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Parameter Uncertainty and the Fiscal Multiplier

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Parameter Uncertainty and the Fiscal Multiplier

Jamie Murray

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Abstract

I present a simple estimated model of the New Zealand economy which is used to assess the sensitivity of the impact multiplier and output losses associated with fiscal consolidations to uncertainty over model parameters. I find that, in normal times, the fiscal multiplier can be expected to lie between 0.1 and 0.5, with a central estimate of 0.3. Uncertainty over the output effects of fiscal tightening can be attributed to several model parameters and it is found that a bad outcome is likely to be worse than a good outcome is to be better – output risks are skewed to the downside. Sensitivity analysis reveals that if monetary policy in New Zealand were to be constrained by the zero-lower bound, the fiscal impact multiplier would rise substantially, consistent with the empirical evidence for other OECD countries in that position.

JEL CLASSIFICATION

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KEYWORDS

Fiscal impact multiplier; Ricardian equivalence; DSGE; SVAR; consolidation; monetary policy; uncertainty; lower bound.

Executive summary

The global financial crisis, which began in 2008, led to a significant deterioration in the fiscal positions of many governments, with a number of advanced economies running structural budget deficits in the years that followed - those expected to remain once the economic cycle has run its course and output has returned to its sustainable level.

Many governments have responded to the deterioration of their fiscal positions by planning large consolidations – usually a mix of spending cuts and tax increases, with most balanced towards the former. A natural question to ask is to what extent might these plans reduce aggregate demand in the economy and, in doing so, slow its cyclical recovery? For the purposes of policy making, it is also helpful to make an assessment of the circumstances under which the effects of fiscal tightening might be more or less severe than expected.

To make this assessment I run fiscal policy simulations using a small estimated model of the New Zealand economy. By varying the parameters of the model I illustrate the sensitivity of estimated output losses to assumptions over the way the economy functions. It is found that uncertainty over the effects of fiscal consolidations can be attributed to a number of model parameters but that some are more important than others.

Of key importance are the degree of monetary activism (how much interest rates can be expected to change in response to a fiscal policy announcement), the responsiveness of demand to changes in the stance of monetary policy and the proportion of those in society who do not change their consumption plans in response to changes in fiscal policy.

I find that the average fiscal multiplier associated with a four-year consolidation in New Zealand is around 0.3, consistent with the findings of Parkyn and Vehbi (2012). Constructing a scenario in which the model parameters mentioned above lie at the unfavourable ends of their distributions causes the average fiscal impact multiplier to rise to 0.5. Furthermore I find that a bad outcome is likely to be worse than a good outcome is to be better – output risks are skewed to the downside. Both estimates lie significantly below those estimated for other advanced economies by Blanchard and Leigh (2013), whose central estimate of the fiscal multiplier is close to unity.

To test whether the differences can be reconciled by monetary policy being constrained by the lower bound of nominal interest rates, I run a scenario in which they are held fixed. I find the estimated fiscal multiplier rises significantly, consistent with the empirical evidence for a number of OECD economies presented by Blanchard and Leigh.

The policy implications of this work are that fiscal policy makers should be sensitive to the prevailing economic environment when determining the fiscal stance, particularly when interest rates are close to the zero-lower bound, and work closely with central banks if the worst outcomes are to be avoided.

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Parameter Uncertainty and the Fiscal Multiplier

1 Introduction

The global financial crisis, which began in 2008, led to a significant deterioration in the fiscal positions of many governments, with a number of advanced economies running substantial budget deficits in the years that followed. Because much of the loss of output associated with the financial crisis is judged to be permanent, this has led to governments running persistent structural deficits – those expected to remain once the economic cycle has run its course and output has returned to its steady-state growth path.

Many governments have responded to the deterioration of their fiscal positions by planning large consolidations – usually a mix of spending cuts and tax increases, with most balanced towards the former. A natural question to ask is to what extent might these plans reduce aggregate demand in the economy and, in doing so, slow its cyclical recovery? Besides explaining the origins of the financial crisis and the implications for policy settings, answering this question has become one of the major focuses of macroeconomists in recent years.

Estimates of the size of the fiscal impact multiplier range widely, as do the techniques used to assess them. Estimation methodologies tend to fall into two categories: the structural vector autoregression (SVAR) approach, pioneered by Blanchard and Perotti (2002), and dynamic stochastic general equilibrium (DSGE) modelling, as recently applied by Davig and Leeper (2011). The former approach draws inferences from statistical relationships identified in the data. To reveal the underlying relationships, a number of assumptions about the way the economy functions are applied during the estimation process. The DSGE approach involves the specification of a model, derived from economic theory, and the calibration of that model's parameters either via estimation or through the application of judgement. The size of the impact multiplier is then derived from the simulation properties of the model.

During the financial crisis, the IMF (2008) published estimates of the size of fiscal impact multipliers for a number of advanced economies, which averaged around 0.5. Using a DSGE approach, Mountford and Uhlig (2002), also find the multiplier to be around 0.5. While the original SVAR estimate of Blanchard and Perotti (2002) is consistent with an impact multiplier of around unity. Another approach, recently applied by Blanchard and Leigh (2013), has been to decompose forecast errors made during periods of fiscal retrenchment into the part related to exogenous shocks and the part related to the assumed fiscal impact multiplier. The estimate associated with this method is consistent with a fiscal impact multiplier of around unity.

Iizetzki et al (2011) apply the SVAR methodology using a large data set which includes a number of economies with different characteristics. They find that the multiplier depends critically on the degree of development, the monetary policy framework and the degree of openness. Crucially, their estimate of the multiplier is not significantly different from zero for countries with a flexible exchange rate and they find the multiplier is smaller for more open economies.

Corsetti et al (2012) also find that the monetary policy and exchange rate regime are important in determining the effect of fiscal policy. But the exchange rate is found to appreciate in response to a positive government spending shock. In most models, the exchange rate plays a stabilising role by boosting output at times of fiscal tightening by bringing about a fall in the relative price of domestically-produced goods. The finding calls into question the assumed transmission mechanism and role of the exchange rate. New Zealand is a small open economy with a flexible exchange rate. Taking an SVAR approach, Parkyn & Vehbi (2013) find a statistically significant impact multiplier of 0.3 associated with a change in government spending, rising to 0.6 when debt dynamics are excluded.

The only conclusion one can safely draw from the expansive literature on the subject is that the size of fiscal multipliers are extremely uncertain. But policy makers need to have some view about the likely effects of discretionary fiscal policy and what the risks surrounding it are. With this in mind, I ask ‘Under what conditions might the impact of a fiscal tightening be bigger or smaller?’

To answer this question I estimate a small, reduced-form model of the New Zealand economy, using Bayesian methods. I then conduct fiscal policy simulations by varying a number of the key model parameters and assess the output effects using two metrics. The first is the fiscal impact multiplier, which represents the degree to which a fiscal consolidation might slow GDP growth and widen the output gap.¹ But to explore the broader effect on social welfare, I also consider the cumulative output loss associated with a fiscal tightening. This takes into account both the degree to which a consolidation might reduce output and the time it takes to return to its steady state growth path. The intention is to give a quantified estimate of the risks associated with fiscal consolidations based on the degree of uncertainty about the way the New Zealand economy functions.

The remainder of this paper is structured as follows. I discuss the choice of modelling methodology in Section 2, before explaining the theoretical underpinnings governing the dynamics of the model. Section 3 is concerned with the estimation of the model, including the choice of priors. Section 4 sets out the key findings of the fiscal consolidation simulations before Section 5 assesses the implications of the results for policy making. Section 6 concludes.

¹ In this paper the fiscal impact multiplier is defined as the change in the output gap over a period of one year associated with a 1 per cent of potential GDP fiscal tightening.

2 A small model of the New Zealand economy

There are a number of ways in which to develop a model of the economy, the suitability of which depends upon its intended use. One type of modelling method is the DSGE approach, referred to above. Such models, often used by central banks, are typically quite large and strictly adhere to the prescriptions of their microeconomic foundations. That is to say that, whether it's a model with three equations or twenty, the laws of motion of the economy are governed by the optimising behaviour of agents operating within it. DSGE models tend to fall into two categories – real business cycle models, which treat all deviations from steady state as optimal responses to shocks, and, so-called, New Keynesian models, which attribute some of the deviation to nominal rigidities. The model presented here can be considered a reduced-form version of the latter.

The strength of micro-founded models is that the equations are based on optimising behaviour and so should be robust to changes in policy – the dynamics of the model are driven by 'deep' or structural parameters.² However, models featuring forward-looking equations tend to underperform simple autoregressive models and, quite often, little empirical support is found for the hypothesised underlying relationships.³ This is partly because many of the variables move with a degree of inertia that is inconsistent with the adjustment paths implied by forward-looking, rational expectations models. In these models, it is the rational but immediate adjustment of households' expectations to innovations which implies jump responses, which are rarely seen in the data. To overcome this problem, many DSGE models feature adjustment costs and other mechanisms introduced with the intention of replicating the inertial responses of the data.

All economic models are misspecified, since they represent a simplification of reality. And while the model presented in this paper is deliberately small, with the objective of parsimony and tractability in mind, it is also likely to be particularly prone to misspecification. Recognising this, I attach structural interpretations only loosely to the parameters of the reduced-form model, since many of them capture broader influences on the variables to which they pertain.

The four key variables of interest are the output gap, bank rate, the inflation rate and the real exchange rate; given by the investment-saving (IS), Taylor, Phillips and real uncovered interest parity (RUIP) relations respectively. In what follows, I present the baseline functional forms adopted for the core equations and identify where the assumptions are consistent with the microeconomic theory upon which they are founded and how that translates into the functional form of the reduced-form model. For reference, a complete set of the equations that constitute the model can be found at the end of this section and descriptions of the data used to estimate are presented in the annex.

² As opposed to being based on statistical relationships identified in the data, which may not be stable over time – Lucas (1976).

³ See Fuhrer and Rudebusch (2004).

2.1 IS relation

The IS equation relates output in the economy to deviations of the real interest rate from the level consistent with stable output and inflation in the medium term. Equations of this form are a staple of macroeconomic modelling and appear, in some form, in all New-Keynesian models.

The standard forward-looking consumption IS relation is given by,

$$c_t = \alpha_c c_{t+1|t} - \alpha_r r_t + \varepsilon_t^c. \quad (2.1)$$

$$\text{Where } r_t = i_t - \pi_{t+1|t} \quad (2.2)$$

Equation 2.1 represents the baseline consumption Euler equation that arises from the representative household's optimisation problem. It has been log-linearised around its steady state so c_t represents the deviation of consumption from its steady-state growth path, $c_{t+1|t}$ is the expected deviation of consumption from its steady state, conditioned on information available at time t , r_t is the real interest rate gap and ε_t^c is an independent, identically-distributed consumption shock. The nominal interest rate and expected rate of inflation are given by i_t and $\pi_{t+1|t}$ respectively.

