A Structural VAR Approach to Estimating Budget Balance Targets

Robert A Buckle, Kunhong Kim & Julie Tam

Abstract

The Fiscal Responsibility Act 1994 states that, as a principle of responsible fiscal management, a New Zealand government should ensure total Crown debt is at a prudent level by ensuring total operating expenses do not exceed total operating revenues. In this paper a structural VAR model is estimated to evaluate the impact on the government's cash operating surplus (or budget balance) of four independent disturbances: supply, fiscal, real private demand, and nominal disturbances. Based on the distribution of these disturbances, stochastic simulations are undertaken to derive the level of the *ex ante* cash budget balance needed to achieve an actual cash budget balance, at a given level of probability, at some future time horizon.

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Keywords: Budget target, Fiscal policy, Fiscal Responsibility Act, Structural VAR, Stochastic Simulation.

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1. Motivation and methodology

Recognition of the dynamic effects of government budget deficits, the importance of policy credibility, timing difficulties associated with discretionary fiscal policy as a result of "inside" and "outside" lags, and difficulties many countries have experienced trying to reverse large fiscal deficits led to renewed interest in the specification of government budget balance rules during the 1980s and 1990s. For example, in several US states there exist strict balanced budget rules. For countries participating in stage III of the European Monetary Union, the Maastricht Treaty imposes a deficit ceiling of 3 per cent of GDP (and a debt limit of 60 per cent of GDP) and the Stability and Growth Pact specifies particular circumstances where a deficit can be regarded as excessive.

Changes in the role and conduct of monetary policy and new developments in macroeconomic research techniques during the past two decades have also prompted a reassessment of the role of counter-cyclical fiscal policy. In a recent summary of these developments, Taylor (2000) concluded that macroeconomic policy research based on model simulations of alternative policy rules suggests that when monetary policy is focused on inflation and is more sensitive to deviations of actual GDP from potential GDP, it is appropriate to let fiscal policy have its counter-cyclical impact through the automatic stabilisers rather than through discretionary policy changes. In an interesting departure from some of the types of models considered by Taylor, Wren-Lewis (2000) concludes that institutional issues and questions of political economy rather than the ineffectiveness of fiscal policy appear to lie behind the reluctance in recent years to assign fiscal policy to short-run stabilisation.

Although the appropriate role for fiscal policy therefore remains an important ongoing issue for research and debate, some of these ideas and developments have nevertheless had a significant influence on fiscal policy in New Zealand during the 1990s. In particular, the Fiscal Responsibility Act 1994 (FRA) specifies that a government must achieve operating surpluses every year until a prudent level of debt is achieved.[1] This effectively requires a government to generate cash-flow surpluses in order to reduce debt levels. Although the FRA does not specify a prudent level of debt[2], the Act does imply that a government must

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[1] Specifically, the principles of responsible fiscal management set out in the FRA include: "Reducing total Crown debt to prudent levels…. by achieving operating surpluses every year until prudent levels of debt have been achieved," and "Maintaining total Crown debt at prudent levels by ensuring that, on average, over a reasonable period of time, total operating expenses do not exceed operating revenues." (New Zealand Government, 1994).

[2] However, the FRA requires a government to publish its long-term objectives for total Crown debt and the operating balance. This is done in the *Budget Economic and Fiscal Update* (New Zealand Treasury, 2000). The

set its fiscal parameters *ex ante* in order to achieve a target budget balance consistent with some desired outcome for public debt.

A common way to view a government's budget balance is to assume it comprises a structural component that is determined by underlying long-run growth rates of government expenditure revenue, and a cyclical component that reflects the response of the operating surplus to the business cycle. In response to unexpected shocks that threaten the viability of achieving its desired budget balance, a government can make adjustments to the long-run growth rates of government expenditure and revenue. Alternatively, it can change the responsiveness of the fiscal balance to the business cycle. However, because of the "inside" and "outside" lags, these adjustments cannot be achieved instantaneously.

A further potential complicating issue arises from the fact that as the volatility of the government budget balance increases, the probability of breaching a desired lower (or upper) bound will increase. This point is stressed by Tam and Kirkham (2001) who argue that the New Zealand government budget balance has tended to be relatively volatile compared to many other OECD countries, for two reasons: New Zealand's business cycle has been relatively volatile and, the budget balance is relatively sensitive to changes in the business cycle.

Therefore, if a government wants to allow automatic fiscal stabilisers to operate unimpeded over the business cycle without breaching some lower or upper bound for the fiscal balance (such as any bound implied by the Fiscal Responsibility Act), it needs to set fiscal parameters and the *ex ante* budget balance so that they take into account the potential impact of unexpected exogenous shocks to the budget balance. Put another way, to avoid breaching a desired budget balance *ex post*, a government needs to form a judgement about the appropriate *ex ante* budget balance in light of given probabilities of the type and size of exogenous shocks that could impact on the structural and cyclical components of the budget balance.

The aim of this paper is to develop a procedure for this purpose. Our approach is to use a structural vector autoregression (SVAR) model to evaluate the probability and impact of different types of shocks to a New Zealand government's cash budget balance.[3] By examining the magnitude of past shocks, and their effect on the cash budget balance, the model is used to estimate the level of the *ex ante* cash budget surplus necessary to achieve a specified cash budget surplus at some future time horizon with a given level of probability. Alternative time horizons are considered because, as the future time horizon is extended, the probability of adverse disturbances to the cash budget balance increases and their propagation effects become more pronounced. Therefore, for a desired probability of continuously avoiding breaching a particular floor (or minimum value) for the cash budget surplus, the appropriate *ex ante* cash budget surplus increases as the time horizon for that target is extended.

Various approaches can be used to estimate prudent budgetary margins. For example, Buti, Franco and Ongena (1998) use estimated elasticities of budget deficits to output changes to evaluate the distance a budget deficit would need to be from its target in order to

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FRA also requires a government to illustrate likely progress towards the objectives in the *Fiscal Strategy Report* (New Zealand Government, 2000)

[3] The terms "cash budget balance" and "budget balance" are used interchangeably in the text. We use the term "cash budget balance" to refer to the Crown's net cash flow from operations, or cash flow generated from its day to day (or operating) activities. The cash budget balance differs from the "operating balance" reported in the Crown's accounts, in that the operating balance is not measured on a cash basis, but is measured on an accrual basis. See Appendix Two for further details.

accommodate the impact on the deficit if a country's output gap was at its historical maximum negative gap.

The New Zealand Treasury uses a number of procedures in the analysis of appropriate budgetary margins. A "Ready Reckoner" model is used to provide indicative fiscal tracks in the event of alternative real output growth paths. For the short term, the Cyclically Adjusted Balance (CAB) model is used to gauge the underlying structural fiscal position. The Treasury also uses a Long Term Fiscal Model (LTFM) to project the path of fiscal variables, beyond the short-term forecast horizon, under alternative economic and fiscal assumptions. The LTFM uses economic assumptions regarding GDP growth, interest rates and employment to model the fiscal position. However, the interaction between these variables and the cash budget balance is not captured and formally estimated probabilities are not assigned to the cash budget balance forecasts.

This paper augments the existing models of The Treasury, in that the interaction between a set of economic variables and the cash budget balance is explicitly modelled. In addition, this paper presents a different approach to the "risks and scenarios" approach that the Treasury undertakes with its set of forecasts[4]. Rather than predicting the behaviour of the cash budget balance under specific, alternative shocks to the economy, we focus on the level of the cash budget balance sufficient to withstand a number of possible shocks and still remain within surplus. In effect, this necessitates forming a judgment on the size and frequency of each particular shock to the economy and their impact on the budget balance.

In order to make this judgment, the approach of this paper is to undertake stochastic simulations based on SVAR equations that capture the dynamic response of the government's cash budget balance to historical structural disturbances. From this SVAR model, we can derive probabilities of breaching particular cash budget balance targets over alternative horizons. The simulation procedure used to derive these probabilities follows the method proposed by Dalsgaard and de Serres (1999). This paper extends their work by specifying a theoretical macroeconomic model and budget balance function to underpin the SVAR model and to make explicit the theoretical explanations for the structural restrictions imposed on the model.

The first step involves specifying a theoretical macro model that explicitly incorporates the government's budget balance and its interactions with the rest of the economy. This stage involves specifying the variables, identifying restrictions, and exogenous shocks that should be captured by the empirical model. It also provides a theoretical basis for identifying the expected short-run and long-run effects of exogenous shocks on the budget balance and other endogenous variables in the model.

The second step involves estimation of a structural VAR model to determine the effects of exogenous shocks on the cash budget balance and other endogenous variables. We consider four types of exogenous shocks: supply, fiscal, real private demand and domestic nominal price shocks. We compare the short-run and long-run behaviour of the endogenous variables in response to these four disturbances as a way of verifying whether the estimated SVAR model successfully captures the four disturbances that are identified by the theoretical model of the budget balance and the macroeconomy.

The third stage involves stochastic simulations of the estimated SVAR equations to build up probabilities of breaching a particular cash budget balance floor over a range of alternative future time horizons.

