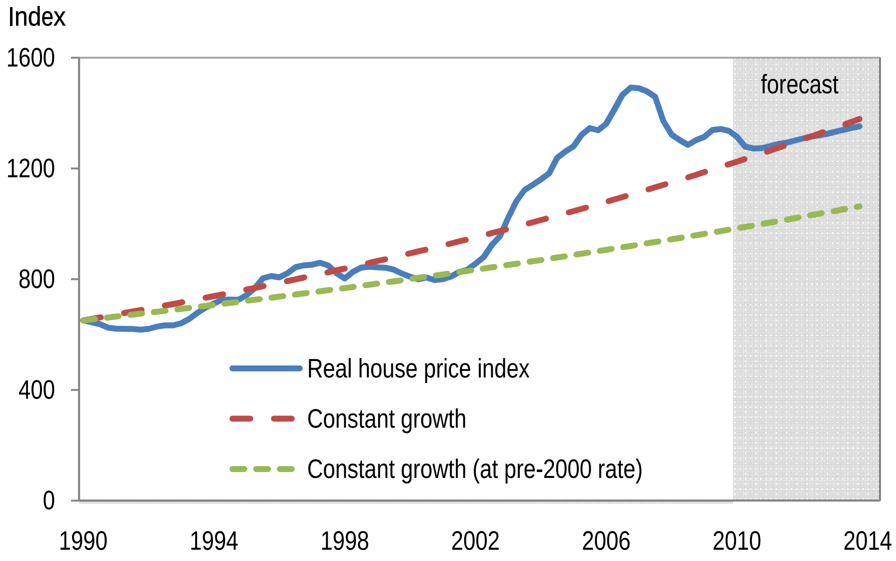
Data

For the revenue surprises, errors are the one-year-ahead Budget forecasts of tax receipts over 1991 to 2009.

Growth surprises are measured using errors in Treasury’s one-year-ahead forecasts of nominal GDP growth. The forecast value used is taken from the published Budget forecasts. For the actual value, the first vintage outturn is used as subsequent revisions incorporate information which was not available at the time of the forecast.

Domestic real estate prices are measured using an index of median dwelling prices deflated by consumer prices. The benchmark, or structural, level of house prices is estimated by applying a constant growth rate to the base (1990) value. Two benchmarks are tested: the first uses a constant growth factor using the average growth from 1990 to the end of the forecast horizon (2014). Using this assumption, prices have converged to their benchmark level by the end of the forecast by construction. The alternative assumption, which is used to test sensitivity, uses the average of the quarterly growth rates over 1990 to 2000. Under this assumption, the rise in house prices in the 2000s can be seen as a bubble, with house prices in 2010 still well above the benchmark level (by around 40%). This latter view is in common with some fundamental indicators such as price-to-income ratios.

Appendix Figure 1 – New Zealand house prices

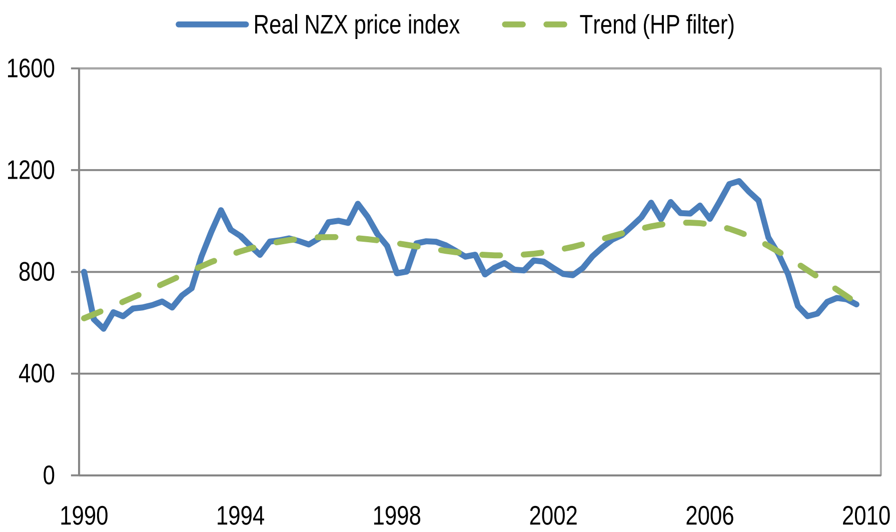


Sources: The Treasury, Quotable Value NZ, Statistics New Zealand, author's calculations

Note: Index is QV median dwelling price deflated by CPI.

