Reserve Bank of New Zealand
Analytical Notes

Quantifying Fiscal Multipliers in New Zealand: the Evidence from SVAR Models

AN2018/5

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June 2018

Reserve Bank of New Zealand Analyical Note Series
ISSN 2230 - 5505

Reserve Bank of New Zealand
PO Box 2498
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NEW ZEALAND

www.rbnz.govt.nz

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Ref #**7573971** v**2.1**

RESERVE BANK OF NEW ZEALAND
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NON-TECHNICAL SUMMARY

Fiscal policy has a substantial impact on aggregate demand both directly via government spending, and indirectly via changes to the disposable income of households and businesses though variations in taxation and transfers (e.g. superannuation). For fiscal policy-makers to accurately forecast the impact of fiscal policy, and for monetary policy-makers to respond appropriately, both need to understand the likely aggregate impact of fiscal changes on economic activity over time. Furthermore, this impact could vary across different fiscal policies, e.g. changes in government spending versus tax changes.

To address these questions, this Analytical Note uses Structural Vector Auto-Regression (SVAR) models to quantify the historical magnitude of fiscal policy changes on economic activity in New Zealand. The economic impact is measured by the GDP multiplier, which shows the percentage-point (ppt) change in GDP in response to an increase in government expenditure or decrease in revenue equivalent to 1 percent of GDP. The analysis in this Analytical Note builds on previous empirical studies by using updated data for the period 1990 to 2017 and estimating multipliers for specific components of fiscal policy rather than just aggregate multipliers. This Note also brings more attention to the interaction of monetary and fiscal policy and how the results can be applied in macroeconomic forecasting.

We find that New Zealand's fiscal multipliers are comparable to other developed countries and that different fiscal policies have very different economic effects. At the aggregate level, the GDP multiplier in the first year for an increase in aggregate government spending (0.24 ppts) is larger than for a decrease in taxes net of transfers (-0.10 ppts), in line with previous New Zealand studies. At the more disaggregated level, the multiplier for a change in public consumption is large and positive (0.82 ppts), while the multiplier for public investment is negative (-0.59 ppts). The weak multiplier for an increase in public investment appears sensitive to several assumptions, highlighting concerns around the accuracy of this estimate. An increase in transfers and decrease in total tax revenue have large multiplier effects, 0.76 ppts and 1.29 ppts respectively.

The duration of the GDP response to a change to fiscal policy also varies depending on the type of policy used. The impulse on aggregate demand from an increase in transfers and public investment appears to be short-lived, with the peak impact

occurring within the first two quarters. On the other hand, the positive impact on GDP from an increase to public consumption or decrease in tax revenue is more long-lasting.

The results can provide a useful indication of how future policy changes could affect the economy, but it should be noted that the results of the model have been extracted from a 30-year period, and hence represent the dynamics that one would expect *on average.* If the nature of the economy today is significantly different from its history, then users need to take this into consideration when applying the estimates. The estimated multipliers for government spending and its components appear more robust to the choice of variables, identification assumptions and sample period compared with taxes and transfer spending. The endogeneity problem between economic conditions and taxes and transfers may be more serious than it is for government spending.

1 Introduction[1]

Fiscal policy has a substantial effect on aggregate demand and business cycle fluctuations. Understanding this effect is important for both fiscal and monetary policy-makers. Monetary policy aims to keep inflation low and stable by managing the business cycle, while also supporting maximum sustainable employment. An aim of fiscal policy is to minimise unnecessary volatility in the business cycle. Understanding the size, channel and timing of fiscal policy's impact on the economy is crucial to achieving either aim. The Analytical Note assists macroeconomic policy assessments by empirically quantifying how fiscal policy initiatives have tended to affect New Zealand's economy in recent years.

We use Structural Vector Auto-Regression (SVAR) models to assess the dynamic effects of different fiscal policies. This approach contrasts with the Fiscal Impulse indicator commonly presented by the Treasury, which captures the direct first-round impact of aggregate fiscal policy changes on economic growth. The Fiscal Impulse represents *discretionary* fiscal policy by excluding changes to revenue and expenditure components that automatically vary with the business cycle (automatic stabilisers).[2] For example, transfer spending tends to rise in a downturn partly due to the increase in unemployment — not just discretionary policy (active decisions made by the government). The Fiscal Impulse along with the automatic stabilisers are shown in Figure 1, the net effect of the two components indicate the overall aggregate impact of fiscal policy on the economy.[3] Based on the Fiscal Impulse, fiscal policy has tended to be more counter-cyclical in the current cycle since 2009 relative to previous cycles since 1993 (see Table A7 of appendix).