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[4] For example, see chapter 3 of The Treasury (2000), *Budget Economic and Fiscal Update*.

2. A “sticky-price” macroeconomic model and the budget balance

Our interpretation of the type of disturbances that will impinge on the budget balance and whether these disturbances will have transitory or permanent effects is based on a traditional sticky-price model of macroeconomic fluctuations. The model is a variant of Fischer’s (1977) sticky-price macroeconomic model. Modifications introduced to that model are the specification of a government budget balance function, a private sector demand function, and the explicit treatment of fiscal shocks in the aggregate and private sector demand functions.

The model is specified as follows:

$$Y_t = -a_1 r_t + a_2\theta_t + a_3\delta_t - a_4\gamma_t; \quad a_1, a_2, a_3, a_4 > 0 \tag{1}$$

$$F_t = b_1 Y_t - b_2 r_t + b_3\delta_t + \gamma_t; \quad b_1, b_2, b_3 > 0 \tag{2}$$

$$D_t = d_1 Y_t - d_2 r_t + d_3\theta_t + \delta_t; \quad d_1, d_2, d_3 > 0 \tag{3}$$

$$M_t - P_t = c_1 Y_t - c_2 r_t; \quad c_1, c_2 > 0 \tag{4}$$

$$\overline{Y}_t = \overline{N} + \theta_t \tag{5}$$

where

$$\gamma_t = \gamma_{t-1} + \varepsilon_t^f \tag{6}$$

$$\delta_t = \delta_{t-1} + \varepsilon_t^d \tag{7}$$

$$\theta_t = \theta_{t-1} + \varepsilon_t^s \tag{8}$$

$$M_t = M_{t-1} + \varepsilon_t^n \tag{9}$$

The variables *Y*, *F*, and *D* denote the logs of realised real output, the government’s real budget balance and real private sector demand, respectively. The natural rate of employment is denoted by $\overline{N}$, θ denotes the log of productivity, *P* and *M* represent the logs of the price level and the money supply respectively, and *r* is the real interest rate.

Equation (1) is a reduced form IS function that recognises that real aggregate demand is determined by the real interest rate and exogenous shocks to total private demand and to fiscal policy.

Equation (2) states that the real budget balance comprises four components: a component determined by real income, a real interest rate component, and two exogenous shock components. The parameter $b_1 > 0$ in equation (2) captures the net effect of real output on the budget balance arising from the interaction of output and taxation, transfer payments and government expenditure. The parameter $b_2 > 0$ captures the effect of real interest rates, arising from the need to service public debt. The two exogenous shocks to the real budget balance arise from shocks to private demand (δ) and fiscal shocks (γ), which are assumed to follow a random walk process.

The inclusion of $b_3\delta_t$ in the real budget function captures the presence of a 'discretionary' stabilisation role of fiscal policy in response to shocks to private demand, in contrast to the 'automatic' role captured by b_1Y_t. The reason for this is as follows. Private demand shocks will tend to cause real private demand to deviate from the natural rate of output and hence either accentuate inflationary pressures or accentuate the size of the output gap. Accordingly, we allow for the possibility of an offsetting (or stabilisation) response by the fiscal authority.

The coefficient $b_3 > 0$ in equation (2) captures this fiscal policy reaction. It implies that, in the presence of a positive real private demand shock, a government will react by increasing the fiscal surplus, thereby moderating the rise in aggregate demand as a consequence of the real private demand shock. Similarly, a negative private demand shock, which will have the potential to increase the output gap and unemployment, is assumed to provoke the converse reaction by a government. In this case, a government will reduce the fiscal surplus with the aim of moderating the decline in real aggregate demand relative to the natural rate of output.

Equation (3) states that aggregate real private demand is a function of realised real income (*Y*), the real interest rate (*r*), productivity and exogenous changes in real private demand (δ). Productivity is allowed to affect aggregate private demand directly. This could occur through investment demand for example, in which case $d_3 > 0$.

Equation (4) is the demand for real money balances. *M* is assumed to follow a random walk process.

Equation (5) is the production function; it relates output, employment, and productivity. $\overline{Y}$ can be interpreted as the natural rate of output which is the rate of output that is realised when employment is at the natural rate, given the level of productivity, θ, which is assumed to follow a random walk process.

The variables ε^f, ε^d, ε^s, ε^n are serially uncorrelated and orthogonal fiscal, private demand, supply (or productivity) and nominal disturbances, respectively.

This model can be reduced to a four equation system by using equation (4) to derive an expression for the real interest rate (*r*) and eliminating it from equations (2) and (3). The result is a four-equation system for *Y*, *F*, *D* and $\overline{Y}$, where the new coefficients (y_i, f_i and z_i) are complex functions of the original coefficients (a_i, b_i, c_i, and d_i):

$$Y_t = y_1(M_t - P_t) + y_2\theta_t + y_3\delta_t - y_4\gamma_t \tag{10}$$

$$F_t = f_1Y_t + f_2(M_t - P_t) + f_3\delta_t + \gamma_t \tag{11}$$

$$D_t = z_1Y_t + z_2(M_t - P_t) + z_3\theta_t + \delta_t \tag{12}$$

$$\overline{Y}_t = \overline{N} + \theta_t \tag{13}$$

The model assumes that monopolistic firms set prices for period *t* at the end of period *t*-1 at a level that is expected to make the quantity demanded equal the to natural rate of output, ie. to achieve $\mathrm{E}_{t-1}(Y_t - \overline{Y}_t) = 0$. This is used to solve for Y_t, F_t, D_t and P_t. The solutions for these endogenous variables imply the following growth paths for real output, the real budget balance, real aggregate private demand and prices:

$$\Delta Y_t = \varepsilon_{t-1}^s + y_2(\varepsilon_t^s - \varepsilon_{t-1}^s) - y_4(\varepsilon_t^f - \varepsilon_{t-1}^f) + y_3(\varepsilon_t^d - \varepsilon_{t-1}^d) + y_1(\varepsilon_t^n - \varepsilon_{t-1}^n) \quad (14)$$

$$\Delta F_t = \left[f_1 - \frac{f_2(y_2 - 1)}{y_1} \right] \varepsilon_{t-1}^s + f_1 y_2(\varepsilon_t^s - \varepsilon_{t-1}^s) + \varepsilon_t^f + \frac{f_2 y_4}{y_1}\varepsilon_{t-1}^f - f_1 y_4(\varepsilon_t^f - \varepsilon_{t-1}^f) + f_3\varepsilon_t^d - \frac{f_2 y_3}{y_1}\varepsilon_{t-1}^d + f_1 y_3(\varepsilon_t^d - \varepsilon_{t-1}^d) + (f_1 y_1 + f_2)(\varepsilon_t^n - \varepsilon_{t-1}^n) \quad (15)$$

$$\Delta D_t = z_3\varepsilon_t^s + \left[z_1 - \frac{z_2(y_2 - 1)}{y_1} \right] \varepsilon_{t-1}^s + z_1 y_2(\varepsilon_t^s - \varepsilon_{t-1}^s) + \frac{z_2 y_4}{y_1}\varepsilon_{t-1}^f - z_1 y_4(\varepsilon_t^f - \varepsilon_{t-1}^f) + \varepsilon_t^d - \frac{z_2 y_3}{y_1}\varepsilon_{t-1}^d + z_1 y_3(\varepsilon_t^d - \varepsilon_{t-1}^d) + (z_1 y_1 + z_2)(\varepsilon_t^n - \varepsilon_{t-1}^n) \quad (16)$$

$$\Delta P_t = \frac{y_2 - 1}{y_1}\varepsilon_{t-1}^s - \frac{y_4}{y_1}\varepsilon_{t-1}^f + \frac{y_3}{y_1}\varepsilon_{t-1}^d + \varepsilon_{t-1}^n \quad (17)$$

In this form, the model implies five long-run restrictions: three in equation (14) and one in each of equations (15) and (16). The presence of nominal price rigidities in the short run means the model predicts that positive real private demand disturbances (ε^d) and nominal disturbances (ε^n) will raise real output in the short run, but these effects disappear in the long run. Similarly, positive fiscal shocks (ε^f) will lower real output in the short run, but the effect disappears in the long run. In the long run, only supply (that is, productivity) disturbances (ε^s) affect output.

However, the long-run effect of real private demand shocks on the real budget balance in equation (15) is ambiguous. It will depend on whether $f_3 - \frac{f_2 y_3}{y_1}$ is less than or greater than zero. f_3 is the direct effect of private demand shocks on the real budget balance (government's offsetting reaction to private demand shocks). $\frac{f_2 y_3}{y_1}$ is the indirect effect of private demand shocks on the budget balance arising from consequential changes in real money balances and hence the real interest rate.

It is not clear which of these two influences dominate. Moreover, it is unrealistic to allow the real budget balance to change permanently in response to real private demand shocks. Therefore we will assume the total long-run effect is zero. Accordingly, this leaves us with six long-run restrictions that are imposed on the SVAR model specified in section 3.