The consumption Euler equation simply states that, in equilibrium, the representative household is unable to increase its utility by shifting consumption between periods – that is, the marginal utility of consumption today is balanced with the discounted marginal utility of consumption tomorrow.

Such an equation implies the immediate adjustment of output as households update their expectations. In practice, consumption appears to react quite slowly to changes in interest rates, for example, and a number of studies attempt to explain this behaviour. One such endeavour is the habit formation model of Fuhrer (2000). Fuhrer postulates that the utility derived from consumption depends both on the absolute level of consumption and the level of current consumption relative to past consumption – that households do not like consuming less than they have been and initially resist changes, before eventually adjusting. This modification was shown to substantially improve the fit of the model.⁴

Other work, predominantly concerned with why the behaviour of consumption appears to invalidate the permanent income hypothesis, such as Muellbauer (1988), suggests that households may be myopic in their consumption choices. Campbell & Mankiw (1989) offer the hypothesis that households do not have the resources to engage in producing full forecasts and so it is optimal for them to use a rule of thumb when updating their consumption plans in response to income shocks.

That lagged output improves the fit with the data is important, but whether one accepts the habit formation story, the rule of thumb hypothesis or simply assumes that households are less forward-looking than is often suggested, is less important for the specification of the IS relation. In empirical work, an assumption of habit formation or myopia in household consumption choices is not uncommon and both Batini & Haldane (1999) and Smets & Wouters (2003) allow for it in their respective models of the UK and the euro area

⁴ See, for example, Giannoni and Woodford (2003) for a formal derivation of the habit formation-augmented NKIS relation.

economies. Indeed, neither Carlin & Soskice (2010) nor Ryan & Szeto (2009) include expected output in their baseline IS relations for the UK and New Zealand respectively.

With this in mind, I introduce persistence to the output gap process by assuming a degree of external habit formation in consumption (given by α_c) – while acknowledging that the true source could be myopia, rule of thumb behaviour or a failure of rational expectations, resulting in an equation of the form,

$$c_t = \alpha_c c_{t-1} + (1 - \alpha_c) c_{t+1|t} - \alpha_r r_t + \varepsilon_t^c. \quad (2.3)$$

To capture the effect of discretionary fiscal policy on the economy I allow for the possibility of non-Ricardian behaviour, in a similar way to Ratto et al (2006). Ricardian behaviour states that, faced with a reduction in taxes, for example, households will tend to save the associated additional income since they know it heralds higher taxation or lower spending in the future. The effect on permanent incomes is zero and, therefore, so is the output response. In this model I allow for non-Ricardian behaviour by specifying the proportion of households who are affected by discretionary fiscal policy.

The consumption of Ricardian households does not respond to changes in public spending and taxation so changes in the fiscal balance do not feature in the consumption equation and this is given by the standard IS relation presented in 2.4, but Ricardian consumption is denoted by a superscript R.

$$c_t^R = \alpha_c c_{t-1}^R + (1 - \alpha_c) c_{t+1|t}^R - \alpha_r r_t + \varepsilon_t^c. \quad (2.4)$$

Non-Ricardian households spend all the additional income/reduce consumption by the full extent of the fiscal tightening and so the change in the fiscal stance is introduced to the consumption equation, where f_t represents the fiscal impulse – a similar measure to the change in the cyclically-adjusted budget balance,⁵

$$c_t^{NR} = \alpha_c c_{t-1}^{NR} - (1 - \alpha_c) c_{t+1|t}^{NR} - \alpha_r r_t + f_t + \varepsilon_t^c. \quad (2.5)$$

The proportion of non-Ricardian households is indexed by the parameter, α_{NR} , giving rise to the aggregate consumption equation

$$c_t = (1 - \alpha_{NR}) [\alpha_c c_{t-1}^R + (1 - \alpha_c) c_{t+1|t}^R - \alpha_r r_t + \varepsilon_t^{Rc}] + \alpha_{NR} [\alpha_c c_{t-1}^{NR} - (1 - \alpha_c) c_{t+1|t}^{NR} - \alpha_r r_t + f_t + \varepsilon_t^{NRc}]. \quad (2.6)$$

Separating out the term capturing the change in the fiscal stance,

$$c_t = (1 - \alpha_{NR}) [\alpha_c c_{t-1}^R + (1 - \alpha_c) c_{t+1|t}^R - \alpha_r r_t + \varepsilon_t^{Rc}] + \alpha_{NR} [\alpha_c c_{t-1}^{NR} - (1 - \alpha_c) c_{t+1|t}^{NR} - \alpha_r r_t + \varepsilon_t^{NRc}] + \alpha_{NR} [f_t], \quad (2.7)$$

and then aggregating the remaining Ricardian and Non-Ricardian terms gives:

$$c_t = \alpha_c c_{t-1} + (1 - \alpha_c) c_{t+1|t} - \alpha_r r_t + \alpha_{NR} f_t + \varepsilon_t^c. \quad (2.8)$$

⁵ This is defined as the change cyclically-adjusted budget balance plus the change in the level of capital expenditure as a share of GDP. A full methodology for the construction of the data set can be found in Philip & Janssen (2002). Broadly, this measure is intended to capture the change in the fiscal position arising from discretionary policy measures.

Based on its structural interpretation, the indexing coefficient, α_{NR} , should be bounded by 0 and unity. But there how much output changes in the short run for a given discretionary policy measure may depend on the precise policy package. There are several ways to bring about a structural adjustment in the public finances. These include revenue measures, such as consumption or income tax changes, and spending measures, such as changes in departmental expenditure or welfare policies. In practice, each of these measures is likely to be associated with a different multiplier, since they tend to affect different groups in society, for example. In this sense, households, in aggregate, might be less ‘Ricardian’ in their response to some measures than to others.

A comprehensive analysis would estimate different α_{NR} parameters for different types of policy measure. This would not be practical here, since I focus only on New Zealand and the time series with which I am working are relatively short. There simply is not enough variation in the series to provide reliable estimates at a granular level. Instead, I focus on the overall (average) fiscal impact multiplier and use changes in the government’s cyclically-adjusted budget balance to estimate its size. This is consistent with the estimated parameter relating to the direct effects of a fiscal policy package of average composition.

Furthermore, because the effects of fiscal policy on the net trade position are not explicitly articulated in the model, the effects of such ‘leakages’ are reflected in the estimate of the parameter α_{NR} . In what follows, I describe this coefficient as the degree of non-Ricardian behaviour but readers should be aware that, due to the reduced-form nature of the model, this parameter captures more than this structural parameter alone – another way to think of it may be as the direct fiscal impact multiplier, before any offset from monetary policy, for example.

In this model, the fiscal policy stance is determined exogenously and follows an autoregressive process,

$$f_t = \zeta_f f_{t-1} + \varepsilon_t^f . \quad (2.9)$$

To get from the consumption Euler equation to the IS equation I assume that the behaviour of the consumer can explain whole-economy behaviour. This is a common assumption in small models of the economy but is not completely satisfactory given, in particular, the contribution of business and inventory investment to the cyclical volatility of output.

Without deriving the behaviour of firms explicitly from microeconomic foundations here, it suffices to say that the change in output associated with firms’ responses to changes in real interest rates is in the same direction as that implied by the response of households. Intuitively, if the real rate of interest falls, this lowers the cost of borrowing and increases the overall rate of return of an investment project. Therefore, any profit-maximising firm has a greater incentive to invest.⁷

There are a number of extensions to these simple theories, which highlight the role of uncertainty and irreversible costs in the investment decision - see Leahy & Whited (1995)

⁶ This specification is intended to account for the autocorrelation introduced by interpolating annual fiscal data

⁷ Tobin’s q theory of the investment decision, Tobin (1969), operates in a similar way. Lower expected interest rates decrease the rate at which income streams are discounted, increasing the valuation of companies’ net assets. When the market value of assets exceeds the book value, there is a profit opportunity and companies expand their investment until such a time that book prices are equal to market prices.

and Pyndick & Solimano (1993), for example. Like habit formation in consumption, these extensions serve to increase the persistence of the model. While these theories are not articulated within the modelling framework here, the cyclical nature of business investment and its contribution to output volatility should already be captured by the reduced-form parameters of the IS relation.

Aggregating the consumption Euler equation to the whole economy level gives equation 2.10. In the spirit of Gali & Monacelli (2005), I also include a term for changes in the trade-weighted real effective exchange rate, which is intended to capture the effect on output of changes in relative prices which serve to shift the allocation of resources to and from the export-facing sector,

$$y_t = \alpha_y y_{t-1} + (1 - \alpha_y) y_{t+1|t} - \alpha_r r_{t-1} - \alpha_q \Delta q_{t-1/t-4} + \alpha_{NR} f_t + \varepsilon_t^y. \quad (2.10)$$

y_t is the output gap, $y_{t+1|t}$ is the expected output gap at time t and r_{t-1} is the real interest rate gap, Δq_{t-1} is the change in the lagged real expected exchange rate gap and ε_t^y is an independent and identically-distributed aggregate demand shock. I include four lags of the change in the real exchange rate to allow output to respond slowly to changes in relative prices.

2.2 The Phillips curve

The New Keynesian Phillips Curve (NKPC) relates current inflation to expectations of future inflation and marginal cost pressures. That the inflation process is forward-looking follows from the price-setting behaviour of firms, which is assumed to follow Calvo (1983). The basic premise is that in each period a firm has a fixed probability that it will keep its prices unchanged, so firms set prices now with a view to the future because they know that they may not be able to change their prices in the subsequent period.⁹ The probability of changing/not changing price each period is independent of the time elapsed since the firm last changed its price, and this attribute simplifies the aggregation of individual firm behaviour to the whole-economy level. This gives an equation of the form,

$$\pi_t = \beta_\pi \pi_{t+1|t} + \beta_y y_t + \varepsilon_t^\pi \quad (2.11)$$

where π_t is the rate of inflation and $\pi_{t+1|t}$ is the expectation of inflation conditioned on information available at the current time.

I assume that real marginal cost pressures drive the inflation process, consistent with Gali & Gertler (1999) and that these cost pressures are well-represented by the output gap, y_t . There are other measures which could be used – Batini et al. (2005) use the labour share of income in their estimate of the Phillips curve, which has the advantage of being directly observable.¹⁰ But using the labour share for forecasting with this model would not be possible because it does not capture the evolution of the labour market, so

⁸ See Gali & Monacelli (2005) for a detailed derivation of the open economy IS curve under domestic inflation targeting.