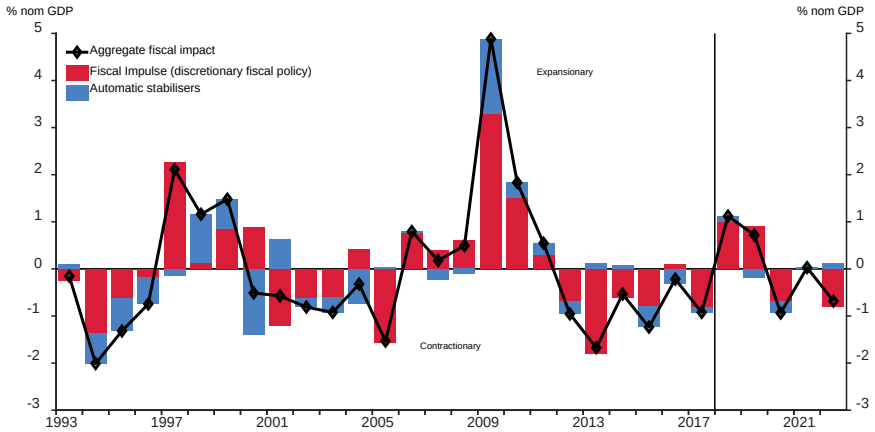
Indicators like the Fiscal Impulse are useful to identify changes in discretionary policy and their direct contribution to demand at a given point in time. However, from a forecasting standpoint, one would also be interested in the indirect and dynamic response of activity to fiscal policy changes beyond the initial stimulus. The Fiscal Impulse also assumes that the effects of different fiscal instruments on aggregate demand are equal. This naturally raises the question, do different fiscal initiatives have different effects on GDP (e.g. tax changes versus changes to government spending)?

[1] The authors wish to thank Robert Kirkby, Oscar Parkyn, Tugrul Vehbi, Michael Callaghan, Murat Ozbilgin, Tom Smith, Rebecca Williams, and the late Roger Perry for their input in preparing this Analytical Note.

[2] The Fiscal Impulse is a cash-based indicator constructed from Crown accounting data. For further details on its construction, see Phillip and Janssen (2002).

[3] The practice of including the automatic stabilisers to reflect the full aggregate demand effect is similar to the Fiscal Impact Measure produced by the Hutchins Centre on Fiscal and Monetary Policy: https://www.brookings.edu/research/the-hutchins-centers-fiscal-impact-measure/

Figure 1: Fiscal Impulse and automatic stabilisers



Source: Treasury - 2018 Budget Economic and Fiscal Update.
Note: The Fiscal Impulse covers Core Crown and Crown Entities and excludes EQC and Southern Response earthquake payouts.

The analysis in this Analytical Note builds on previous SVAR studies for New Zealand by using updated data for the period 1990 to 2017 and estimating multipliers for specific components of fiscal policy, in addition to aggregate multipliers for government spending and net taxes. We separately examine the effects of public consumption expenditure, public investment, spending on transfers, and tax revenue.[4] This Note also brings more attention to the interaction of monetary and fiscal policy and how the results can be applied in macroeconomic forecasting.

The rest of the Analytical Note proceeds as follows. Section 2 describes the modelling approach and data used. Section 3 presents the results, a comparison with existing literature, and how the estimates can be used to examine a more persistent change in fiscal policy. Section 4 briefly discusses how multiplier estimates can be influenced by different states of the world. Section 5 concludes.

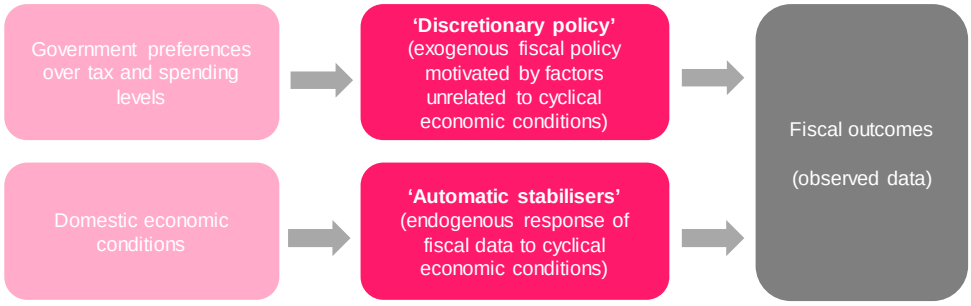
2 Methodology and data

2.1 The model

We model the dynamic impact of *discretionary* fiscal policy changes on the economy, for example, the impact from a reduction in government expenditure to manage budget deficits. However, this poses an estimation challenge because observed aggregate fiscal data encompass discretionary policy changes and automatic stabilisers responding to current economic conditions (Figure 3).