The short-run and long-run response of real output, the fiscal balance, real private demand and inflation to the four disturbances implied by this theoretical dynamic model are summarised in Table 1.

The model predicts that in the short run the budget balance will rise in response to positive supply, real private demand and nominal shocks. The short-run response to fiscal shocks is unclear because there are offsetting forces arising from the direct impact on the budget balance of a fiscal shock and the induced fall in real output that lowers net taxation revenue. It seems likely however that $f_1 y_4$<1, in which case a positive fiscal shock will raise the budget balance in the short run. In the long run, supply and fiscal shocks permanently affect the budget balance while real private demand and nominal shocks are neutral.

Positive supply, real private demand and nominal shocks raise real private demand in the short run. The impact of positive fiscal shocks on real private demand is negative. This occurs because a positive fiscal shock lowers real aggregate demand and realised output, which in turn reduces real private demand.

In the long run, the response of real private demand to positive supply shocks and real demand shocks is ambiguous, because there is a positive impact of these shocks on private demand, but there is also a possible negative effect arising from a fall in real money balances and a rise in the real interest rate. The long-run effect of positive fiscal shocks is positive via the “crowding in” effect of a fall in real interest rates. The long-run impact of nominal shocks on real private demand is neutral, even though these are random walk shocks, ie. permanent shocks. The reason for this is that the price level changes, so that real money balances are unchanged in the long run.

The model therefore incorporates a dichotomy between the long-run effects of demand and supply shocks. While this is common practice, there are many reasons to think that demand and fiscal disturbances could have long-run effects on output. These include the presence of increasing returns, of learning by doing, and the possibility that fiscal policy may affect the savings rate, and subsequently the long-run capital stock.

Despite these possibilities, it is common practice to assume these long-run effects are small compared to those of supply disturbances. Thus, distinguishing between the long-run effects of real demand, nominal and fiscal shocks and the long-run effects of supply shocks has important implications for their related long-run effects on real private demand, inflation and the budget balance.

3. Specification of the structural VAR model

In this section, we construct and estimate a four variable structural VAR model in order to decompose fluctuations in the government budget balance into the four structural (or economic) disturbances identified in the model described in section 2, i.e., ε^s , ε^f , ε^d , and ε^n .

The model can be represented by a 4×1 vector of endogenous variables ΔZ (comprising ΔY, ΔF, ΔD, and ΔP) with the moving average representation given by

$$\Delta Z_t = A(L)\varepsilon_t \, , \qquad (18)$$

where $A(L) = \sum_{s=0}^{\infty} A_s L^s = A_0 + A_1 L + A_2 L^2 + \cdots$ is a 4×4 matrix of polynomials in the lag operator L and ε_t is a 4×1 vector of white noise disturbance terms ε^s, ε^f, ε^d, and ε^n. We assume that A_0 has 1's along its diagonal and that $\varepsilon_t \sim (0, \Sigma_\varepsilon)$ and Σ_ε is diagonal (that is, the structural shocks are mutually orthogonal). The variables in ΔZ are all stationary. (If any of the variables are non-stationary, it should be further differenced to make it stationary provided the variables are not cointegrated). The ε_t's are structural disturbances, and we are interested in estimating the response of elements of Z to innovations in the elements of ε. For example, we are interested in the response of the budget balance to four different structural disturbances. A plot of the row i, column j element of A_s as a function of s is called the impulse response function. It describes the response of ΔZ_{it+s} to a one-time one-unit impulse in ε_{jt}.

It is convenient to define the matrix H such that $HH' = \Sigma_\varepsilon$; the diagonal elements of H are the standard errors of the elements of ε. Then equation (18) can be rewritten as

$$\Delta Z_t = A(L)\varepsilon_t = A(L)HH^{-1}\varepsilon_t = \widetilde{A}(L)\widetilde{\varepsilon}_t \, , \qquad (19)$$

where $\widetilde{A}(L) = A(L)H$, and $\widetilde{\varepsilon}_t = H^{-1}\varepsilon_t$ is the vector of structural shocks measured in one standard deviation units. Note that

$$\mathrm{E}\widetilde{\varepsilon}_t\widetilde{\varepsilon}_t' = (H^{-1})(\mathrm{E}\varepsilon_t\varepsilon_t')(H^{-1})' = H^{-1}HH'(H^{-1})' = \mathrm{I} \, .$$

The ij-th element of $\widetilde{A}_s$ represents the response of ΔZ_{it+s} to a one-time one standard deviation impulse in ε_{jt}.

One way to summarise the information contained in our ΔZ data is to estimate the VAR representation of appropriate order k:

$$B(L)\Delta Z_t = u_t \text{, where } B(L) = I - B_1 L - B_2 L^2 - \cdots - B_k L^k \, . \qquad (20)$$

Since ΔZ is stationary, the roots of $B(L)$ are all greater than 1. Therefore the VAR representation can be inverted into $\Delta Z_t = C(L)u_t$, where $C(L) = B(L)^{-1}$ and $C(0) = I$. In terms of (13), $C(L) = A(L)A(0)^{-1}$ and $u_t = A(0)\varepsilon_t$. Thus in order to recover estimates of the structural disturbances, ε_t, from the estimated VAR residuals, u_t, it is necessary to estimate $A(0)$.

The covariance matrix of the VAR residuals, Σ_u, is related to $A(0)$ and Σ_ε by

$$\Sigma_u = A(0)\Sigma_\varepsilon A(0)' = A(0)HH'A(0)' \, . \qquad (21)$$

Since Σ_u is symmetrical, equation (21) provides $n(n+1)/2$ restrictions, where *n* is equal to four. But we have to estimate n^2 elements in $A(0)$ and *H*. Therefore, $n^2 - n(n+1)/2 = n(n-1)/2$ additional restrictions are necessary for complete identification. For the four variable system we consider, six additional restrictions are required.

Such identifying restrictions have taken a variety of forms in the literature. One approach achieves identification by imposing *a priori* restrictions on the contemporaneous interactions among the variables in the system. These restrictions take the form of exclusion restrictions i.e., zero restrictions on some of the elements of $A(0)$. These include the recursive structure popularised by Sims (1986) and the simultaneous equations approach by Bernanke (1986), Blanchard and Watson (1986), and Blanchard (1989).

An alternative approach to identification relies on restrictions on long-run effects implied by an underlying theoretical model. As shown by Blanchard and Quah (1989), this can be translated into a restriction on the dynamic system that may aid in the identification of model parameters.

The lag polynomial $C(L)$ that is obtained by inverting the VAR representation is defined by

$$C(L)A(0) = A(L). \qquad (22)$$

Assume that economic theory implies that certain structural disturbances have no long-run impact on some elements of Z. This imposes zero restrictions on the elements of $A(1)$. In this case, the restrictions imposed by

$$C(1)A(0) = A(1) \qquad (23)$$

together with restrictions implied by (21) may allow $A(0)$ to be estimated.[5] This is the approach taken by Blanchard and Quah (1989). Examples of the application of long-run identifying restrictions to estimate SVAR models for the New Zealand macroeconomy are Conway (1998), Fisher (1996) and Fisher, Fackler and Orden (1995). Some studies like Gali (1992) apply combinations of contemporaneous and long-run restrictions by imposing zero restrictions on some of the elements of both $A(0)$ and $A(1)$.

In this paper, only long-run restrictions are imposed. This allows the data to determine the short-run dynamics. The theoretical model developed in Section 2 suggests it may be appropriate to impose restrictions on the contemporaneous reaction of prices to structural disturbances. However, the model is estimated using annual data and, although goods prices would be expected to display inertia, according to recent research the duration of prices is typically significantly less than one year. Buckle and Carlson (1995) estimate the average duration of prices set by NZ manufacturing, building, merchant and service firms was approximately 4.7 months during the high inflation in the 1970s and 1980s and was approximately 8.5 months during the 1990s when inflation was much lower.

The long-run restrictions are as follows. Three restrictions arise because fiscal, real private demand, and nominal shocks do not have permanent effects on real output, but supply shocks can have a permanent effect. Two further restrictions are that real private demand shocks and nominal shocks do not have long-run effects on the government budget balance.

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[5] If $A(L) = A_0 + A_1 L + A_2 L^2 + \cdots$, then $A(1) = A_0 + A_1 + A_2 + \cdots$ equals the sum of the lag coefficients.