⁹ Note that this probability is independent of the general level of inflation. This seems unlikely, and has implications for the model, such as the potential non-neutrality of money.

¹⁰ It is also the case that, under certain assumptions, the labour share (the average product of labour) is proportional to real marginal cost in an economy characterised by a Cobb-Douglas production function.

the output gap is preferred. The error term, ε_t^π , is an independent, identically-distributed inflation shock.

As with the IS relation, the purely forward-looking version of this equation fits the data poorly – failing to capture the observed inertia of inflation. The equation specification implies that persistence in either movements in the output gap or changes in inflation expectations could produce an inertial path for inflation, but leaves open the possibility of large jumps. It also implies that inflation should lead the output gap, which is the opposite of what we observe in the data; both empirical evidence and conventional wisdom suggests that monetary policy affects inflation only with a lag, rather than instantaneously.¹¹

A model that does not adequately capture the persistence of inflation would not fit the data and have misleading simulation properties. Therefore, in what follows, I relax the restrictive assumption that households and firms are completely forward-looking and anchor expectations of inflation to the middle of the Reserve Bank’s target range.

The hybrid version of the New Keynesian Phillips Curve, used in a number of empirical estimates of the equation (Gali & Gertler, 1999) modifies the standard NKPC formulation by allowing a proportion of firms to use a rule of thumb when setting prices, consistent with a degree of indexation in price setting. This modification provides a theoretical justification for the presence of an inflation lag in the first order condition of the NKPC. Intuitively, the inclusion of lags of inflation serves to act as a proxy for the rational expectation of future values of the driving variable. The resulting equation therefore includes a backward-looking term and a coefficient, β_π , that determines the weight placed on past inflation relative to inflation expectations in the inflation process,

$$\pi_t = \beta_\pi \pi_{t-j} + (1 - \beta_\pi) \pi_{t+j_t} + \beta_y y_{t-j} + \varepsilon_t^\pi. \quad (2.12)$$

The restriction placed on the inflation coefficients summing to unity (effectively imposing a discount factor of one) means that money is super-neutral in this model. It also implies that the coefficient, β_π , can be interpreted directly as the proportion of firms in the economy that set prices in a backward/forward looking manner.

In this paper I take a slightly different approach to the Gali & Gertler set-up and adopt the prior expectation that agents in the economy expect that monetary policy is able to return inflation to target at some time horizon (typically assumed to be around two years). Therefore, I use equation 2.12 and set π_{t+1_t} equal to the inflation target, π^* ,

$$\pi_t = \beta_\pi \pi_{t-j} + (1 - \beta_\pi) \pi^* + \beta_y y_{t-j} - \beta_q \Delta q_{t-j} + \varepsilon_t^\pi. \quad (2.13)$$

To allow for the effect of exchange rate pass-through to prices, I include lags of the change in the real trade-weighted exchange rate.¹² That the Phillips curve can be augmented in this way is demonstrated formally in Batini et al. (2005) and Gali & Monacelli (2005).

Finally, linearising around the target rate of inflation gives the Phillips curve in ‘inflation gap’ terms.

$$\pi_t = \beta_\pi \pi_{t-1} + \beta_y y_t - \beta_q \Delta q_{t-1/t-4} + \varepsilon_t^\pi \quad (2.14)$$

¹¹ See Rudd & Whelan (2007) for a detailed discussion of this point.

¹² It is assumed that the real exchange rate is proportionate to the terms of trade – i.e. that the elasticity of substitution between domestically-produced and foreign goods is equal to unity.

2.3 The real exchange rate

In specifying the dynamics of the real exchange rate, I begin by setting its medium-term anchor. In the long run, the nominal exchange rate is thought to move in such a way that prices between two countries are equalised. That is to say that capital will flow between countries such that relative unit labour costs are equalised and that the relative demand for currency acts to push the nominal exchange rate so that price differentials gradually erode, albeit with a wedge arising from transport costs. Such a medium-term relationship is known as relative purchasing power parity (PPP) where, the nominal exchange rate is given by the ratio of domestic to foreign prices and a permanent wedge. Linearising around this steady state and taking logs gives the long-run PPP steady state condition,

$$e_t = p_t^* - p_t. \quad (2.15)$$

The short-run dynamics of the nominal exchange rate, e_t , are given by the uncovered interest rate parity condition (UIP),

$$e_t = e_{t+1|t} + i_t - i_t^f, \quad (2.16)$$

where the nominal exchange rate gap is given by the expected nominal exchange rate one period ahead and the relative interest rate between New Zealand and a foreign country.

Substituting in the real exchange rate identity, $q_t = e_t + p_t - p_t^*$, gives the real-UIP (RUIP) condition,

$$q_t - (p_t^f - p_t) = q_{t+1|t} - (p_{t+1|t}^f - p_{t+1|t}) + i_t - i_t^f. \quad (2.17)$$

And solving for the real exchange rate gives

$$q_t = q_{t+1|t} + (i_t - \pi_{t+1|t}) - (i_t^f - \pi_{t+1|t}^f) + \varepsilon_t^{qs}. \quad (2.18)$$

Gali & Monacelli (2005) include a similar equation in their open-economy model and convergence with a steady state is achieved by iterating forward, such that the expectations term drops out of the equation. Because they linearise around long-run PPP this is consistent with agents in the economy expecting long-run PPP to hold in subsequent periods. In practise, deviations of the observed real exchange rate from that consistent with long-run PPP can persist for long periods of time and it is thought that convergence with PPP is slow. To allow for this empirical observation I include a convergence parameter, ψ_q , which weakens the pull from the steady state in the short term. Compared with the G&M model, this specification increases the responsiveness of the exchange rate to interest and inflation shocks, consistent with the high degree of volatility associated with the New Zealand Dollar.

Taking the RUIP equation, linearising around long-run PPP and introducing a convergence term gives the equation,

$$q_t = q_{t+1|t} + (i_t - \pi_{t+1|t}) - (i_t^f - \pi_{t+1|t}^f) - \psi_q q_{t-1} + \varepsilon_t^q. \quad (2.19)$$

The equation is based on the notion that, if a real interest rate differential exists, the real rate of return on domestic and foreign assets is equalised by movements in the exchange rate. The assumption of convergence with long-run PPP is consistent with more sophisticated models. For example, in macro-balance models of the exchange rate, short-run dynamics are typically governed by some version of real or nominal uncovered interest parity. But, in the medium term, the real exchange rate moves to stabilise a country's net international investment position.¹³

In this model, foreign interest rates follow an autoregressive process and, in steady-state, are equal to the steady-state domestic nominal interest rate,

$$i_t^f = \zeta_{if} i_{t-1}^f + \varepsilon_t^{if}. \quad (2.20)$$

For the purposes of including changes in the real exchange rate in the IS relation it is necessary to have a forecast of foreign inflation. This too follows an autoregressive process and is assumed to have a steady-state rate consistent with the domestic inflation target, a similar assumption to that made by Carlin & Soskice (2010),

$$\pi_t^f = \zeta_\pi \pi_t^f + \varepsilon_t^{\pi f}. \quad (2.21)$$

Given the share of primary goods in New Zealand's exports, it is perhaps unsurprising that commodity price changes influence the exchange rate. To allow for the effect of persistent commodity price changes on the exchange rate, I introduce persistence to the shock term,

$$\varepsilon_t^q = \psi_\varepsilon \varepsilon_{t-1}^q + \varepsilon_t^{q2}. \quad (2.22)$$

2.4 The central bank reaction function

Taylor (1993) observed that the conduct of monetary policy can be well-captured by a simple rule relating interest rates to inflation and the output gap. Following Taylor's paper there began a concerted academic effort to assess this class of policy rules and their implications for optimal monetary policy. However, some form of Taylor's original rule, which is entirely backward-looking, remains the default specification for the behaviour of the central bank in many economic models.

The IS and Phillips relations described above operate with a lag. That is to say, it takes time for interest rates to affect the output gap and, in turn, for inflation to respond to the output gap. The lag structure embodied in these equations means that monetary policy should be conducted with a view to the future. Therefore, given the involvement of the central bank in forecasting the economy and the lags associated with the conduct of policy, I specify a forward-looking form of the Taylor rule which is consistent with the other equations in the model – the Bank's expectations are assumed to be model-consistent.

As well as being a reasonable empirical description of the conduct of monetary policy, Svensson (1997) and others have shown that the Taylor class of rules can also be derived from the inflation targeting central bank's optimisation problem. Simply allowing for the lag structure associated with the monetary transmission mechanism gives a forward-looking Taylor rule of the form,

$$i_t = \bar{i}_{t-j} + \delta_y y_{t+j_t} + \delta_\pi (\pi_{t+k_t} - \pi^*), \quad (2.23)$$

¹³ Larger-scale DSGE models, such as that of Harrison & Oomen (2010) ensure that the real exchange rate converges with its steady-state value by applying a risk premium to net foreign asset holdings in the UIP equation. Such an assumption is also consistent with relative PPP holding in the medium-term.

where i_t is Bank Rate, \bar{i}_{t-j} is the equilibrium nominal rate of interest, y_{t+j_t} is the output gap forecast at the relevant time horizon and $\pi_{t+k_t} - \pi^*$ is the forecast deviation of inflation from target.^{14,15}

Unlike the IS and Phillips relations, I do not include an exchange rate term in the specification of the Taylor rule. In this model, the central bank responds to movements in the exchange rate only indirectly, via its effect on output and domestically-generated inflation. This is consistent with both New Zealand's Policy Targets Agreement and the Taylor (2001) finding that the inclusion of exchange rates does little to improve the stabilisation of output and inflation and is possibly detrimental.

A substantial literature also exists on the observed inertia of interest rate setting by central banks around the world, see for example Goodfriend (1991). In what follows, I adopt the same approach as Clarida, Gali & Gertler (1999), which is to assume the presence of a policy rate smoothing parameter in the central bank's reaction function. They suggest this smoothing arises from a desire to avoid the credibility costs associated with large policy reversals, a desire to minimise disruption to capital markets and the time it takes build a consensus to support a policy change.¹⁶

Later discussions have identified ways in which interest rate smoothing might be optimal for a central bank in the presence of parameter uncertainty. Svensson (1999), for example, shows that parameter uncertainty for an inflation-targeting central bank dampens the policy response, confirming what Brainard (1967) first described. Soderstrom (2002) extends this analysis to a dual-mandate central bank with output in its loss function. He finds that uncertainty over inflation dynamics tends to heighten the response to inflation deviations (in case expectations become unanchored) but uncertainty over output dynamics encourages caution.