[4] See Dunstan et al. (2007) for a qualitative discussion on the disaggregate effects of fiscal policy changes on aggregate demand, potential output, savings, and the current account.

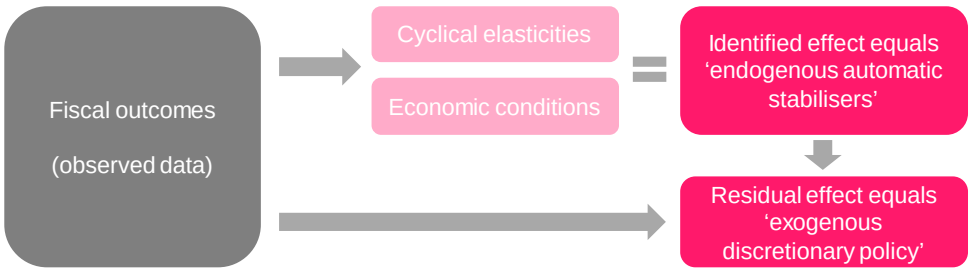
Figure 3: The endogeneity problem: stylised description of the fiscal policy stance



To illustrate this challenge, consider data on tax revenues. Tax revenues can change as a result of two factors – changes in the rate of taxation (e.g. the personal income tax rate), which is a discretionary policy choice, and changes in the amount of activity that is covered by the tax (e.g. the number of people working), which responds endogenously to developments in the economy. To isolate the impact of discretionary fiscal policy changes on the economy, we need to strip out the variation in fiscal data due to cyclical economic conditions. We use a SVAR model, following the widely-used approach proposed by Blanchard and Perotti (2002) (B-P hereafter). The B-P approach isolates the effect of economic conditions on fiscal outcomes using elasticities that relate changes in fiscal instruments to changes in macroeconomic variables.

The elasticities are informed by institutional information about tax and transfer systems, estimates from the OECD, and information on decision lags in fiscal policy (for example, discretionary government expenditure is seldom able to react to changes in output within a quarter given decision and implementation lags by fiscal authorities). Changes in fiscal policy that are not explained by the SVAR while controlling for these elasticities are assumed to represent the discretionary fiscal policy shocks (see Figure 4).

Figure 4: Stylised representation of SVAR identification strategy



Discretionary fiscal policy shocks are then simulated once the models are estimated to examine the dynamic response of macroeconomic variables through impulse response functions. Primarily, we are interested in the impact of discretionary fiscal policy on real activity, which is calculated as a GDP multiplier.

The models used in this Analytical Note closely follow Parkyn and Vehbi (2014) and Claus, Gill, Lee and McLellan (2006) who apply the B-P approach to New Zealand data. The Parkyn and Vehbi approach is of more relevance to our analysis as it extends B-P's three variable framework (government spending, net taxes and GDP) to include inflation and interest rates.[5] While Parkyn and Vehbi use the 10-year interest rate to understand the interaction of fiscal policy and the government's borrowing costs, we focus on the interaction of fiscal and monetary policy. Therefore, we use the 90-day interest rate instead as a proxy for the Reserve Bank's policy instrument – the Official Cash Rate – and CPI inflation instead of the GDP deflator.

The aggregate model (Model 1) can be described by the reduced-form five-variable SVAR with $k = 3$ lags represented by equation (1):

$$Y_t = \sum_{i=1}^{k=3} C_i Y_{t-i} + U_t \tag{1}$$

where Y_t is a five variable vector including government spending (G_t), tax revenue net of transfers (NT_t), output (y_t), inflation (Δp_t) and interest rates (i_t).[6] C_i is a *5 X 5* matrix of coefficients. The reduced-form residuals are represented by the vector $U_t \equiv [u_t^G, u_t^{NT}, u_t^y, u_t^{\Delta p}, u_t^i]$. We take these *observed* reduced-form residuals (U_t) and restrict the system in order to identify discretionary fiscal policy shocks. These restrictions apply only to a selection of contemporaneous (within quarter) relationships between the variables in the SVAR. The lagged relationships between variables are wholly unrestricted. We use the AB model[7] to relate the discretionary fiscal shocks (E_t) and reduced-form residuals (U_t) as follows:

$$AU_t = BE_t \tag{2}$$

where A is a *5 x 5* matrix representing the contemporaneous relationship between each of the reduced-form shocks (see equation (3a)), and B is a *5 x 5* matrix representing the contemporaneous relationship between each of the structural shocks (see equation (3b)).