The sixth restriction is that nominal shocks have a permanent effect on the aggregate price level but do not have a permanent effect on any other variable in the system. These long-run restrictions imply that

$$a_{12}(1) = a_{13}(1) = a_{14}(1) = a_{23}(1) = a_{24}(1) = a_{34}(1) = 0 , \qquad (24)$$

where $a_{ij}(L)$ is the *ij*-th element of $A(L)$. This provides us with six restrictions, which is just enough to identify the model. Thus $A(1)$ has the form:

$$\begin{bmatrix} a_{11}(1) & 0 & 0 & 0 \\ a_{21}(1) & a_{22}(1) & 0 & 0 \\ a_{31}(1) & a_{32}(1) & a_{33}(1) & 0 \\ a_{41}(1) & a_{42}(1) & a_{43}(1) & a_{44}(1) \end{bmatrix},$$

which is lower triangular. Noting that $C(1)u_t = A(1)\varepsilon_t$, where $C(1)$ is the matrix of estimated long-run multipliers from the VAR,

$$C(1)\Sigma_u C(1)' = A(1)\Sigma_\varepsilon A(1)' = A(1)HH'A(1)' .$$

Since $C(1)$ and Σ_u are available from the estimation of a standard VAR representation, the estimate of the lower triangular matrix $\widetilde{A}(1) = A(1)H$ can be obtained as the Cholesky factor of $C(1)\Sigma_u C(1)'$. Once $\widetilde{A}(1)$ is estimated, the estimate of $\widetilde{A}(0) = A(0)H$ is obtained from equation (18) as $C(1)^{-1}\widetilde{A}(1)$. Since the diagonal elements of $A(0)$ equal 1, we can recover estimates of $A(0)$ and P from an estimate of $\widetilde{A}(0)$.

4. Data, model estimation and impulse responses

To estimate the SVAR system, data were required for the four endogenous variables: real output, the real government budget balance, real private demand, and the general price level. The annual data used to estimate the model included:

- *Y*: Log of real GDP;
- *F*: Central Government's net cash flows from operations as a ratio to nominal GDP[6];
- *D*: Log of the sum of real private consumption and real private investment;
- *P*: GDP deflator.

The longest sample period available was 1971 – 1999. Details of the data and their sources are described in Appendix One. *Y*, *D* and *P* are available on a March year basis throughout the sample period whereas *F* is only available on a March year basis until 1989, thereafter it is measured on a June year basis. An in-built lag between *F* and the other three endogenous variables will therefore already partially exist. This should be taken into consideration when interpreting the impulse responses. Whether these four variables are

[6] As we define our real budget balance variable to be the nominal net cash flow from operations as a ratio to nominal GDP, hereafter the term "real budget balance" will refer to the ratio specified above.

able to successfully capture the four disturbances can be evaluated by examining the impulse responses.

Unit roots

In order for the methodology described in Section 3 to be valid, all the variables included in the SVAR system should be stationary. If a variable is non-stationary, it should be differenced until it becomes stationary. The time series of the four variables are depicted in Figure 1. The results of formal Augmented Dickey-Fuller (ADF) unit root tests are reported in Table 2.[7] For real output, the real budget balance and real private demand in level form, and for the first difference of the GDP deflator, the test fails to reject the null hypothesis of a unit root. In each case, however, first differencing of the real variables and second differencing of the GDP deflator induces stationarity.

Cointegration

While the preceding test suggests that the variables are nonstationary in level form when considered individually, it is possible that these variables share a common nonstationary trend. In this case, a stationary linear combination of the variables may be found, and the variables are said to be cointegrated. When variables are cointegrated, estimating a SVAR model where the series are expressed in first differences would be inappropriate. One reason is that first-differencing would remove important information about the behaviour of the variables contained in the common trend.

We checked for the possibility that the four-variable system might be cointegrated. Vector cointegrating regressions do not indicate stationary residuals using the ADF test suggested by Engle and Granger (1987)[8]. In particular, the ADF statistics from the levels regression normalised to either real GDP, the real budget balance, private real demand, or the inflation rate are –2.40, –2.81, –2.42, –2.71 respectively. The 5 percent critical value is – 4.22.

Based on these findings, we proceed to estimate our SVAR model with first differences.

Lag Order

Lag order determination constitutes a well-known problem when it comes to implementing a SVAR model. Whether a time trend should be included as a deterministic component also needs to be considered. Typically the issue is handled by performing likelihood ratio tests. However, we have an extremely small sample size. The likelihood ratio test is based on asymptotic theory, which may not be useful for the small sample size of this study. Instead, we used multivariate generalisations of the Akaike Information Criterion and Hannan Quinn Information Criterion.

Table 3 reports the values of these criteria for different model specifications. Both criteria select a model that includes 3 lags in the VAR, with a time trend. Therefore, the impulse responses and stochastic simulation results reported below are based on a SVAR model that incorporates three lags and a time trend.

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[7] Our data set runs from 1971 to 1999 and covers a period in which there may have been structural changes to the New Zealand economy. If so, there may be an argument to use Perron's test for unit roots in the presence of structural change. However, the small sample size, means it is not feasible to adopt this approach.

[8] The Johansen (1988) method is another way by which the possibility of cointegration can be checked. However, that procedure is based on the maximum likelihood method which may not be reliable in view of the short sample period over which the model in this paper is estimated.

Impulse Responses

Impulse responses from the VAR estimation are presented in Figure 2. Since no restrictions other than the six long-run identifying restrictions are imposed on the effects of the shocks, it is possible to check whether the identified shocks behave in a way which is consistent with the implications of the theory discussed in Section 2. Most of the effects match the implications of the theory summarised in Table 1.

The real budget balance responds to the four disturbances in the estimated model in a manner consistent with our theoretical model, with the exception of the immediate reaction to a nominal shock. It is worth noting that a positive supply shock raises the budget balance in the short run and in the long run. The short-run reaction of the fiscal balance to supply shocks could in fact be consistent with the theoretical model. Note that, since the rise in GDP is greater than the rise in the budget balance, the real budget balance (which is the ratio of the budget balance to GDP) falls in the short run and in the long run, as Figure 2 illustrates.

Turning to the other components of our model, the reactions of real output, real private demand and inflation are for the most part consistent with our theoretical model. Real output responds positively in the short run to positive supply, real private demand and nominal shocks. The positive supply shocks generate the expected positive long-run effects on real output and the impact of real private demand and nominal shocks on real output disappear in the long run. Similarly, the impact of fiscal shocks on real output disappear in the long run. In the short run however, positive fiscal shocks raise real output, which is not a result anticipated by our theoretical model.

Real private demand rises in the short run and in the long run in response to positive supply and positive real private demand shocks. The short-run reactions are consistent with the theoretical model. The long–run reactions are also consistent since the signs for the theoretical model are ambiguous. The long-run reaction of real private demand to nominal shocks is neutral which is also consistent with the theoretical model. The immediate response of real private demand in response to a positive fiscal shock is positive, which is not predicted by the theoretical model. The long-run effects, although small, are positive which is consistent with the theoretical model.

The long-run reactions of inflation to positive supply, real private demand and nominal shocks are consistent with our theoretical model results. According to our theoretical model, the long-run reaction of inflation to a positive productivity shock depends on two opposing forces. Productivity has an ambiguous effect on inflation because it can induce a change in real output and a change in real demand. The rise in demand could be direct (via the reaction of investment to the rise in productivity) and indirect as a result of the rise in real output inducing further increases in real private demand. Figure 2 shows that in the short run, inflation falls in response to a positive supply shock (implying the supply effect dominates in the short run) but rises in the long run (implying the direct and induced demand effects dominate in the long run.)

Our theoretical model also implies that, due to prices being set one period ahead, there will be no immediate reaction of actual prices to any of the former disturbances. The SVAR impulse responses show however an immediate change of inflation in response to all four shocks.

There are at least two possible reasons for this result. First, the data are likely be capturing the fact that not all prices are necessarily rigid in the short run. Second, as explained in Section 3, even if most prices are sticky in the short run the average duration of prices for many types of output in New Zealand is significantly shorter than one year (which is the frequency of the data used to estimate the SVAR model). Accordingly, impulse responses based on annual data could be expected to reveal significant price reactions even if many prices are preset.

Forecast Error Variance Decomposition

The relative importance of the contribution of the four shocks to the variance of each endogenous variable can be deduced by decomposing the forecast error variance. Table 4 provides this information and it reveals some interesting results.

In the short run, supply shocks and fiscal shocks account for most of the variance of real GDP. Because of the long-run identifying restriction, the relative importance of fiscal shocks declines as the forecasting horizon increases. Supply, fiscal and real demand shocks each contribute about one-third of the variance of real private demand in the short run. The contribution of fiscal and real demand shocks is smaller in the long run. Supply shocks are the dominant source of variation in real private demand in the long run. The variance of inflation is dominated by nominal shocks in the short run and long run, although the importance of supply shocks increases in the long run.

Particularly interesting is the large contribution of fiscal shocks to the variance of the budget balance in the short run and long run. In the short run they contribute about two-thirds of the explanation for the variance of the real budget balance and supply shocks contribute a little under a third. Real private demand and nominal shocks have a negligible influence on the variance of the budget balance. In the long run, over 80 percent of the variance in the real budget balance is explained by fiscal shocks.

5. Stochastic simulations and implied budget targets

The SVAR model satisfactorily captures key properties of the theoretical macro model. The model can therefore be used to generate stochastic simulations to assess the risk of breaching an *ex post* real budget balance target over different time horizons. Each stochastic simulation generates a hypothetical path for the four variables of the model. These hypothetical paths are functions of two determinants: structural disturbances to the economy and the propagation mechanism of the economy.