Regardless of the precise motive, the inclusion of central banks' smoothing of policy rates in their reaction functions significantly improves the fit with the data. Equation 2.24 captures interest rate inertia as in Clarida et al (1999),

$$i_t = (1 - \delta_i)i_t^* + \delta_i i_{t-1} \quad (2.24)$$

where i_t is the interest rate set, ψ is the smoothing parameter, i_t^* is the interest rate implied by the reaction function (absent smoothing) and i_{t-1} is the interest rate set in the preceding period.

Substituting the generalised Taylor rule in to equation 2.21 as the i_t^* term gives the central bank reaction function with policy rate smoothing equation 2.25,

$$i_t = (1 - \delta_i)\bar{i}_t + (1 - \delta_i)\delta_y y_{t+j_t} + (1 - \delta_i)\delta_\pi (\pi_{t+j_t} - \pi^*) + \delta_i i_{t-1} + \varepsilon_t^i. \quad (2.25)$$

¹⁴ The specification is slightly different from the original Taylor rule but consistent with Nelson and Nikolov (2002).

¹⁵ I use effective bank rate in place of actual bank rate to account for the effects of credit spreads and unconventional monetary policy on lending rates to the wider economy. I discuss this in more detail from section 2.5.

¹⁶ In a rational expectations context, Woodford (2003) also shows that it can be optimal for a central bank to move the current policy rate less in response to demand and inflation shocks if, at the same time, the changes are characterised by a high level of persistence. This way, agents in the economy expect interest rates to be lower for longer once they have been cut, in turn lowering longer-term interest rates as well as short rates.

I choose a forecast horizon of 6 months for the output gap and a year and a half for inflation, consistent with conventional wisdom over the transmission mechanism of monetary policy. Linearising equation 2.25 around the steady-state interest rate and inflation target gives the ‘nominal interest rate gap’ equation,

$$i_t = \delta_i i_{t-1} + (1 - \delta_i) \delta_y y_{t+2|t} + (1 - \delta_i) \delta_\pi (\pi_{t+6|t}) + \varepsilon_t^i. \quad (2.26)$$

2.5 Credit spreads

Since the onset of the recent financial crisis, a rise in the perceived degree of risk associated with lending and borrowing has significantly widened the gap between the interest rate set by the Reserve Bank of New Zealand and the price of credit available to the wider economy. As a result, monetary policy has subsequently taken serious account of the effect of credit spreads on the behaviour of agents in the economy.

While the existence of a credit spread is not important to the running of fiscal policy simulations (since there is no hypothesised relationship between credit spreads experienced by the wider economy and discretionary fiscal policy) it is important to the estimation of the model. To exclude the effect of higher credit spreads would miss important information relevant to the monetary policy decision and the real interest rate faced by households and businesses.

The inclusion of credit spreads in the model presented here is based on a simple principle: the Reserve Bank is ultimately concerned with the interest rates paid by household and firms in the economy. So if the spread of interest rates experienced by agents in the wider economy over policy rates is higher than usual, this implies that the Bank would set policy rates lower than usual. Therefore, rather than targeting policy rates, in this model, the Bank takes credit spreads into account directly and targets an adjusted policy rate, described here as Effective Bank Rate, i_t^e .

By extending the baseline New-Keynesian model of the economy to include a measure of credit spreads, Curdia & Woodford (2009) show that agents in the economy respond in a similar fashion to increases in borrowing rates arising from changes in the default risk premium as they would to an increase in Bank Rate.¹⁷ Importantly, the C&W model shows that, so long as central bankers take credit spreads into account, the Taylor class of policy rules remains optimal in choosing the stance of monetary policy.

To construct a measure of the credit spread, I use a selection of quoted household borrowing and deposit rates and subtract from those the relevant reference rate of interest.¹⁸ For example, I take the average interest rate quoted for a 2-year fixed-rate mortgage and subtract from this the two-year government bond rate. This gives the spread over expected policy rates at the relevant time horizon.¹⁹

In this paper, the model is presented in terms of deviations around a steady-state. Therefore, the credit spread series should also be expressed in terms of deviations

¹⁷ Curdia & Woodford create a model which assumes that banks are able to finance themselves by issuing deposits which must attract the same rate of interest as government bonds of the same maturity to avoid arbitrage opportunities. In this paper I assume that the relevant spread is over the cost of borrowing, as set by the central bank. This approach is motivated by the observation that the Bank targets a policy rate defined in terms of very short-term government borrowing rates.

¹⁸ Ideally, a measure of credit spreads would also include corporate sector borrowing and deposit rates, but there is little data available with which to construct such a measure.

¹⁹ Insofar as the two-year government bond rate is a good proxy for expectations of policy rates.

around a steady-state. For simplicity, I assume that the steady-state credit spread is stationary around its long-run average value.

The evolution of the credit spread is given by equation 2.27,

$$cs_t = \theta_{cs} (cs_{t-1}) + \varepsilon_t^{cs} \quad (2.27)$$

where cs is assumed to follow an autoregressive process that reverts to an equilibrium mean value of zero.²⁰

The effective interest rate is defined as,

$$i_t^e = i_t + \tau_{cs} cs_t, \quad (2.28)$$

where the coefficient, τ_{cs} , allows for the possibility of a rise in credit spreads affecting consumer behaviour more or less than a corresponding move in bank rate.

Credit spreads enter the model in two places: the IS relation and the Taylor rule. The real interest rate gap, which features in the IS relation, becomes,

$$r_t = i_t^e - \pi_{t+1|t} \quad (2.29)$$

and Taylor rule becomes,

$$i_t = \delta_i i_{t-1} + (1-\delta_i) \delta_y y_{t+2|t} + (1-\delta_i) \delta_\pi (\pi_{t+6|t}) + (1-\delta_i) \delta_{cs} cs_t + \varepsilon_t^i \quad (2.30)$$

The Taylor rule is augmented to allow the central bank to respond to deviations of the credit spread from its steady state. When the coefficient, δ_{cs} , is equal to unity, the Bank treats the increase in the credit spread as equivalent to an increase in bank rate. Values not equal to unity allow for a partial or excess response of policy rates to credit spreads. Since the bank's expectations are model consistent, the effect of the credits spread on the economy and the bank's policy response are constrained to be consistent with one another,

$$\delta_{cs} = \tau_{cs}. \quad (2.31)$$

²⁰ i.e. it is exogenous, as in the Curdia-Woodford model.

2.6 Model equations

$$y_t = \alpha_y y_{t-1} + (1 - \alpha_y) y_{t+1|t} - \alpha_r r_{t-1} - \alpha_q \Delta q_{t-1/t-4} + \alpha_{NR} f_t + \varepsilon_t^y. \quad (2.10)$$

$$\pi_t = \beta_\pi \pi_{t-1} + \beta_y y_t - \beta_q \Delta q_{t-1/t-4} + \varepsilon_t^\pi \quad (2.14)$$

$$i_t = \delta_i i_{t-1} + (1 - \delta_i) \delta_y y_{t+2|t} + (1 - \delta_i) \delta_\pi (\pi_{t+6|t}) + (1 - \delta_i) \delta_{cs} cs_t + \varepsilon_t^i \quad (2.30)$$

$$q_t = q_{t+1|t} + (i_t - \pi_{t+1|t}) - (i_t^f - \pi_{t+1|t}^f) - \psi_q q_{t-1} + \varepsilon_t^q \quad (2.19)$$

$$cs_t = \theta_{cs} (cs_{t-1}) + \varepsilon_t^{cs} \quad (2.27)$$

$$i_t^f = \zeta_{if} i_{t-1}^f + \varepsilon_t^{if} \quad (2.20)$$

$$\pi_t^f = \zeta_{\pi} \pi_t^f + \varepsilon_t^{\pi f} \quad (2.21)$$

$$f_t = \zeta_f f_{t-1} + \varepsilon_t^f \quad (2.9)$$

$$\delta_{cs} = \tau_{cs} \quad (\text{identity}) \quad (2.31)$$

$$i_t^e = i_t + \tau_{cs} cs_t \quad (\text{identity}) \quad (2.28)$$

$$r_t = i_t^e - \pi_{t+1|t} \quad (\text{identity}) \quad (2.29)$$

$$\varepsilon_t^q = \psi_\varepsilon \varepsilon_{t-1}^q + \varepsilon_t^{q2} \quad (\text{persistent shock}) \quad (2.22)$$

3 Estimation

3.1 Method

While some models are parameterised using estimated coefficients, others are calibrated to fit certain aspects of the data. With a model this small, incomplete specification is unavoidable – there are features of recent economic history that cannot be explained within the very narrow modelling framework considered here. But this does not mean it cannot be used for quantitative assessment. It simply implies that accepting the estimation results without some sensitivity to information that is available outside the small model would likely lead to bias.

Likewise, simply choosing the model parameters by applying judgement or with reference to theory would ignore the useful information contained within the data. Bayesian estimation serves as a bridge between calibration and estimation – the selection of priors allows for the incorporation of additional information available to the modeller, while the process of maximum likelihood estimation extracts some value from the data. In practice, the priors serve to guide the maximum likelihood estimate by placing more weight on certain areas of the parameter space. And the chosen prior variance acts to determine the

weighting between the prior and the unconstrained maximum likelihood estimate contained within the posterior estimate.

My choice of prior distributions for the model parameters is informed by other studies relating to the New Zealand economy including, Lubik & Schorfheide (2007), Szeto (2013), Parkyn & Vehbi (2013) and Karagedikli et al (2013). I also refer to the simulation properties of the New Zealand Treasury Model and Reserve Bank of New Zealand forecasting models - see Ryan & Szeto (2009), Szeto et al (2003) and Benes et al (2009).