The reduced-form parameters in equation (3a) are either estimated via maximum likelihood, or assumed. The contemporaneous elasticities in the upper-right section of matrix A (highlighted blue) are chosen using institutional information about the

[5] Parkyn and Vehbi (2014) build on work by Perotti (2005) who uses a five-variable framework for five countries. They also include a government debt constraint, following Favero and Giavazzi (2007).
[6] A constant and linear time trend are also included in the SVAR specification.
[7] See Amisano and Gianni (1997).

behaviour of fiscal policy. These elasticities are in line with the approach taken by Parkyn and Vehbi (2014) and B-P, but are updated to incorporate the estimates of Price, Dang and Botev (2015) for OECD countries.[8] Government spending and net taxes are assumed not to respond to interest rates within the quarter (a_{Gi} and a_{NTi} are set to zero).[9] The elasticity of government spending with respect to output is set as zero (a_{Gy}=0) as government spending is assumed not able respond to GDP within the quarter due to information, decision-making, and implementation lags.[10] The elasticity of government spending with respect to inflation ($a_{G\Delta p}$) is set as -0.5, following Perotti (2005). GDP and net taxes (a_{NTy}) have a positive elasticity of 1.20, and the elasticity of net taxes to prices ($a_{NT\Delta p}$) is set to 0.39. See section II of the appendix for full details on how these parameters are constructed.

$$AU_t = \begin{bmatrix} 1 & -a_{GNT} & -a_{Gy} & -a_{G\Delta p} & -a_{Gi} \\ -a_{21} & 1 & -a_{NTy} & -a_{NT\Delta p} & -a_{NTi} \\ -a_{31} & -a_{32} & 1 & -a_{y\Delta p} & -a_{yi} \\ -a_{41} & -a_{42} & -a_{43} & 1 & -a_{\Delta pi} \\ -a_{51} & -a_{52} & -a_{53} & -a_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^G \\ u_t^{NT} \\ u_t^y \\ u_t^{\Delta p} \\ u_t^i \end{bmatrix} \tag{3a}$$

The parameters a_{21} and a_{GNT} are set to zero which means that there is no automatic mechanism for government spending to respond to net taxes (tax revenue less transfers) in the same quarter (and vice versa). Output, inflation and interest rates are recursively ordered by setting $a_{y\Delta p}$, a_{yi} and $a_{\Delta pi}$ equal to zero so that they are only affected by the variables ordered before them.[11] The diagonal elements of A are set to one as the numeraire.

In equation (3b), the diagonal elements in matrix B are the variance of the structural shocks, while most of the off-diagonal elements are set to zero, assuming that the structural shocks are uncorrelated. The off-diagonal elements (b_{12} and b_{21}) determine the ordering of government expenditure and tax decisions. Here it is assumed that government spending decisions are ordered first prior to tax (b_{12}=0 and b_{21} is estimated), although in section I of the appendix, we show that the multipliers are not

[8] Varying these elasticities by ± 0.5 generally have minimal impacts on the results. The only exceptions are the elasticities between the fiscal variables and output, which can change the results significantly.

[9] Debt servicing costs and investment income are excluded from the measure of government spending used in this analysis. Transfers are assumed to be contemporaneously uncorrelated with interest rates. While the tax base includes interest income, tax on interest lent to businesses is deductible, so taxes levied on interest tend to depend largely on the interest rate margin between lending and deposit rates charged by banks. This margin appears relatively stable over the time period analysed, and largely invariant to interest rate changes.

[10] Information lags (GDP data is often released with a quarter lag), fiscal policy decision-making lags, and implementation lags are well documented (Blanchard and Perotti, 2002).