The process of using the SVAR analysis of historical data to specify those determinants and generate these simulated paths is similar to the process used by Dalsgaard and de Serres (1999). This process involves the following steps:

1. Assuming that the structural shocks to the economy are distributed as $N(0, \Sigma_{\varepsilon})$. That is, structural shocks are mutually independent and are normally distributed. The estimate of Σ_{ε} is obtained from the SVAR estimation explained in section 3;

2. Replacing the third diagonal element of Σ_{ε} with zero in the first simulation so that the variance of the fiscal shock is identically equal to zero. This is to exclude autonomous changes in the real budget balance and to capture the pure effects from induced changes to the real budget balance. These results are shown in Figure 3;

3. Incorporating autonomous changes in the real budget balance in the second simulation by including the impact of fiscal shocks. These results are shown in Figure 4;

4. Assuming that the propagation mechanism of the economy is captured by the estimate of $A(L)$ obtained from the SVAR estimation.

Once the distribution of fundamental shocks and the propagation mechanism of the economy are specified, the stochastic simulation is done through the following steps:

1. Values of simulated structural shocks are drawn randomly, at each time period, from their distribution.

2. The simulated time series of structural shocks, together with the assumed initial values of the variables, are fed into the non-deterministic part of the estimated SVAR system. This generates hypothetical time paths for the four variables. The initial values for all variables are taken to be zero because the procedure simulates the non-deterministic components of the model i.e., the stochastic components which have a mean value of zero.[9]

3. Large numbers (in this case we used 1000) of simulated data sets are generated by repeating steps 1 and 2.

4. For each simulated path of the real budget balance, find the minimum value during a particular time horizon considered.

5. These minimum values are ranked in ascending order to form a distribution for each time horizon.

6. Percentiles calculated from this distribution are used to assign a confidence level that the minimum real budget balance will be reached during that time horizon. For example, the 10^{th} percentile in the distribution can be interpreted as the minimum real budget balance that may be reached with a 90 per cent confidence level.

7. For each confidence interval, if the relevant percentile breaches the specified lower bound by say *x*%, the initial value of the real budget balance is adjusted upward by *x*%. This adjusted initial value of the real budget balance is the *ex ante* real budget surplus required for not breaching the specified lower bound at a given confidence interval during the time horizon considered.

8. Steps 4, 5, 6, and 7 are repeated for various time horizons.

This procedure is equivalent to simulating the response of the non-deterministic or stochastic component of the fiscal balance. The reason is that the simulations show how various macroeconomic shocks are propagated into the stochastic component of the fiscal balance. Accordingly, the simulations show how the budget balance would fluctuate around its trend value in response to unexpected shocks. Therefore, the simulations provide a basis for determining the size of the buffer required in order to avoid unexpected shocks driving the budget balance below some specified lower bound.

The first simulations exclude autonomous changes in the real budget balance. This procedure assumes that while supply, private demand and nominal shocks are assumed to be independent of fiscal policy, fiscal shocks are at the discretion of Government. The results for different time horizons and levels of confidence are shown in Figure 3. They can be interpreted as follows. Suppose the fiscal target the government wishes to achieve with 95 percent confidence is a lower bound of zero for the real budget balance. According to

[9] This means that the results are not dependent on the stage of the business cycle.

Figure 3, the average annual *ex ante* budget balance for New Zealand should therefore be set at a surplus of 1.5 percent of GDP if the fiscal planning horizon is one year. As the planning horizon is extended to two years the appropriate average annual *ex ante* surplus rises to approximately 1.8 percent of GDP, for three years it rises to 2 percent of GDP, and for a five-year horizon it increases to about 2.3 percent of GDP.[10]

The appropriate *ex ante* budget surplus increases as the planning horizon increases because the probability of adverse shocks to the real budget balance increases and the propagation process becomes more pronounced as the planning horizon is extended outward. Similarly, as the desired probability of not breaching a lower bound for the budget balance is raised, the appropriate *ex ante* budget surplus is increased.

These results for New Zealand are comparable to results obtained by Dalsgaard and de Serres (1999) who used a similar procedure to estimate appropriate budget targets for several EU countries. The purpose of their exercise was to determine the budget balance target that would ensure, at a given probability, that the three percent deficit limit required by the Maastricht Treaty was not breached over a particular time horizon.

By appropriate scaling of the Dalsgaard and de Serres results we can deduce their implied *ex ante* budget surpluses required to ensure, for a given confidence level, that a zero lower bound for the budget balance is not breached. For example, the results estimated for the UK using bi-annual data for the period 1965 to 1996 and for a 95 percent confidence level are approximately: 2 percent for a one-year planning horizon; 3.5 percent for a three-year planning horizon; and 4 percent for a five-year horizon. Corresponding results for Germany (estimated using data from 1961 to 1997) are: 1.8 percent for a one-year planning horizon; 2 percent for a three-year planning horizon; and 2.5 percent for a five-year horizon. For Austria (estimated using data from 1966 to 1995): 1.5 percent for a one-year planning horizon; 2.2 percent for a three-year planning horizon; and 2.5 percent for a five-year horizon.

Our results can also be used to derive the probability that the net cash flows from operations forecast by governments, such as in the *Budget Economic and Fiscal Update,* will not breach a zero floor. For example, the forecast for the net cash flow from operations for the year ended June 2001 is NZ$1,089 million or approximately 1.0 percent of GDP. From Figure 3, this cash flow has an approximately 85 percent probability of not breaching a zero floor for the year to June 2001. The *ex ante* forecast for the net cash flow from operations for the year to June 2002 is NZ$2,351 million or approximately 2.0 percent of GDP. This implies that the mean net cash flow from operations for the two years to June 2002 is approximately 1.5 percent of GDP [i.e., (1 + 2)/2]. Figure 3 indicates therefore that on the basis of the current budget forecasts for the two years to June 2002, there is approximately a 90 percent probability that the average annual net cash flow from operations will not be less than zero for the two-year period.

The second set of simulations incorporates fiscal shocks and therefore it <u>includes</u> autonomous changes in the real budget balance. The forecast error variance decomposition shown in Table 4 showed that the presence of fiscal shocks was the dominant explanation of the variance for the real budget balance. We can therefore expect the inclusion of fiscal shocks to have a significant influence on the *ex ante* budget balance targets compared to those derived in the first simulations, which excluded fiscal shocks. The results for different time horizons and levels of confidence are shown in Figure 4. They confirm our expectation.

[10] The different time horizons are in reference to the duration of time under which the corresponding simulation is performed. For example, if the planning horizon is 2 years, an *ex ante* budget surplus of 1.8 percent of GDP means that the average annual balance should be 1.8 percent for the two-year period. It does not mean that the budget surplus must be maintained at 1.8 percent throughout the entire two-year period.

The probability that the net cash flow from operations forecast by governments will not breach a zero floor, when fiscal shocks are included, can be deduced from Figure 4. The inclusion of a fiscal shock lowers the probability of not breaching a zero floor. Without fiscal shocks, Figure 3 implied there was an 85 percent probability of the net cash flow from operations for the year ended June 2001 not breaching a zero floor. With fiscal shocks included, Figure 4 implies that this probability is now 69 percent. Figure 3 also suggested that there was a 90 percent probability of the net cash flow from operations for the two years to June 2002 not breaching a zero floor. Figure 4 suggests this probability falls to 66 percent when fiscal shocks are included.

The acceptability of incorporating fiscal shocks will depend, as is assumed for the other shocks, on whether past unexplained fiscal changes are likely to be representative of the type of fiscal shocks that could occur in the future. The introduction of the Fiscal Responsibility Act 1994 may render that assumption invalid if it has significantly changed the way in which fiscal policy decisions are made.

Incorporating fiscal shocks generates substantially larger *ex ante* budget balance targets required to avoid a budget deficit for a given level of probability. For example, by including fiscal shocks, the *ex ante* budget balance required to avoid a budget deficit at 95 percent level of confidence over a one-year planning horizon, increases from a surplus of 1.5 percent of GDP to over 3 percent of GDP. For a two-year horizon, the *ex ante* surplus increases from approximately 1.8 percent of GDP to 4 percent of GDP and for a five-year horizon it increases from 2.3 percent to about 5.3 percent of GDP.

6. Conclusions

This paper endeavours to tackle a practical fiscal management problem. If government wants to allow automatic fiscal stabilisers to operate unimpeded over some specified future time horizon (such as the length of a business cycle for example) without breaching some lower or upper bound for the fiscal balance (such as any bound implied by the Fiscal Responsibility Act for example), it needs to set fiscal parameters and the *ex ante* budget balance to take into account the potential impact of possible future exogenous shocks to the budget balance. This paper develops a procedure for identifying the probability of future shocks to the budget balance, their impact on the budget balance, and the size of the *ex ante* budget balance that will satisfy that requirement.

The approach used in this paper is to estimate a structural vector autoregressive (SVAR) model of components of the New Zealand economy and the fiscal balance to quantify the likelihood of different shocks to the economy, based on the last 30 years experience, and to give an overall assessment of the *ex ante* cash budget position that should be targeted, in order to absorb potential shocks without breaching a particular lower bound for the budget balance. The size of the *ex ante* budget cash position will depend on the fiscal planning horizon and on how certain the policy maker wishes to be that potential shocks will be able to be absorbed without breaching the specified lower bound. It will also obviously depend on the specified size of the lower (or upper) bound for the budget balance.