With regard to the Bayesian estimation process, I use data from the final quarter of 1993 to the third quarter of 2012 – avoiding New Zealand’s disinflationary period but making use of data over the recent recession. The likelihood function is estimated using the Kalman filter and the Metropolis-Hastings algorithm is used to generate draws from the posterior distribution. 100,000 draws are run with the first 25,000 discarded as burn in. Table 1 presents both the choice of priors and the posterior estimates of the model parameters.²¹

Table 1 – Priors and posterior estimation results

| Param. | Eq. | Description | Prior mean | Posterior mean | Posterior LCI ^{1a} | Posterior UCI ^{1b} | Prior S.E. ^{1c} | Dist. ^{1d} |
|---------------------------|-------|---|------------|----------------|-----------------------------|-----------------------------|--------------------------|---------------------|
| α_y | IS | Output gap persistence | 0.80 | 0.87 | 0.83 | 0.91 | 0.03 | Norm |
| α_r | IS | Interest rate elasticity of demand | 0.25 | 0.09 | 0.06 | 0.13 | 0.04 | Norm |
| α_q | IS | Exchange rate elasticity of demand | 0.025 | 0.022 | 0.018 | 0.026 | 0.0025 | Norm |
| α_{NR} | IS | Degree of non-Ricardian behaviour | 0.65 | 0.44 | 0.30 | 0.57 | 0.08 | Norm |
| ε_t^y | IS | Demand shock | 0.50 | 0.67 | 0.58 | 0.75 | 0.10 | Inv G. |
| ζ_f | IS | Fiscal policy persistence | 0.60 | 0.83 | 0.77 | 0.89 | 0.20 | Norm |
| ε_t^f | IS | Fiscal policy shock | 0.14 | 0.13 | 0.12 | 0.15 | 0.05 | Inv G. |
| β_π | PC | Inflation persistence | 0.20 | 0.22 | 0.14 | 0.29 | 0.05 | Norm |
| β_y | PC | Inflation sensitivity to output gap | 0.25 | 0.26 | 0.15 | 0.29 | 0.10 | Norm |
| β_q | PC | Exchange rate sensitivity of inflation | 0.025 | 0.025 | 0.021 | 0.029 | 0.0025 | Norm |
| ε_t^π | PC | Inflation shock | 1.40 | 1.40 | 1.23 | 1.55 | 0.10 | Inv G. |
| δ_i | TR | Interest rate smoothing parameter | 0.75 | 0.79 | 0.76 | 0.82 | 0.02 | Norm |
| δ_y | TR | Interest rate sensitivity to output gap | 0.50 | 0.57 | 0.28 | 0.85 | 0.20 | Norm |
| δ_π | TR | Interest rate sensitivity to inflation | 1.50 | 1.48 | 0.84 | 2.09 | 0.40 | Norm |
| ε_t^i | TR | Interest rate shock | 0.60 | 0.70 | 0.63 | 0.77 | 0.05 | Inv G. |
| $\delta_{cs} = \tau_{cs}$ | TR/IE | Spread equality with base rate | 1.00 | 0.98 | 0.83 | 1.14 | 0.10 | Norm |
| ψ_q | RUIP | PPP convergence parameter | 0.020 | 0.022 | 0.014 | 0.030 | 0.005 | Norm |
| ψ_ε | RUIP | Exchange rate shock persistence | 0.85 | 0.85 | 0.86 | 0.81 | 0.90 | Norm |
| ε_t^{q2} | RUIP | Exchange rate shock | 0.70 | 0.63 | 0.43 | 0.80 | 0.20 | Inv G. |
| θ_{cs} | CS | Spread persistence | 0.80 | 0.79 | 0.71 | 0.87 | 0.10 | Norm |
| ε_t^{cs} | CS | Credit spread shock | 0.45 | 0.43 | 0.38 | 0.47 | 0.05 | Inv G. |

²¹ Estimation is conducted using the Dynare software package

| Param. | Eq. | Description | Prior mean | Posterior mean | Posterior LCI ^{1a} | Posterior UCI ^{1b} | Prior S.E. ^{1c} | Dist. ^{1d} |
|-------------------------|-----|-----------------------------------|------------|----------------|-----------------------------|-----------------------------|--------------------------|---------------------|
| ζ_{if} | IF | Foreign interest rate persistence | 0.90 | 0.90 | 0.85 | 0.94 | 0.10 | Norm |
| ε_t^{if} | IF | Foreign interest rate shock | 0.40 | 0.36 | 0.32 | 0.40 | 0.05 | Inv G. |
| ζ_{π} | PF | Foreign inflation persistence | 0.15 | 0.12 | 0.04 | 0.19 | 0.05 | Norm |
| $\varepsilon_t^{\pi f}$ | PF | Foreign price shock | 2.00 | 2.29 | 1.99 | 2.58 | 0.50 | Inv G. |

^{1a} LCI refers to the lower 95 per cent confidence interval value
^{1b} UCI refers to the upper 95 per cent confidence interval value
^{1c} S.E refers to the prior standard error of the distribution
^{1d} Dist. refers to parameter distributions – prior distributions are assumed normal for model parameters and inverse gamma for shocks

3.2 Model evaluation

To evaluate the fit of the model I first estimate a two-lag SVAR model, which allows the data to speak with the minimum number of identifying restrictions applied. The data series included are the inflation deviation from target, the output gap, the real interest rate gap and the exchange rate gap, which is also the Cholesky ordering of the variables. Fiscal policy enters the SVAR exogenously since it does not theoretically depend on any other variable in the model.

This time, I use data from the final quarter of 1993 to the first quarter of 2008 to exclude the influences of the earlier disinflation associated with shifting to a new monetary policy framework and the global financial crisis. This model represents a baseline comparator from a time when the data were well-behaved and the SVAR results appear sensible. Akaike information criteria results support the inclusion of two lags and unit root analysis suggests the model has a stable equilibrium.

I then compare the impulse responses from the SVAR with those of the estimated reduced-form model. I find that, broadly speaking, the impulse responses are consistent with one another. In particular, the humped responses of inflation to the output gap and the output gap to interest rates receive good empirical support. The dynamics of the exchange rate and the associated influences on output are less well-supported. Overall, the SVAR impulse responses generally support the dynamics of the reduced-form model – Figures A.1-A.16 in the Annex illustrate this in full.

There is good reason to suspect that the dynamics of the model associated with the exchange rate are muddled by commodity prices. International evidence such as that presented in IMF (2012) suggests that domestic output is positively correlated with commodity prices for exporters of primary goods, such as New Zealand. Because the exchange rate is also correlated with commodity prices the exchange rate is positively correlated with output – which is not consistent with theory.

The introduction of commodity prices – which are so persistent as to be indistinguishable, in practice, from a random walk – would affect the stability of the VAR and reduced-form modelling results. Instead, my priors over the exchange rate – drawn from evidence from other, larger models of the New Zealand economy, that include the effect of commodity prices - are imposed more strictly than priors relating to other parameters of the reduced-form model.

To provide an alternative model against which to compare the impulse responses, I estimate a sign-restricted VAR (SRVAR) in a similar way to Jaaskala & Jennings (2010).

The associated impulse responses are presented alongside the responses of the other models in the Annex (Figures 14-17). The restrictions are presented in Table 4, within the Annex. The restrictions serve to eliminate both the exchange rate and price puzzles associated with the VAR estimates and leaves the magnitude of many of the impulse responses broadly consistent with those from the reduced-form model.²² However, the approach also introduces an excess sensitivity of the exchange rate to endogenous factors, probably reflecting misspecification and the omission of relevant variables in the estimation process.

Finally, I am also interested to see whether the cross-equation restrictions of the reduced-form model have a significant bearing on its dynamics. To investigate whether this is the case I run a stochastic simulation of the model and record the data that is generated. I then estimate another SVAR using that simulation data and compare the impulse responses with those of the estimated model. I find that the impulse responses are broadly consistent with one another, suggesting the findings presented later are not overly dependent on the cross equation restrictions of the reduced-form model. Again, Figures A.1 – A.16 in the Annex present these impulse responses.

4 Fiscal policy simulations

In this section, I first set out a fiscal policy simulation using the estimated model parameters, which serves as the baseline case against which other simulations are compared. I then vary the model parameters one at a time, to show the sensitivity of the fiscal impact multiplier and associated cumulative output losses to those parameters. The variations are proportionate to the confidence intervals obtained during the Bayesian estimation procedure, which serve as proxies for parameter uncertainty.

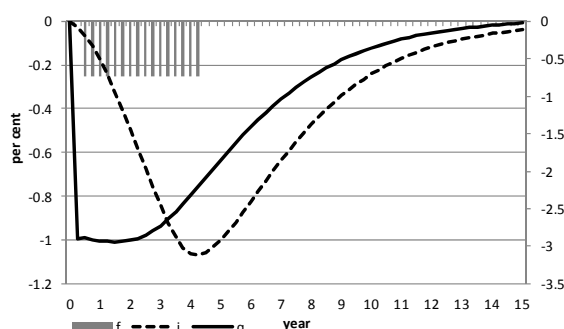
4.1 A baseline fiscal consolidation

The baseline fiscal consolidation scenario presented here is based on a four-year consolidation program equal to a one per cent of GDP tightening in each year, starting one quarter after it is announced. The full consolidation is, therefore, expected by the central bank, foreign exchange market participants and households. Figures 1a and 1b illustrate the dynamics of the four key model variables in response to a scheduled fiscal consolidation.

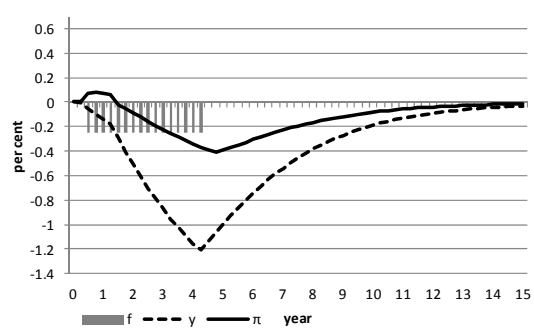
²² The drawback of this approach is that the sign restrictions appear to make the responses more immediate, since they apply to the first lag of the VAR – this is also a feature of the sign-restricted estimates presented in Jaaskela and Jennings (2010).

Figure 1 – Baseline simulation dynamics

1a) Interest and exchange rates



1b) Output and inflation

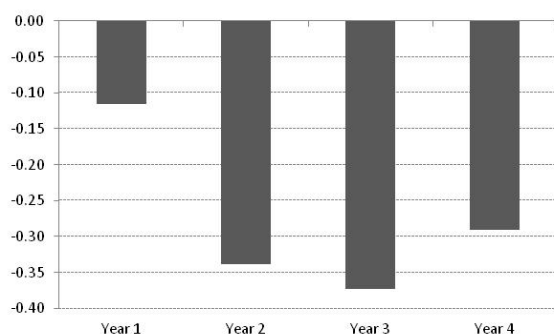


The charts show that the exchange rate depreciates at the point of announcement, while interest rates fall with a degree of inertia. The level of prices rises initially, reflecting the increase in import costs associated with the currency depreciation. The exchange rate depreciation provides support to output over the first year; thereafter the output gap opens up and exerts downward pressure on the annual rate of inflation. The output gap continues to widen over the period of fiscal consolidation, implying a negative GDP growth effect and a positive fiscal impact multiplier.