Real domestic equity prices are measured using an index of the New Zealand stock market (NZX), deflated by consumer prices. For the trend component, an HP filter is used (with quarterly data and a smoothing parameter of 1600).

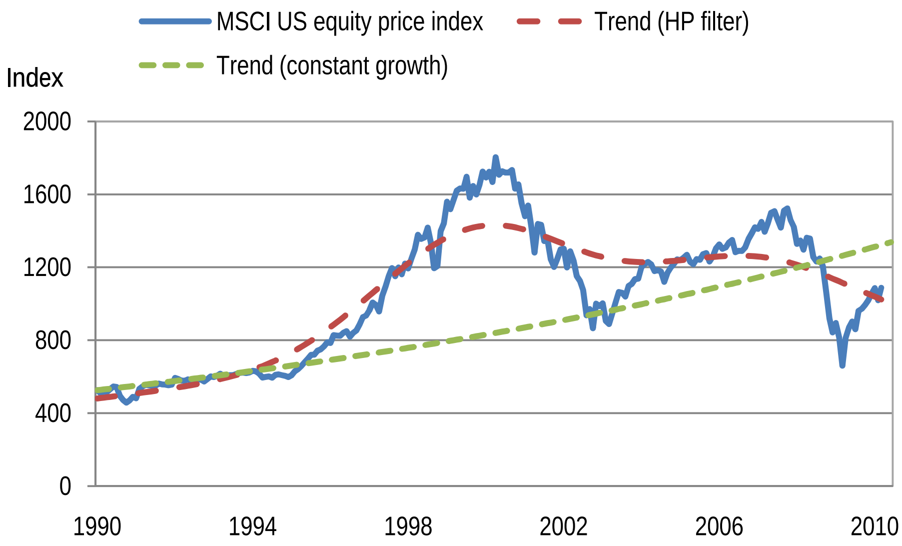
Appendix Figure 2 – New Zealand equity prices



Sources: Datastream, author's calculations

US equity prices are also controlled for since New Zealanders' financial portfolios are likely to be exposed to, or correlated with, US equity prices. The MSCI US equity price index, deflated by US consumer prices, is used. For the benchmark level, both an HP filter and constant growth assumptions are used (the latter based on the average monthly growth rate over this period).

Appendix Figure 3 – US equity prices



Sources: Datastream, author's calculations

Regression results

The results for regressions under different specifications are reported in Table 9. Caveats of course must apply given the relatively limited data and simple regression methodology. The main conclusion drawn is that growth surprises have high explanatory power, whereas the other variables to do not.

Appendix Table 1 – Regression results under alternate specifications

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Growth surprises	1.661***	1.703***	1.731***	1.529***	1.732***	1.660***	1.544***	
	(0.272)	(0.293)	(0.297)	(0.312)	(0.264)	(0.280)	(0.282)	
Real estate prices								
Constant growth		-0.019					-0.038	-0.015
		(0.041)					(0.040)	(0.067)
"" at pre-2000 rate			-0.017					
			(0.027)					
Domestic equity				0.065			0.147*	0.307**
				(0.074)			(0.076)	(0.120)
Global equity								
H-P trend					-0.075		-0.104**	-0.110
					(0.047)		(0.048)	(0.081)
Constant growth						0.002		
						(0.016)		
R-squared	0.69	0.69	0.69	0.70	0.73	0.69	0.79	0.34

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

Appendix 2: Fan chart data and methodology

Approach

The use of fan charts to indicate uncertainty in fiscal forecasts has been used *inter alia* by fiscal authorities in the United States and United Kingdom (Congressional Budget Office, 2006; Office of Budget Responsibility, 2010). A broadly similar method is implemented here.

The approach taken is to construct confidence intervals by looking at the average historical error of the variables which are inputs for the CAB indicator. These variables are revenue, expenses, output gap, unemployment rate, revenue elasticities and nominal GDP.

This is done using data from Treasury's forecasts made at each Budget from 1994 to 2009. Therefore, the results rely on the assumption that data from forecasts for 1994 to 2009 form a representative sample for future forecast errors.

A key assumption is that forecast errors in the future will be unbiased and normally distributed. The assumption of unbiased forecasts (ie, symmetric confidence intervals) is a matter of judgement. Tax revenues have been underestimated, on average, over the sample period. However, the hypothesis that there is no bias cannot be rejected at the 5% significance level. Moreover, the sample period is dominated by the boom of the last decade. There is reason to think that forecast errors are cyclical, underestimating revenue in an expansion and overestimating revenues in a contraction. It will be helpful to get more data which will indicate if there is an opposite bias in during a downturn. A further alternative would be to subjectively skew risks based on judgement of the current balance of risks (as done by the Bank of England for inflation forecasts).