The degree of certainty is based on the frequency and magnitude of past supply, fiscal, real private demand and nominal shocks to the New Zealand economy, and the historical responses of macroeconomic variables to these shocks. There are several potential directions in which this paper could be further developed that may improve the accuracy of identifying the probability of shocks, their impact on the budget balance, and the appropriate *ex ante* fiscal stance. These include a more explicit treatment of open economy features, separation of the government expenditure and revenue components of the budget balance function, and the inclusion of a government debt function that interacts with the budget balance function.

A significant step involved in estimating the model in this paper was the derivation of a consistent long-term series for the central government budget balance. This work is discussed in Appendix Two. Similar data problems will need to be overcome before we can incorporate separate government expenditure, revenue and debt functions. In view of the importance of fiscal shocks in explaining the past variance of the budget balance (shown in Table 4) and the likelihood of significant differences in the dynamic impact of government expenditure and revenue changes, this would seem to a priority for future work on this topic. Furthermore, appropriate inclusion of the stock-flow relationship between budget balances and public debt may suggest a different modelling approach to that used in this paper.

The Fiscal Responsibility Act 1994 specifies that operating surpluses must be run to reach a prudent level of debt, and then to maintain that prudent level of debt. Although this paper has primarily concentrated on the level of the *ex ante* budget balance necessary to ensure the *ex post* budget balance is not less than zero, the results can be applied to any lower or upper bound simply by appropriate scaling. This paper does not attempt to determine the appropriate lower bound for the budget balance. Nor does it attempt to determine the optimal level of public debt or public debt to GDP ratio. These are issues for further research. In an operational sense, this paper assists the policy maker to specify the appropriate *ex ante* budget balance, once a desired lower bound for the *ex post* budget balance is derived and specified.

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Appendix One: Data description and source

Year	*GDP*	*RGDP*	*NCFO*	*CI*	*GDP deflator*
1971	5,832	50,653	281	38,739	0.12
1972	6,871	51,942	293	38,864	0.13
1973	7,887	54,244	230	42,293	0.15
1974	9,181	58,136	334	46,593	0.16
1975	10,107	60,479	346	48,452	0.17
1976	11,712	61,497	107	47,291	0.19
1977	14,162	61,586	404	46,365	0.23
1978	14,970	59,992	331	44,271	0.25
1979	16,958	60,115	-356	44,439	0.28
1980	19,795	61,649	-90	46,153	0.32
1981	22,992	62,312	-535	45,905	0.37
1982	27,891	65,374	-586	48,300	0.43
1983	31,409	65,793	-929	47,670	0.48
1984	34,839	67,595	-1,706	49,358	0.52
1985	39,346	70,929	-1,386	52,501	0.55
1986	45,282	71,476	-361	53,120	0.63
1987	54,725	72,973	-1,010	54,777	0.75
1988	61,641	73,275	-396	56,778	0.84
1989	66,454	72,989	-164	57,083	0.91
1990	70,773	73,607	-332	58,180	0.96
1991	72,248	73,174	-1,861	57,196	0.99
1992	72,278	72,278	-2,021	54,935	1.00
1993	74,578	73,124	-1,201	55,710	1.02
1994	80,824	77,740	1,259	59,727	1.04
1995	86,556	81,920	3,490	64,733	1.06
1996	91,461	85,016	4,233	68,468	1.08
1997	94,940	87,211	2,720	71,272	1.09
1998	98,025	88,949	1,803	72,955	1.10
1999	98,913	88,923	392	73,692	1.11

GDP = Nominal GDP (NZ$m), March year, production based; Statistics NZ.

RGDP = Real GDP (NZ$m), March year, production based, 1991/2 prices; PC Infos, Statistics NZ, series SNBA.S2AZAT.

NCFO = New Zealand central government net cash flow from operations (NZ$m), March year up until 1989, June year from 1990 to 1999. See Appendix Two.

CI = Sum of real private consumption (C) and real private investment, (I) (NZ$m), March year. C is from Dalziel and Lattimore (1999), Data appendix p. 126, updated with PC Infos, Statistics New Zealand, series SNBA.S3AG. I is from Dalziel and Lattimore (1999), Data appendix p. 127, updated with series constructed from data from PC Infos, Statistics New Zealand, series SNBA.S3AI, SNBA.SDB, SNBA.SDC, SNBA.SDD.

GDP deflator = GDP/RGDP

Appendix Two: Derivation of the fiscal balance variable

The Fiscal Responsibility Act 1994 states that a government must achieve operating surpluses every year until a prudent level of debt is achieved. The emphasis on "operating surplus," implies a government must attain surpluses from its regular, day to day activities. Sales of assets and capital spending are not classified as being part of the Crown's operating activities. Hence, although a government can reduce debt from the sale of assets, this inflow of funds does not preclude the need to run an operating surplus if it is to satisfy the requirements of the Fiscal Responsibility Act.

The Crown's operating results are presented in the Statement of Financial Performance, which summarises revenue earned and expenses incurred by the Crown. The difference between total revenue and total expenses, plus the net surplus from state-owned enterprises and Crown entities, is the operating balance for the period. The operating balance is calculated in compliance with generally accepted accounting practice (GAAP), and is thus produced on an accrual basis. That is, transactions involving revenue and expenses are recorded when they occur, rather than when the resulting cash flow occurs. It could therefore be argued that an accrual basis for reporting results in a more complete picture of the underlying fiscal position, especially if significant variations occur in the timing of cash receipts and payments.

The New Zealand Treasury has only calculated the operating balance since 1992. This is due to the change to the accrual basis of accounting on 1 July 1991. Prior to this date, all transactions were measured using the cash basis of accounting. Calculating a consistent measure of the operating balance on an accrual basis prior to 1992 is not feasible, because of the significant differences in the bases of accounting for transactions. Indeed, the format of the Crown's Financial Statements prior to the adoption of accrual accounting was very different. The current three core financial statements, the Statement of Financial Performance, Statement of Financial Position, and Statement of Cash Flows, were not prepared. Budget tables were primarily focused on calculating the cash deficit or surplus before borrowing transactions (the Table 2 balance). However, since the net cash flow from operations has been published in the Crown's Financial Statements since the change in accounting policy in 1991, it is possible to derive a cash based measure of the Crown's operating balance for the entire sample period since 1971.

Therefore, the choice of fiscal variable for the purposes of this paper is the net cash flow from operations. While the operating balance is an accrual measure of the surplus from the Crown's operations, net cash flows from operations is a cash measure of the surplus from the Crown's operations. A reconciliation of the operating balance and net cash flows from operations is provided in the Crown's Financial Statements.

The main items in the reconciliation are for items that are included in the operating balance, but not in net cash flows from operations. These items include valuation changes (such as unrealised net foreign exchange gains), physical asset movements (specifically depreciation and the loss on sale of physical assets) and movements in working capital.

The earlier Table 2 balance, the deficit or surplus before borrowing, included flows of funds resulting from the Crown's investing activities and some financing activities, in addition to its operating activities. To obtain net cash flows from operations, it is necessary to exclude the non-operating activity flows.

Relationship between Table 2 balance and net cash flows from operations

Deficit/surplus before borrowing (Table 2 balance)
Add: Lending minus repayments
Equals: Adjusted Financial Balance[11]
Less: *Items included in adjusted financial balance but not in net cash flows from operations*
Sale of physical assets
Less: Purchase of physical assets
Equals: Net cash flow from operations

The table above shows the derivation of the net cash flow from operations from the Table 2 balance. The main items needed to convert the earlier Table 2 balance to net cash flows from operations are lending minus repayments, and the net cash flow from the sale and purchase of physical assets. From 1971 onwards the International Monetary Fund (IMF), in its Government Finance Statistics (GFS) yearbook, calculates these two items.[12] The IMF uses a cash-based system to classify revenue and expenditure into its current and capital flows.

Lending minus repayments is added to the Table 2 balance for the following reason. The Table 2 balance includes the effects of a government making loans to other parties. That is, when an external party repays part of the principal, this is counted as a cash inflow in the Table 2 balance. Alternatively, when a government lends money to an external party, this is counted as a cash outflow in the Table 2 balance. To exclude these balance sheet effects, it is necessary to subtract the repayment cash inflow and to add back the lending cash outflow.

We adjust for items included in the adjusted financial balance, but not in the net cash flow from operations. However, there are also items that are included in net cash flows from operations but not in the adjusted financial balance. These include items such as realised gains from exchange-rate changes, and cash flows from operations attributable to the Reserve Bank. As these items were not separately disclosed in the financial statements prior to 1991, it is not possible to adjust our proxy for net cash flows from operations for these items. However, these items are small in nature, so should not make a significant difference to the overall results.