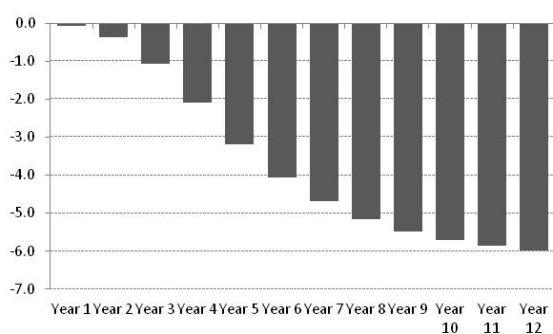
Figure 2a shows that the fiscal impact multiplier is small in the first year as much of the effect of the consolidation is offset by the output effects of currency depreciation. Thereafter, the multiplier rises to around 0.4 before shrinking to around 0.3 toward the end of the consolidation period. The average fiscal impact multiplier over the consolidation period is also 0.3.

Figure 2 – Baseline fiscal effects

2a) Fiscal impact multiplier



2b) Cumulative output loss



The opening of the output gap is associated with a cumulative loss of income of around 6 per cent of annual GDP – illustrated in Figure 2b. This output will never be recovered since there is no offsetting positive output gap following the consolidation – i.e. the level of output returns to its steady-state growth path and remains there.

The risks associated with speed of consolidation are not quantified here. Varying the pace of the fiscal consolidation by, for example, compressing the duration over which it takes place to two years does not yield a larger estimated cumulative output loss or a larger fiscal multiplier. The implication is that fiscal policy can be set without any regard to speed of consolidation and, in effect, makes achieving fiscal balance today just as costly as achieving it over four years – this is a limitation that arises from the linearity of the model.

Adjusting the baseline scenario so that the consolidation starts in a year's time (rather than the next quarter) affects the profile of GDP growth over time. This is because the exchange rate adjusts at the point of announcement, not when the consolidation begins, which means the associated benefits to growth are felt before consolidation begins. But this simply brings demand forward from later years and, overall, the cumulative gains associated with preannouncement are small - equal to around 0.1 per cent of annual GDP over the period in which the consolidation takes place.

4.2 Measuring parameter uncertainty

I have used the confidence intervals from the Bayesian estimation for the relevant parameters as proxies for parameter uncertainty. Table 2 ranks the model parameters by the cumulative output losses (relative to baseline) associated with a one standard deviation variation from their respective estimated values.²³ The mean estimates for each of the model parameters do not always lie at the centre of their estimated distributions – some of them are skewed. This means that not all parameters are varied symmetrically proportionate to the mean estimates - this introduces a skew to some of the simulated cumulative output loss scenarios.

Table 2 – Cumulative output losses

| Equation | Description | Cumulative output loss -1 s.d. | Cumulative output loss +1sd | Cumulative output loss -1sd vs baseline | Cumulative output loss +1sd vs baseline |
|----------|---|--------------------------------|-----------------------------|---|---|
| TR | Interest rate sensitivity to output gap | 9.2 | 4.4 | 3.0 | -1.7 |
| IS | Interest rate elasticity of demand | 8.7 | 4.6 | 2.5 | -1.6 |
| TR | Interest rate sensitivity to inflation | 8.2 | 4.8 | 2.1 | -1.4 |
| IS | Degree of non-Ricardian behaviour | 4.3 | 8.0 | -1.9 | 1.8 |
| PC | Inflation sensitivity to output gap | 6.7 | 5.6 | 0.6 | -0.6 |
| PC | Inflation persistence | 6.2 | 5.9 | 0.0 | -0.2 |
| RUIP | Error correction coefficient | 6.0 | 6.1 | -0.2 | -0.1 |
| TR | Interest rate smoothing parameter | 6.0 | 6.2 | -0.2 | 0.0 |
| IS | Degree of habit formation | 6.1 | 6.0 | 0.0 | -0.2 |
| IS | Exchange rate elasticity of demand | 6.1 | 6.0 | -0.1 | -0.1 |
| PC | Exchange rate sensitivity of inflation | 6.1 | 6.0 | -0.1 | -0.1 |

4.3 Some parameters that matter

The **degree of monetary activism** is captured by the responsiveness of interest rates to both the output gap and deviations of inflation from target. The persistence of the output gap is affected by variations in both of these parameters and the risks posed by both the fiscal impact multiplier and cumulative losses are skewed to the downside.

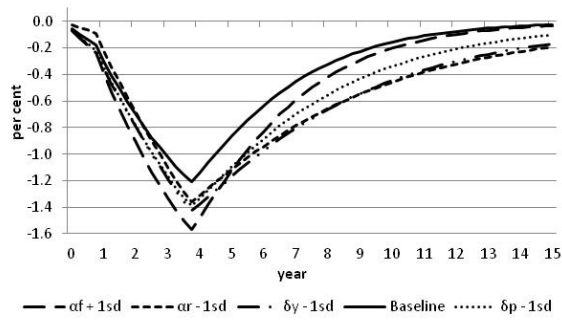
The **interest rate elasticity of demand** represents the willingness of households to swap consumption today for consumption tomorrow. It is important because it determines how effective a given interest rate change will be in stimulating aggregate demand and variations in this parameters alter the persistence of the output gap. The results show that the risks posed to both the cumulative output losses and associated fiscal impact multipliers are skewed to the downside when this parameter is varied.

²³ To some extent, the confidence intervals reflect the priors for the standard error of the parameters but the data also influences these ranges.

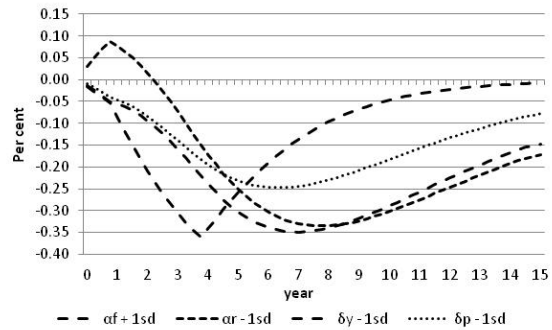
The **degree of non-Ricardian behaviour**²⁴ introduces considerable uncertainty over the likely effect of fiscal consolidation on the economy. This is not surprising since it is the scalar for the size of the initial shock. The results are consistent with a broadly symmetric loss/gain in cumulative output and varying this parameter has a roughly equal effect on the impact multiplier when varied in both directions.

Figure 3 – Variations in output responses

3a) Output gap simulations



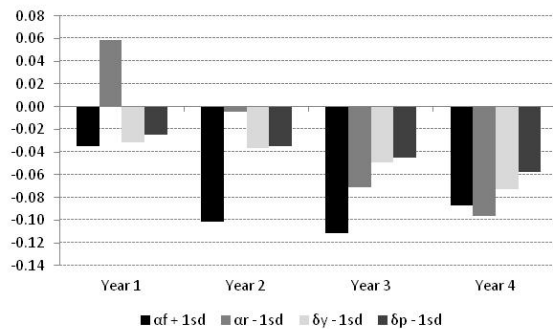
3b) Output gaps relative to baseline



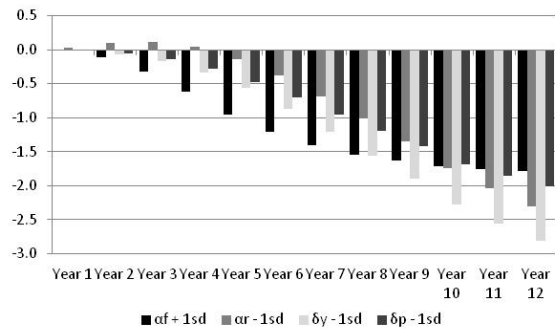
The output gap paths associated with independently varying each of the four parameters above by one standard deviation of the parameter estimate are presented in Figure 3a while Figure 3b shows these in terms of deviations from the baseline scenario. The simulation shows that a higher degree of non-Ricardian behaviour would reduce output sooner and more sharply than would a lower interest rate elasticity of demand or interest rate sensitivity to the output gap/inflation. This is reflected in estimates of the fiscal impact multiplier illustrated in Figures 4a and 4b.

Figure 4 – Variations in fiscal effects

4a) Fiscal impact multiplier vs baseline



4b) Cumulative output loss vs baseline



4.4 Some parameters that matter less

Several parameters affect the distribution of GDP growth over the consolidation period but not the cumulative output losses associated with it. Exchange rate variables, for example, affect the impact multiplier in the first year but work in the opposite direction in later years as the initial depreciation is offset by appreciation to achieve parity with the rest of the world.

²⁴ Which includes the effect of other leakages

The parameters that have this sort of influence include the degree of interest rate smoothing, the degree of habit formation, the pass-through from the exchange rate to inflation and the elasticity of output with respect to the exchange rate. None of the standard deviation variations of these parameters affects the fiscal impact multiplier by more than 0.1ppts in any single year. The sensitivity of inflation to the output gap also has a relatively small influence on cumulative output losses and the fiscal impact multiplier, although it does not fall into the same category as the other variables described in this section.

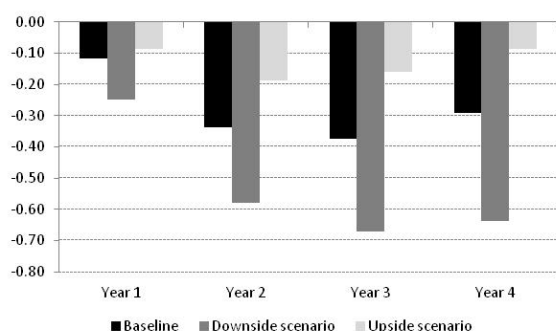
4.5 How much better or worse might it be?

The four parameters which are most important in determining the overall output losses are the sensitivity of output to interest rates, the sensitivities of interest rates to both output and inflation and the degree of non-Ricardian behaviour. If these parameters are independent, unbiased and normally distributed, the likelihood of all four of these parameters lying at one end of their respective confidence intervals simultaneously is rather small. Nonetheless, it is an interesting thought experiment to ask what the output path might be if they did. Likewise, it is informative to explore the implications for output if these parameters were to lie at the favourable end of their respective confidence intervals.

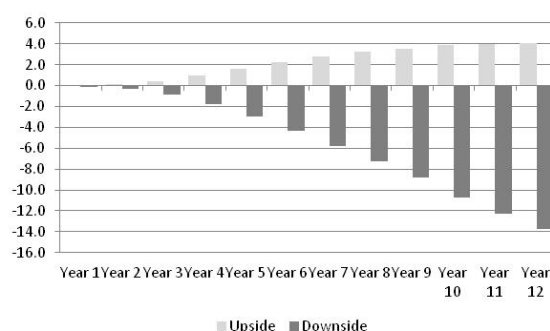
The results of this exercise suggest that the cumulative output loss associated with a one standard deviation shock to each parameter (to the side consistent with output losses) would be substantial – more than tripling the total cumulative output loss associated with the consolidation. And the fiscal impact multiplier is also larger, peaking at 0.7 in Year 3, compared with 0.4 in the baseline scenario. The average multiplier is 0.5 in this scenario compared with 0.3 in the baseline case. These results are illustrated in Figures 5a and 5b.