The root mean square error (RMSE) is used to estimate the standard deviation of the error distributions:

$$RMSE_i = \sqrt{\frac{\sum_{t=1}^{N} E_t{}^2}{N}}$$

for each $i = 0, \ldots, 4$ which is the number of years ahead in the forecast. Confidence intervals are computed by assuming the future forecasts errors are normally distributed with zero mean and standard deviation of $RMSE_i$ (ie, $\hat{E}_{2010+i} \sim \mathcal{N}(0, RMSE_i^2)$)

Uncertainty about these assumptions, combined with limited data series, means that results should be interpreted as only very approximate.

Revenue

There are two data sources for the tax revenue forecast errors. The first is a series of one-year-ahead forecasts of tax receipts (ie, cash) over 1972 to 2009. The second is for revenue (ie, accrual-based) over 1994 to 2009 for forecasts made up to three years ahead. The latter series is also adjusted for tax policy changes which were made after the forecasts were done. The latter data series is used (ie, revenue, adjusted for policy changes) as it is more fit for purpose. However, the longer time series of cash tax receipts is useful as a check that the error dispersion over 1995 to 2009 is reasonably consistent with a longer series.

Forecast errors (E_t) are measured as a nominal difference between forecast revenue ($\widehat{R_t}$) and actual revenue (R_t) as a percentage of the actual:

$$E_t = \frac{\widehat{R_t} - R_t}{R_t}$$

In Appendix Table 2, the summary statistics are shown which are used to construct the confidence intervals. Appendix Table 3 shows the results for the longer series which shows that errors are significantly larger as would be expected since they are cash, not accrual, and unadjusted for policy changes.

Appendix Table 2 – Revenue forecast errors adjusted for policy changes, 1994 to 2009 (% of actual)

	Current year	1 year ahead	2 years ahead	3 years ahead
Mean error	-0.2	-1.3	-2.5	-3.1
Standard deviation	0.9	3.0	4.8	6.1
Root mean square error	0.9	3.2	5.3	6.6
Sample size	16	15	14	13

Appendix Table 3 – 1-year-ahead forecast errors for tax recepits (% of actual)

	1972 to 1994	1995 to 2009	1972 to 2009
Mean error	-1.0	-1.0	-1.0
Standard deviation	4.1	3.4	3.8
Root mean square error	4.1	3.4	3.9

Expenses

Uncertainty around future expenses uses data on errors in core Crown primary expenses over 1994 to 2009. These are not adjusted for policy changes. While clearly there is a close relationship between expenses and policy, there will be uncertainty about transfer payments (where these are indexed to economic variables), take-up rates and underspends by departments (where expenses are governed by appropriations which defines a maximum, but not a minimum, limit on expenses).

In Appendix Table 4, it can be seen that forecast errors are about half of the magnitude of 1-year-ahead errors for tax revenues. But 2- and 3-year ahead errors are much higher and biased which will reflect policy changes. Because the 1-year-ahead errors would be expected to be minimally effected by policy changes (since these are generally made at one year intervals through the annual Budget), it seems reasonable to put greater weight on that value. If the assumption is made that outyear forecast errors, adjusted for policy change, would follow a random walk, the error dispersion can be estimated with the following formula: $\sigma_N = \sigma_T\sqrt{N/T}$ for N-year ahead forecasts. (The derivation of this formula can be found in standard financial mathematics textbooks, eg, Campbell *et al,* 1996). This suggests that as a reasonable working assumption, the confidence intervals for the 2- and 3-year ahead expense forecasts should use a standard deviation of 2.1% and 2.6% respectively. These are the values used for constructing the confidence intervals.

Appendix Table 4 – Expenses forecast errors (% of actual)

	Current year	1 year ahead	2 years ahead	3 years ahead
Mean error	0.1	-0.6	-3.0	-4.9
Standard deviation	0.9	1.4	2.3	3.7
Root mean square error	0.9	1.5	3.7	6.1
Sample size	16	15	14	13

Output gap

The output gap is unobservable and hence there is no "actual" value from which to measure the error. However, a proxy can be derived by looking at the distribution of revisions to the Treasury's official estimate of the output gap. Unlike revenue and expenses, these revisions apply to history as well as over the forecast horizon. The Treasury only began reporting the output gap in 1997, so there is a limited time series. To compute a proxy for error, the official Treasury forecasts in real time are compared with the most recent estimate (Budget 2010). The root mean square errors are used to form the standard deviation of the confidence intervals, and are reported in Appendix Table 7.