[11] Strictly speaking, the Table 2 Balance Less Lending minus Repayments equals the Financial Balance. Then the Financial Balance less abnormal items (such as changes in the value of foreign currency assets resulting from exchange rate movements) equals the Adjusted Financial Balance. The financial statements show that such abnormal items were only recorded from 1991 onwards.

[12] Respectively in its Lending minus repayments (C.V) figures and its Gross Fixed Capital Formation figures (C4-A14).

Table 1: Theoretical Impulse Responses

Response of output level

	0	1	…	∞
ε^s	+	+	…	+
ε^f	-	0	…	0
ε^d	+	0	…	0
ε^n	+	0	…	0

Response of real budget balance

	0	1	…	∞
ε^s	+	?	…	?
ε^f	?	+	…	+
ε^d	+	0	…	0
ε^n	+	0	…	0

Response of real private demand

	0	1	…	∞
ε^s	+	?	…	?
ε^f	-	+	…	+
ε^d	+	?	…	?
ε^n	+	0	…	0

Response of inflation rate

	0	1	…	∞
ε^s	0	?	…	?
ε^f	0	-	…	-
ε^d	0	+	…	+
ε^n	0	+	…	+

+ = rise; - = fall in the level of the endogenous variable in response to a positive shock

Table 2: Tests for Unit Roots

Annual
(Augmented Dickey-Fuller t-statistic)

	Level	1st difference
Log of Real GDP	-1.14	-2.96*
Ratio of NCFO to Nominal GDP	-2.12	-4.92**
Log of Private Demand	-0.96	-3.27*
Inflation Rate	-1.77	-5.36**

Lag lengths in the ADF regressions were chosen by the Bayesian information criterion.
Asymptotic critical values are: 1 percent, -3.51; 5 percent, -2.89; 10 percent, -2.58
* Null hypothesis of unit root rejected at 5 percent level of significance, in favour of stationarity
** Null hypothesis of unit root rejected at 1 percent level of significance, in favour of stationarity

Table 3: Model Selection Criteria

Annual, 1976 – 1999

	AIC	HQ
2 lags, constant	6.7278	7.1966
2 lags, constant, trend	6.7783	7.2992
3 lags, constant	6.7225	7.3996
3 lags, constant, trend	6.4212	7.1504

Table 4: Forecast Error Variance Decomposition

Decomposition of Variance for Real GDP

Forecasting Horizon	Supply Shock	Fiscal Shock	Real Private Demand Shock	Nominal Shock
1	52.22	42.95	3.82	1.01
2	62.78	27.63	8.40	1.18
3	66.74	26.17	6.31	0.77
4	76.53	18.32	4.38	0.77
8	89.70	7.50	2.26	0.53
16	94.61	3.85	1.24	0.30

Decomposition of Variance for Real Budget Balance

Forecasting Horizon	Supply Shock	Fiscal Shock	Real Private Demand Shock	Nominal Shock
1	27.38	67.66	0.98	3.98
2	16.31	76.98	3.03	3.69
3	13.23	81.72	2.35	2.69
4	11.77	83.91	1.94	2.39
8	11.54	83.64	2.53	2.29
16	12.97	84.05	1.58	1.40

Decomposition of Variance for Real Private Demand

Forecasting Horizon	Supply Shock	Fiscal Shock	Real Private Demand Shock	Nominal Shock
1	32.35	32.93	32.58	2.14
2	35.58	23.96	39.73	0.73
3	34.95	25.44	38.72	0.88
4	43.97	21.08	33.33	1.62
8	76.81	8.20	13.93	1.06
16	84.26	4.21	10.96	0.56

Decomposition of Variance for Inflation Rate

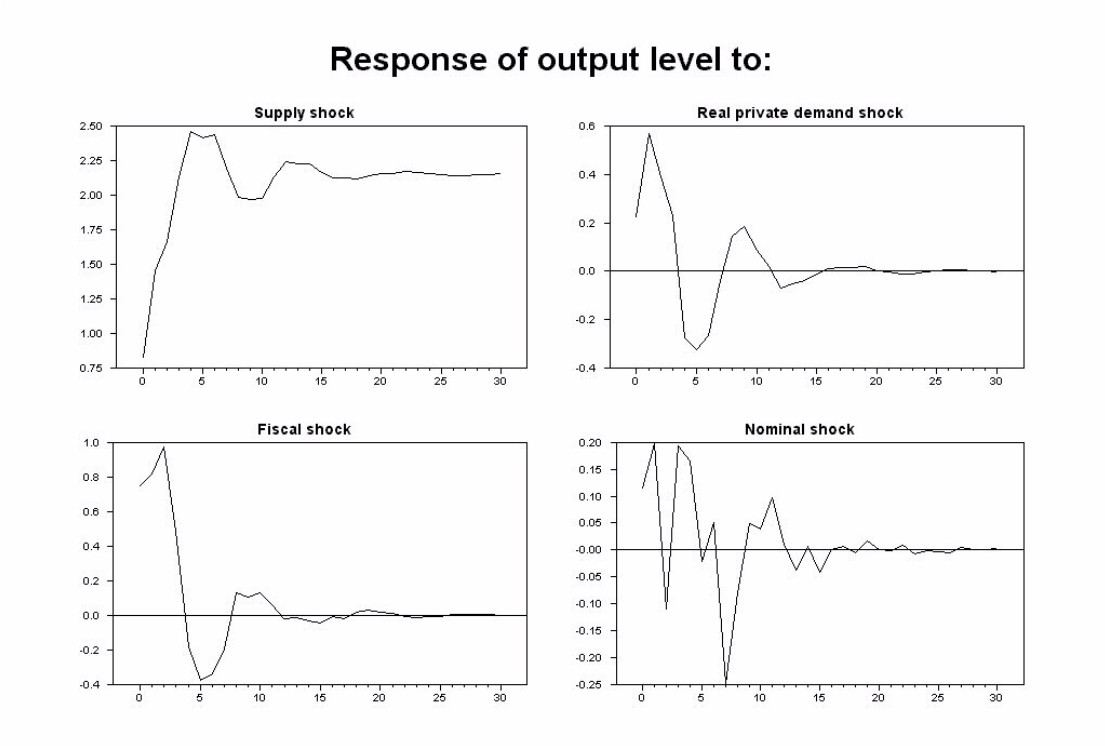
Forecasting Horizon	Supply Shock	Fiscal Shock	Real Private Demand Shock	Nominal Shock
1	5.35	3.76	9.83	81.06
2	3.47	4.06	8.74	83.72
3	5.13	5.79	11.03	78.04
4	12.85	5.38	10.01	71.76
8	21.78	3.83	6.45	67.94
16	24.96	2.31	5.65	67.09