[11] The economic reasoning being that higher activity generates price pressure and then a monetary policy response. This is a standard specification in VAR models.

particularly sensitive to this ordering. The structural shocks that will be identified are those included in vector $E_t \equiv [e_t^G, e_t^{NT}, e_t^y, e_t^{\Delta p}, e_t^i]'$.

$$BE_t = \begin{bmatrix} b_{11} & b_{12} & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix} \begin{bmatrix} e_t^G \\ e_t^{NT} \\ e_t^y \\ e_t^{\Delta p} \\ e_t^i \end{bmatrix} \tag{3b}$$

We can also illustrate the contemporaneous relationship between changes in a fiscal instrument with other variables in the SVAR more clearly by expressing them as a system of equations:[12]

$$u_t^G = a_{GNT} u_t^{NT} + a_{Gy} u_t^y + a_{G\Delta p} u_t^{\Delta p} + a_{Gi} u_t^i + b_{12} e_t^{NT} + b_{11} e_t^G \tag{4a}$$

$$u_t^{NT} = a_{21} u_t^G + a_{NTy} u_t^y + a_{NT\Delta p} u_t^{\Delta p} + a_{NTi} u_t^i + b_{21} e_t^G + b_{22} e_t^{NT} \tag{4b}$$

Equations (4a) and (4b) show that the government spending and net tax reduced-form residuals are a function of changes in the economy (e.g. output, prices and interest rates) and discretionary policy (structural shocks to net taxes and government spending policy). In our model specification there is no automatic way for government spending and net taxes to affect one another within a quarter ($a_{GNT} = a_{21} = 0$), and structural shocks to government spending affect net taxes but not the other way around (government spending is ordered first, b_{12}=0).

To gauge the macroeconomic impacts from a wider set of fiscal instruments, we estimate a variation of the aggregate model — which we refer to as Model 2 — where government spending is more granularly defined as public consumption and public investment, and tax revenue is examined separately from transfers. Public consumption captures government purchases of goods and services, including the compensation of public servants. Public investment measures government purchases of capital goods such as equipment, and the construction of infrastructure. Transfers largely represent spending on social assistance benefits and superannuation, and tax revenue includes revenue from sources such as goods-and-services tax.

The disaggregated model (Model 2) can be described by the reduced-form five-variable SVAR with $k = 3$ lags represented by equation (5):

$$Y_t = \sum_{i=1}^{k=3} C_i Y_{t-i} + U_t \tag{5}$$

[12] Note, a negative coefficient in the A matrix on the left hand side of equation (2) is positive when moved to the right hand side, where inferences are typically drawn (e.g. when written as equation (4a) and (4b)).

where Y_t is a seven variable vector including public consumption (c), public investment (k), tax revenue (T), transfers (tr), output (y_t), inflation (Δp_t) and interest rates (i_t).[13] C_i is a *7 X 7* matrix of coefficients. The reduced-form residuals are represented by the vector $U_t \equiv [u_t^c, u_t^k, u_t^T, u_t^{tr}, u_t^y, u_t^{\Delta p}, u_t^i]$.

The identification strategy for Model 2 is very similar to Model 1. From equation (6a) the contemporaneous elasticity of public consumption and public investment to output is set to zero (a_{cy}= a_{ky} =0). With respect to inflation, the elasticity of public consumption ($a_{c\Delta p}$) and public investment ($a_{k\Delta p}$) are set to -1 and 0, respectively. The response of transfers to output (a_{try}) and inflation ($a_{tr\Delta p}$) are assumed to be -0.78 and -1, respectively. The elasticity of tax revenue to GDP (a_{Ty}) is set as 1.35 and the elasticity with inflation ($a_{T\Delta p}$) is 0.17. The parameters coloured in red are set as zero because the fiscal variables are assumed not to automatically respond to one another within a quarter, and the macroeconomic variables are ordered recursively.

$$AU_t = \begin{bmatrix} 1 & -a_{ck} & -a_{ctr} & -a_{cT} & -a_{cy} & -a_{c\Delta p} & -a_{ci} \\ 0 & 1 & -a_{ktr} & -a_{kT} & -a_{ky} & -a_{k\Delta p} & -a_{ki} \\ 0 & 0 & 1 & -a_{trT} & -a_{try} & -a_{tr\Delta p} & -a_{tri} \\ 0 & 0 & 0 & 1 & -a_{Ty} & -a_{T\Delta p} & -a_{Ti} \\ -a_{51} & -a_{52} & -a_{53} & -a_{54} & 1 & -a_{y\Delta p} & -a_{yi} \\ -a_{61} & -a_{62} & -a_{63} & -a_{64} & -a_{65} & 1 & -a_{\Delta pi} \\ -a_{71} & -a_{72} & -a_{73} & -a_{74} & -a_{75} & -a_{76} & 1 \end{bmatrix} \begin{bmatrix} u_t^c \\ u_t^k \\ u_t^{tr} \\ u_t^T \\ u_t^y \\ u_t^{\Delta p} \\ u_t^i \end{bmatrix} \quad (6a)$$