Unemployment rate

Errors for the unemployment rate are measured by comparing the forecasts with the actual. The actual is defined as the original vintage data released by Statistics New Zealand since errors attributable to statistical revisions following forecasts would complicate the analysis. Confidence intervals use the RMSE to estimate of the standard deviation of the error distribution and are shown in Appendix Table 7. The Okun's law relationship is used to estimate the structural rate of unemployment for a given probability distribution of the output gap.

GDP

A similar approach is used for nominal GDP as for the unemployment rate. Errors with respect to the original vintage data are found for growth rates in nominal GDP (again, to avoid issues with statistical revisions). Summary statistics are shown in Appendix Table 5.

Appendix Table 5 – Nominal GDP growth forecast errors (% points)

	Current year	1 year ahead	2 years ahead	3 years ahead
Mean error	-0.2	0.1	-0.4	-0.3
Standard deviation	0.7	2.1	2.4	2.3
Root mean square error	0.7	2.1	2.4	2.3
Sample size	21	20	19	17

Elasticities

Quantifying the uncertainty in the elasticity estimates is problematic as many values are assumed rather than econometrically estimated. One case where there is an econometric estimate is for the standard error of the elasticity of the wage bill with respect to the output gap (by Girouard and André, 2005). Girouard and André find an average standard error of 0.2 using cross-country panel data which is used to calibrate the New Zealand parameter. Making the arbitrary assumption that the standard errors for other elasticities (both base-to-output gap and revenue-to-base) are of this magnitude, then the standard error for the combined revenue-to-output gap elasticity would be approximately 0.3.[4] This is used to calibrate the standard deviation for the confidence intervals for all elasticity values used. This would suggest an that a 95% confidence interval around an elasticity parameter of 1.0 would be (0.4,1.6).

Covariances

Since the approach used is to construct a confidence interval for the CAB based on estimates of the errors of the constituent parts, an assumption is required for the covariances between the error distributions. Appendix Table 5 shows the sample correlation coefficients for the 1-year-ahead errors.

Appendix Table 6 – Sample correlation coefficients for 1-year-ahead errors

	Revenue	Expenses	Output gap	Unemployment
Expenses	0.0			
Output gap	0.3	-0.2		
Unemployment	-0.8***	0.2	-0.1	
Nominal GDP	0.8***	0.1	0.0	-0.8***

* significant at 10% level; ** significant at 5% level; *** significant at 1% level

These sample estimates are used in the computation of the CAB confidence interval. While many of the sample coefficients are not statistically different from zero, they appear to reflect economically plausible relationships and are the best point estimates available.

4 This assumes independent distributions of errors for the revenue-to-base and base-to-output gap elasticities. It is derived by observing that the formula for the variance of the product of two independent random variables, X and Y, is $Var[XY]=E[X]^2 Var[Y] + E[Y]^2 Var[X] + Var[X]Var[Y]$. Let X represent the revenue-to-base elasticity and Y the base-to-output gap elasticity. E[X] and E[Y] are approximately equal to 1 and by assumption Var[X] and Var[Y] are each equal to 0.04 (the square of 0.2). Thus $Var[XY] \approx 0.08$ and, by taking the square root, the standard deviation is approximately 0.3.

The elasticity errors are assumed to be independent distributions since there is no empirical means of estimation, nor any theoretical reason to believe the case is otherwise.

Summary of assumptions

The assumed standard deviation for the distribution of errors for each variable is summarised in Appendix Table 6.

Appendix Table 7 – Standard deviation assumptions for confidence intervals

Year	Revenue (% of actual)	Expenses (% of actual)	Output gap (% points)	Unemployment rate (% points)	Nominal GDP growth (% points)
t – 10	-	-	0.5	-	-
t – 9	-	-	0.3	-	-
t – 8	-	-	0.4	-	-
t – 7	-	-	0.5	-	-
t – 6	-	-	0.5	-	-
t – 5	-	-	0.5	-	-
t – 4	-	-	0.5	-	-
t – 3	-	-	0.7	-	-
t – 2	-	-	0.9	-	-
t – 1	-	-	1.0	-	-
t	0.9	0.9	1.4	0.2	0.7
t + 1	3.2	1.5	1.9	0.7	2.1
t + 2	5.3	2.1	1.8	1.1	2.4
t + 3	6.6	2.6	1.6	1.0	2.3