Figure 1: Time-series Observations

New Zealand, Annual, 1971 to 1999

Figure 2: Impulse Response Functions

New Zealand, Annual, 1976 to 1999



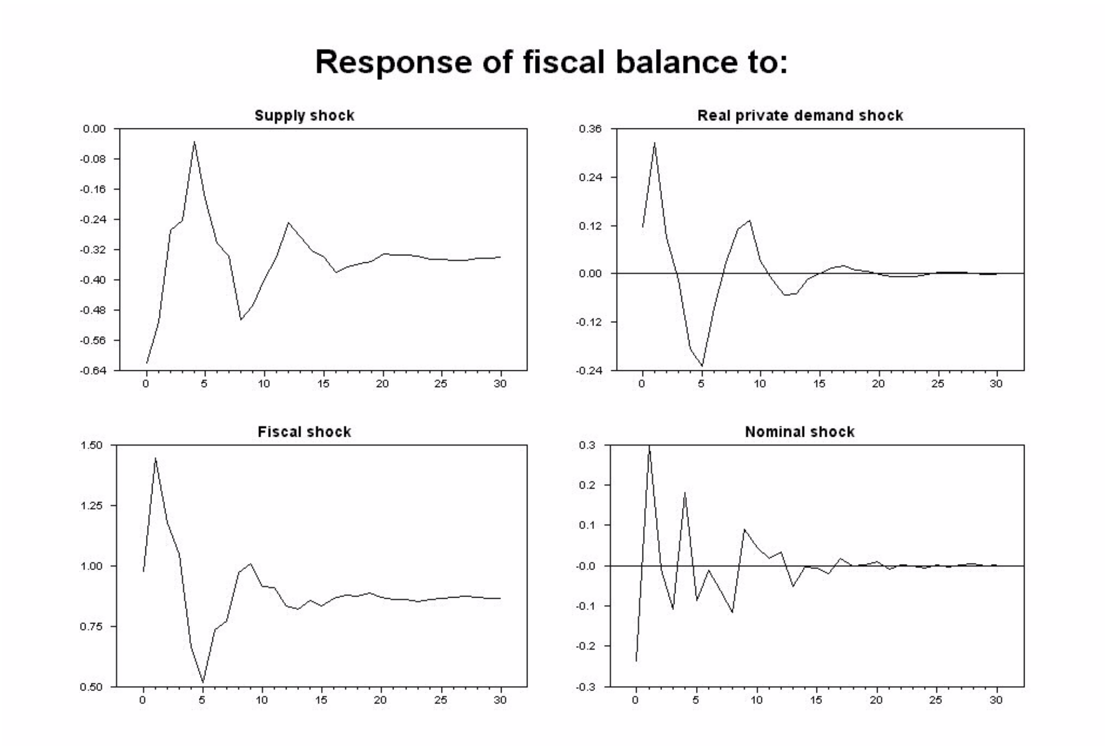
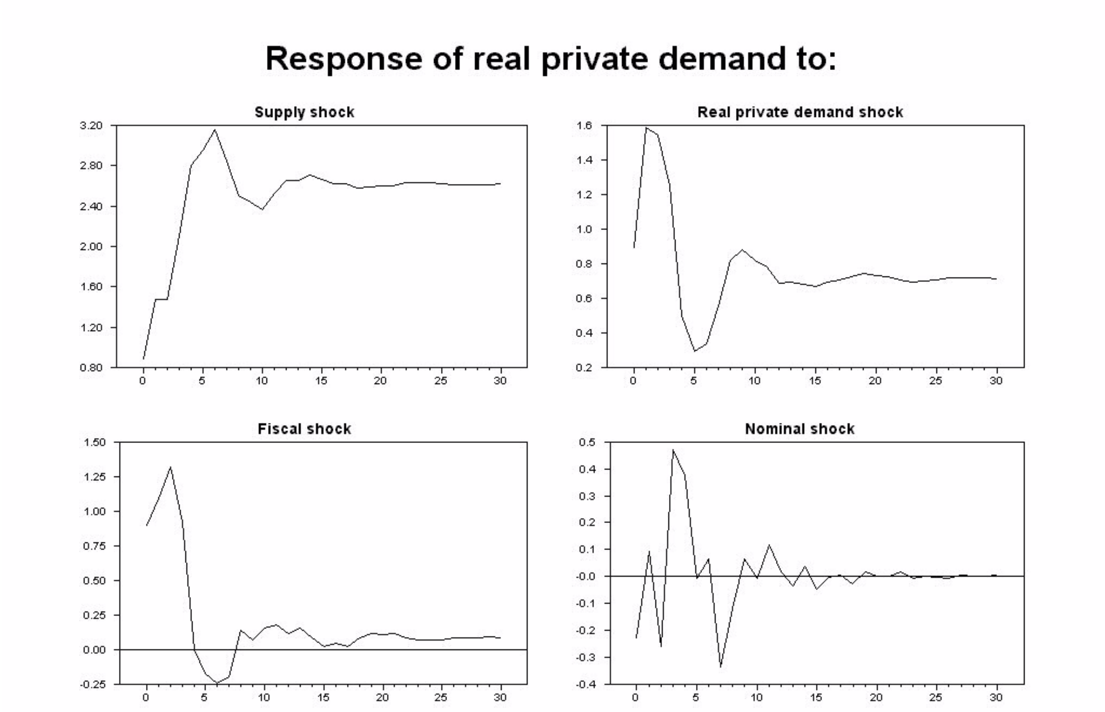


Figure 2 cont.: Impulse Response Functions

New Zealand, Annual, 1976 to 1999



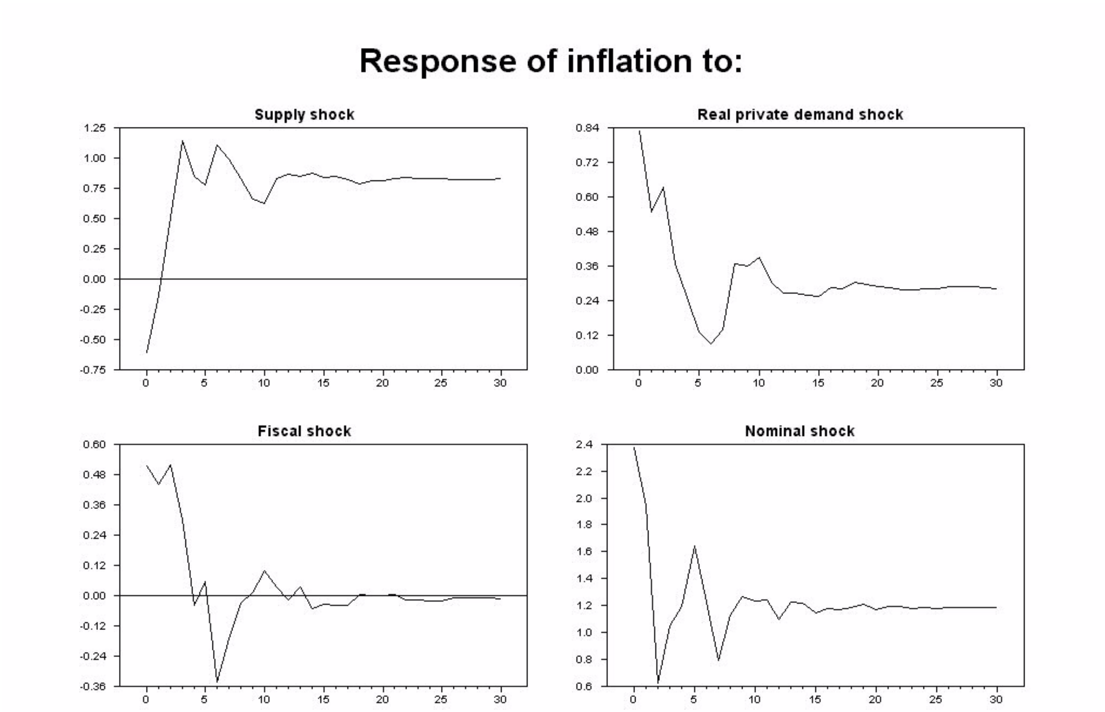


Figure 3: *Ex Ante* Budget Targets: with fiscal shocks excluded

New Zealand, Annual, 1976 to 1999

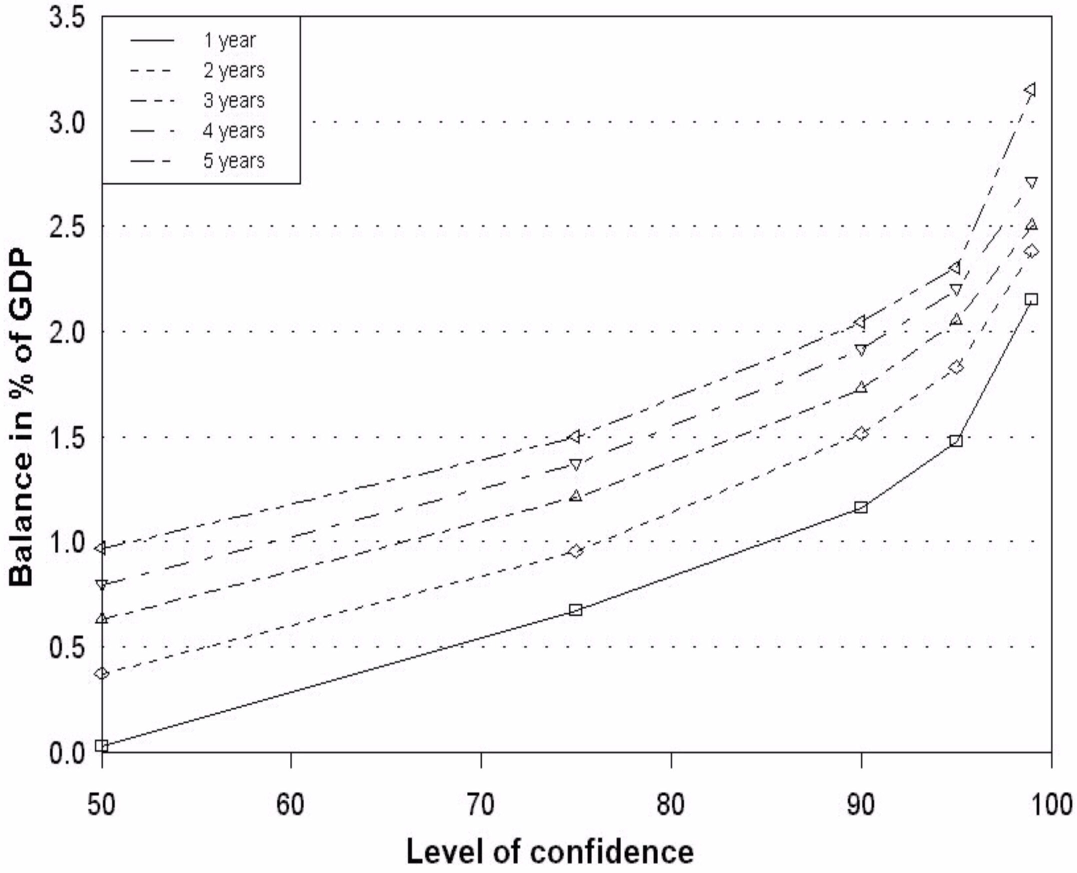


Figure 4: *Ex Ante* Budget Targets: with fiscal shocks included

New Zealand, Annual, 1976 to 1999