Figure 5 – Scenarios relative to baseline

5a) Fiscal impact multiplier vs baseline



5b) Cumulative output loss/gain vs baseline



A key finding of this study is that a bad outcome is likely to be worse than a good outcome is to be better, suggesting that risks associated with the consolidation are skewed to the downside. This finding reflects the underlying distributions of the parameter estimates which are found to be skewed themselves.²⁵

However, the interaction between the increased degree of non-Ricardian behaviour (which widens the output gap) and the increased persistence of the output gap arising from variations in the other model parameters means that the cumulative loss of output is greater than the sum of losses associated with varying each of the model parameters

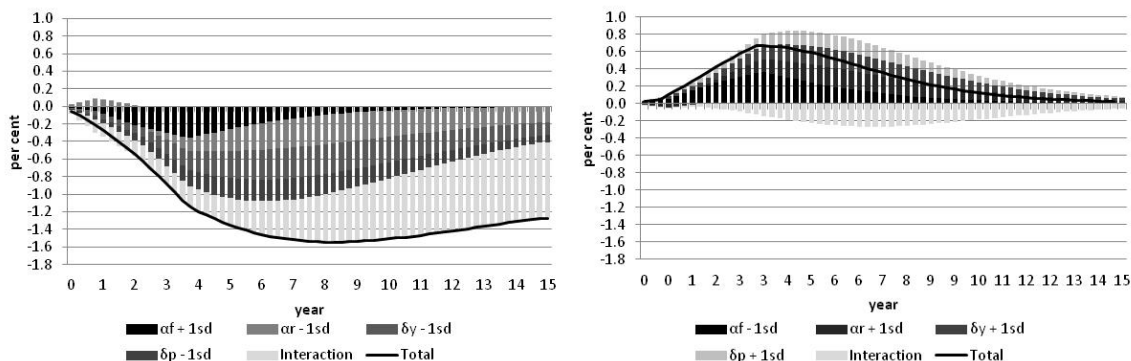
²⁵ The model itself is linear, but the degree by which the parameters are varied depends on the confidence intervals of the estimated parameters, which reflect their distributions.

independently. This is illustrated in Figures 6a and 6b which show the contributions to the wider output gap from independent variations in model parameters and the contribution of the interaction between them.

Figure 6 – Parameter contributions

6a) Downside scenario

6b) Upside scenario



4.6 Fiscal policy at the zero-lower bound

The central estimate of the average fiscal multiplier associated with a four-year fiscal consolidation is 0.3, consistent with the findings of Parkyn & Vehbi (2013). The results of the sensitivity analysis conducted here suggest that the fiscal impact multiplier is likely to be larger and the cumulative output losses substantially greater if certain model parameters differ from the central estimates. But these variations do not cause the estimated fiscal impact multiplier to reach unity – the peak impact multiplier over the consolidation period is 0.7 in the downside scenario while the average impact multiplier is 0.5.

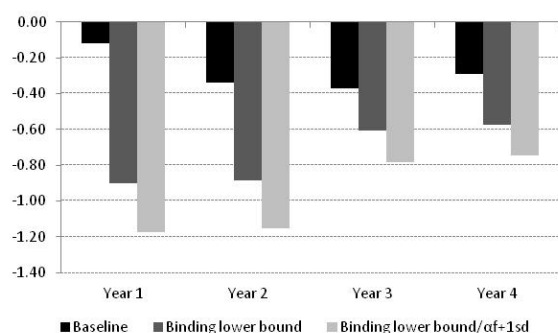
Partly, these findings may reflect the choice of priors and so the parameters may simply not be varied by enough.²⁶ However, the results suggest that the functioning of the economy would have to be greatly different to the model specified here for the fiscal impact multiplier to be as large as is found by Blanchard & Leigh (2013). Given the importance of monetary policy in determining the size of the fiscal multiplier, it is useful to test whether the zero-lower bound of nominal interest rates is able to reconcile the differences. To that end, I run a simulation in which the nominal interest rate is held fixed over the period of consolidation and monetary policy is unable to stimulate aggregate demand.

In this scenario the fiscal impact multiplier is substantially higher, peaking at 0.9, and averaging 0.7 over the consolidation period. Assuming that the parameter capturing the degree of non-Ricardian behaviour lies at the unfavourable end of its distribution increases the peak multiplier to 1.2 and the average multiplier to unity – Figure 7. These estimates are fairly consistent those of Blanchard and Leigh, suggesting that much of the difference between estimates of the fiscal multiplier in New Zealand relative to other OECD countries is due to monetary policy constraints.²⁷

²⁶ See Leeper et al (2011) for a discussion of this possibility.

²⁷ Note that the assumption that the lower bound binds is consistent with the belief that other measures taken by central banks to stimulate aggregate demand have had limited positive effects.

Figure 7 – Fiscal impact multiplier at the lower bound



5 Implications for policy and research

The key findings of the research presented here are that uncertainty surrounding the effects of fiscal consolidations on output can be attributed to several model parameters and that a bad outcome is likely to be worse than a good outcome is to be better. Overall, the evidence suggests that policy makers should be sensitive to the prevailing economic environment when determining the fiscal stance because cumulative output losses can vary substantially in some situations - particularly when monetary policy is constrained by the lower bound of nominal interest rates.

The responsiveness of aggregate demand to changes in interest rates is a key determinant of the output losses associated with any fiscal consolidation. This is thought to be related to a structural parameter – the elasticity of intertemporal substitution – which, in turn, is often considered to be stable and not to fluctuate over the cycle. This is of particular interest at the current juncture since little is known about how the structural position of household and corporate balance sheets might affect those agents' willingness to bring consumption forward in response to lower interest rates. Further work into the validity of this assumption would improve our understanding of the effects of fiscal consolidations on the economy.

The degree of monetary activism – how much a central bank might be expected to move interest rates in response to an announced fiscal consolidation – is also an important determinant of the effect of consolidations on output. And, in extremis, when monetary policy is constrained by the zero lower bound of interest rates, the effects of fiscal tightening are likely to be much larger. The implication is that central banks and fiscal authorities should coordinate their activities closely if the worst outcomes are to be avoided.

The degree of non-Ricardian behaviour, which (due to the reduced-form nature of the model) also includes the effect of trade leakages, is of particular importance. When setting policy governments should consider whether the particular mix of measures is likely to affect households likely to exhibit more or less Ricardian behaviour. A government should also consider whether the package it designs is likely to be more or less prone to leakage, reflecting the import intensity of certain areas of expenditure, for example. This reduces the uncertainty over this parameter to the extent that the central estimate can be thought of as being based on the average effect of a number of packages which differ in their precise make-up.

A broader question is how this information should shape a government's policy choices. In the parallel literature on optimal monetary policy, uncertainty over model parameters implies an inertial response of interest rates to shocks. The issue for fiscal authorities is rather more complicated since the benefits of reducing structural budget deficits need to be balanced against the output losses associated with fiscal consolidations - I leave this area unexplored but it stands to reason that the asymmetric output losses arising from parameter uncertainty might incentivise a degree of gradualism in policy setting.

6 Conclusion

In this paper, I have presented and estimated a small model of the New Zealand economy. I then ran a number of fiscal consolidation scenarios and used the results to show the sensitivity of the fiscal impact multiplier and the associated cumulative output losses to uncertainty over the model parameters.

The key findings are that uncertainty surrounding the effects of fiscal consolidations on output can be attributed to several model parameters and that a bad outcome is likely to be worse than a good outcome is to be better. I find that, if monetary policy were to be constrained by the zero-lower bound, the estimated fiscal impact multiplier for New Zealand would be broadly consistent with estimates of the fiscal multiplier in a number of other OECD countries in that position.

Overall, the evidence suggests that fiscal policy makers should be sensitive to the prevailing economic environment when determining the fiscal stance and work closely with central banks if the worst outcomes are to be avoided.

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Appendix

Impulse responses

Reduced-form model, SVAR, SRVAR and SVAR using simulated data

Figure 8 – Output impulse responses

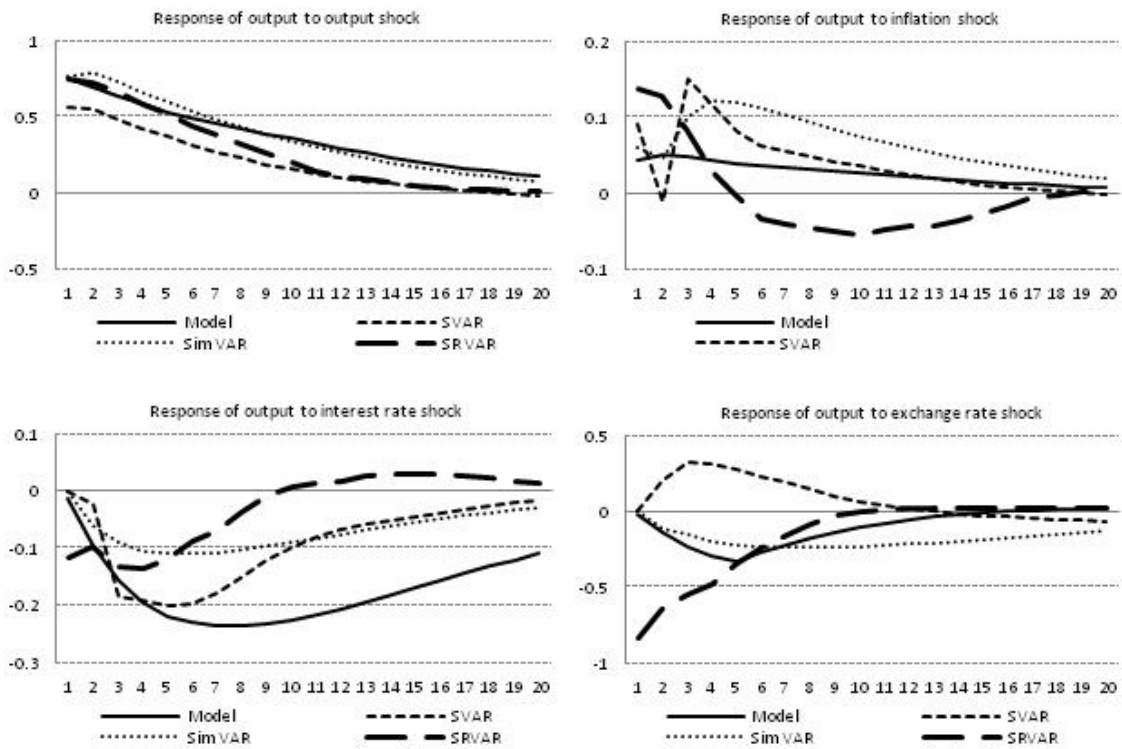


Figure 9 – Inflation impulse responses

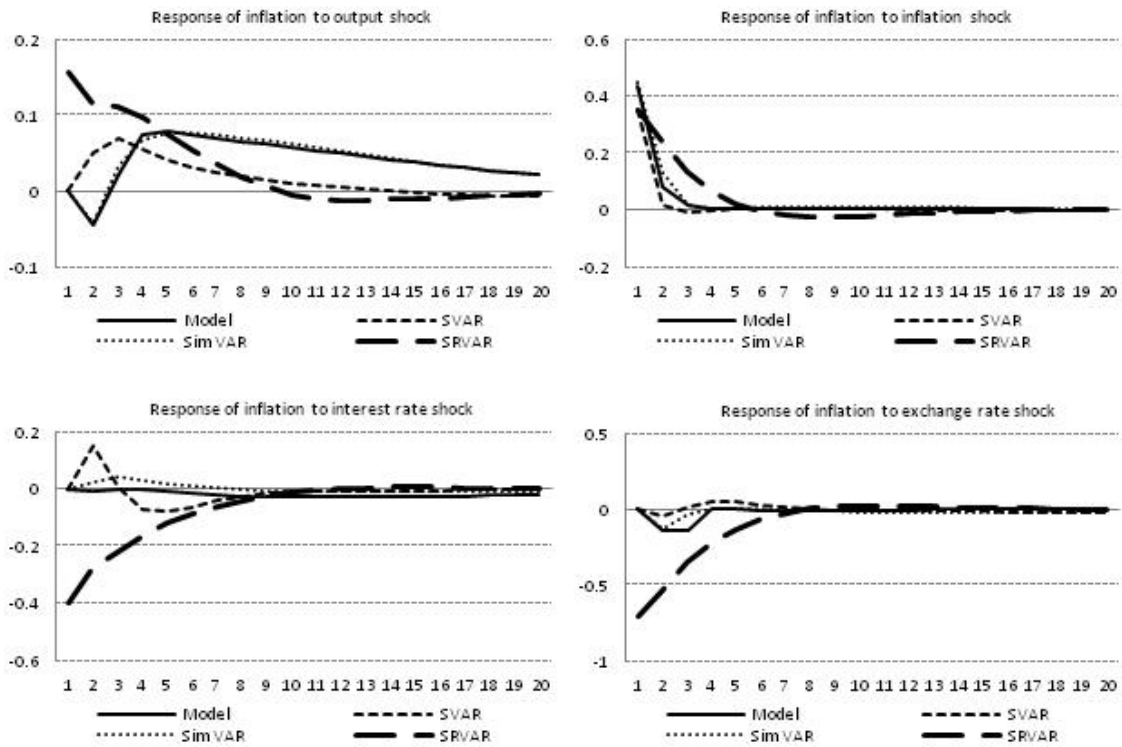


Figure 10 – Interest rate impulse responses

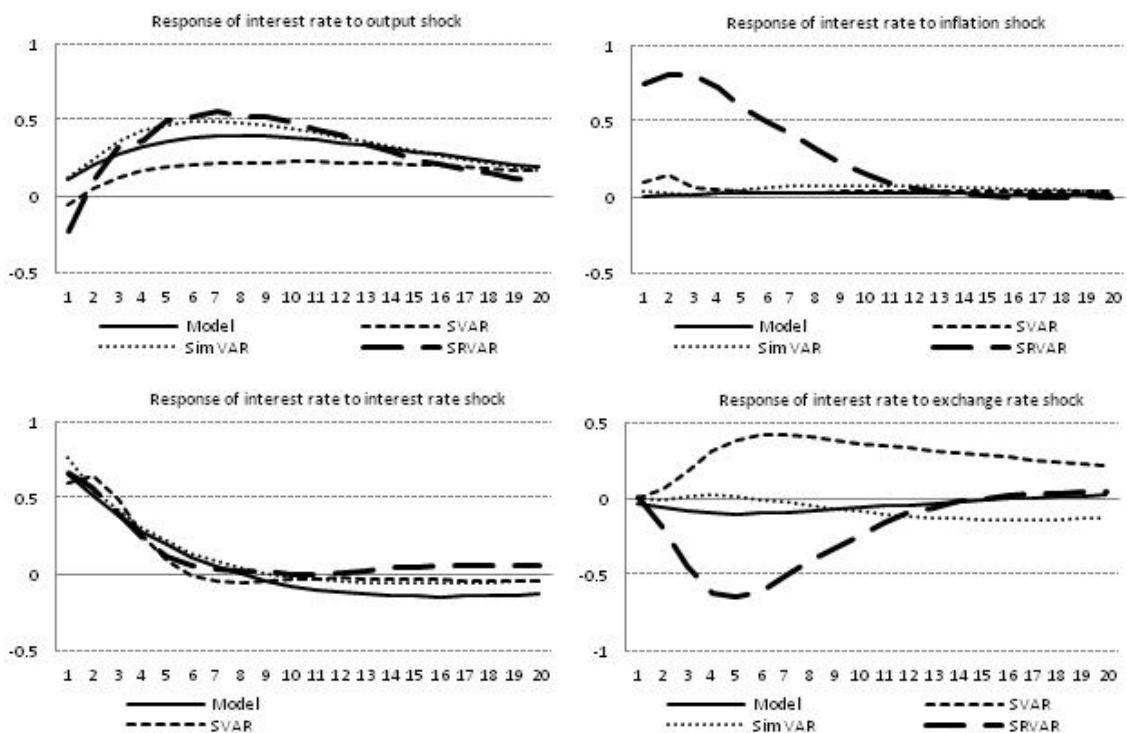


Figure 11 – Exchange rate impulse responses

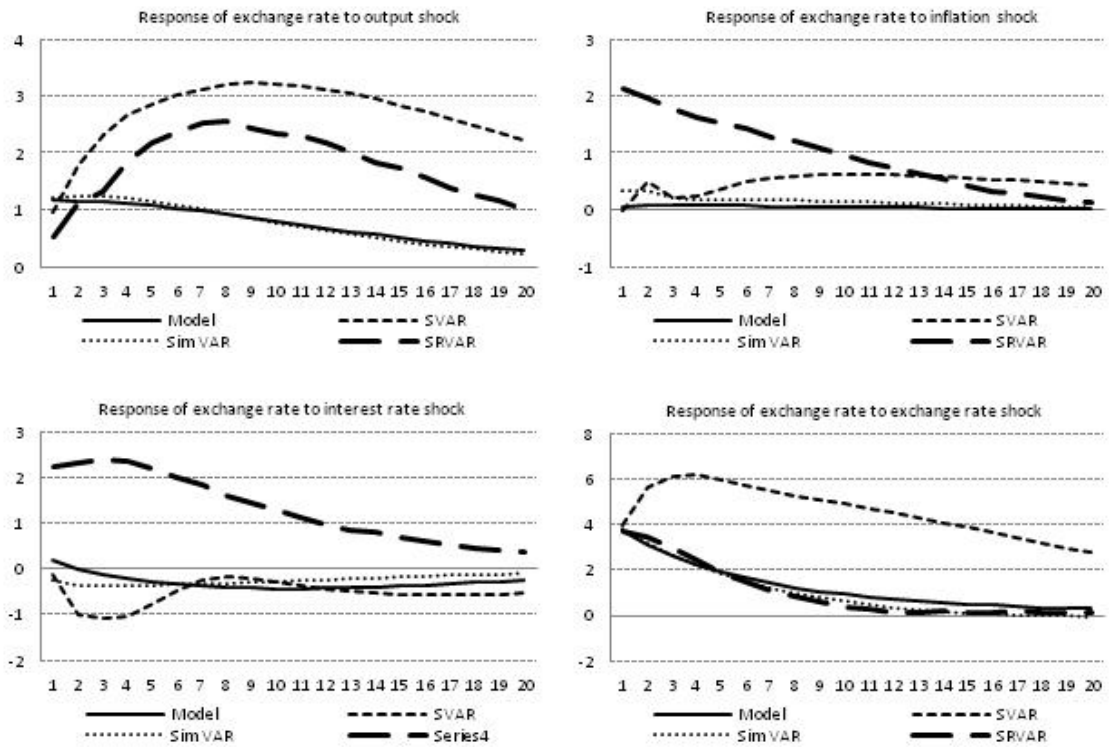


Table 3 – Data description

| Variable | Description | Source |
|-----------|---|--|
| y | Output gap as a percentage of GDP | Szeto (2013) |
| i | Official cash rate deviation from sample average | RBNZ, own calculations |
| q | Real trade-weighted exchange rate deviation from sample average | Bilateral exchange rates (Reuters), trade-weights (SNZ), π_t^f (below), own calculations. |
| π | Quarterly annualised seasonally-adjusted CPI inflation deviation from target (assumed to be 2 per cent). | Non seasonally-adjusted CPI (SNZ), own calculations (seasonally). |
| cs | Credit spread deviation from sample average. | Deposit, borrowing and weights in lending for household and corporations (RBNZ), reference rates i.e. government bond rates and OIS (Reuters), own calculations. |
| i_t^f | Trade-weighted foreign policy rates, deviation from sample average. | Policy rates (Reuters), trade weights (SNZ). 0 weight applied to China for earlier part of sample. Own calculations. |
| π_t^f | Foreign, trade-weighted quarterly annualised, seasonally-adjusted CPI inflation, deviation from sample average. | Non-seasonally-adjusted CPI inflation (Reuters), trade weights (SNZ), own calculations. |
| f | Change in the cyclically-adjusted budget balance (AKA fiscal impulse) | Annual data (New Zealand Treasury), own calculations. |

Table 4 – Sign restrictions in SRVAR*

| Shock to: | Interest rate | Output | Inflation | Exchange rate |
|---------------|---------------|----------|-----------|---------------|
| Interest rate | Positive | - | Negative | Positive |
| Output | - | Positive | Positive | - |
| Inflation | Positive | - | Positive | Positive |
| Exchange rate | - | Negative | Negative | Positive |

*Shocks are in rows, responses in columns