In matrix B of equation (6b), the off-diagonal elements highlighted in red ($b_{12}, b_{13}, b_{23,} b_{14}, b_{24}, b_{34}$) are set to zero, which assumes that decisions affecting public consumption are ordered first, followed by public investment, government transfers and tax decisions. Section I of the appendix shows that the results are largely robust if this ordering of fiscal instruments is reversed.

$$BE_t = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} & 0 & 0 & 0 \\ b_{21} & b_{22} & b_{23} & b_{24} & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & b_{34} & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} \end{bmatrix} \begin{bmatrix} e_t^c \\ e_t^k \\ e_t^{tr} \\ e_t^T \\ e_t^y \\ e_t^{\Delta p} \\ e_t^i \end{bmatrix} \quad (6b)$$

[13] A constant and linear time trend are also included in the SVAR specification.

2.2 Data

Government spending is the sum of public consumption and public investment (net of weapons systems purchases)[14] from Statistics New Zealand's National Accounts data. We use government spending variables that relate to the central government as this expenditure is under the direct influence of the Government. Data on central government investment is unavailable post-2015, therefore we construct the series beyond 2015 by applying the historical ratio of central government spending to general government expenditure.[15] Tax revenue is sourced from monthly tax outturn data from the Treasury.[16] The time series for transfer spending is sourced from the Government's monthly and yearly financial statements.[17] Output is measured using expenditure GDP from Statistics New Zealand. We show the sensitivity of our results to the way these variables are defined in section I of the appendix.

Government spending, tax revenue, transfers, and GDP are all specified in log, real, per-capita terms. The fiscal and GDP data are quarterly, seasonally-adjusted and deflated with the expenditure GDP deflator where official deflated series are unavailable. Inflation is measured by the quarterly growth rate in headline CPI inflation and the 90-day bank bill rate is used for the short-term interest rate. See section III of the appendix for charts of the variables used in the estimation.[18]

The data used for the estimation spans the sample period 1990Q3 to 2017Q4, which encompasses the Reserve Bank's inflation-targeting monetary policy regime. The fiscal policy framework is also broadly consistent over this sample, with the introduction of the Fiscal Responsibility Act (1994), which included a requirement for debt to be at prudent levels. Over this period, other economically significantly events also occurred, such as the Global Financial Crisis (2007-8) and the Canterbury earthquakes (2010-11). We test whether our results are sensitive to these events in section I of the appendix, within the constraints of the sample size.

3 Results

This section presents the response of macroeconomic variables in both the aggregated and disaggregated models to a discretionary stimulus for particular fiscal variables. We illustrate the results using impulse response functions where the fiscal variables and

[14] Government investment in weapon systems has been excluded due to its volatile nature and because it does not correlate with underlying investment trends.
[15] We use the average ratio from 2000-2015 (0.65).
[16] GST on the imported navy frigates in 1997 and 1999 were removed.
[17] Statements are available from the following links:
http://www.treasury.govt.nz/government/financialstatements/monthend
https://treasury.govt.nz/publications/financial-statements-government/year-end-financial-statements
[18] The dataset used is available on the Reserve Bank website.

GDP are scaled such that the results can be interpreted as a percent of GDP. This allows the output response to be interpreted as a GDP multiplier, or 'fiscal multiplier', which shows the percentage-point (ppt) change in GDP from a change in a fiscal variable equivalent to 1 percent of GDP.[19]

In this note we refer to the multiplier on impact and the multiplier observed over the first year using the following definitions:

Impact multiplier

$$\frac{\Delta Y_{t=1}}{\Delta S_{t=1}}$$

First year multiplier

$$\sum_{t=1}^{t=4} \frac{\Delta Y_t}{\Delta S_t}$$

where ΔY_t is the impact on GDP, ΔS_t is the fiscal shock, and the time frequency (t) is quarterly.

This multiplier could be greater than 1 if the fiscal stimulus encourages more private sector activity. The multiplier can also be less than 1 for a number of reasons:

- Leakages: If government expenditure is used to purchase imports from abroad some of the potential boost to domestic demand will leak overseas;
- Crowding out: If the economy is near capacity, stimulatory fiscal policy may contribute to upward pressure on prices, interest rates and the exchange rate, thereby leading to some crowding out of private sector activity;
- Substitution: A fiscal expansion may act as a direct substitute for private sector spending; and
- Ricardian equivalence: Households may behave in a forward-looking manner by increasing their savings in response to a fiscal stimulus in anticipation of higher tax liabilities in the future.

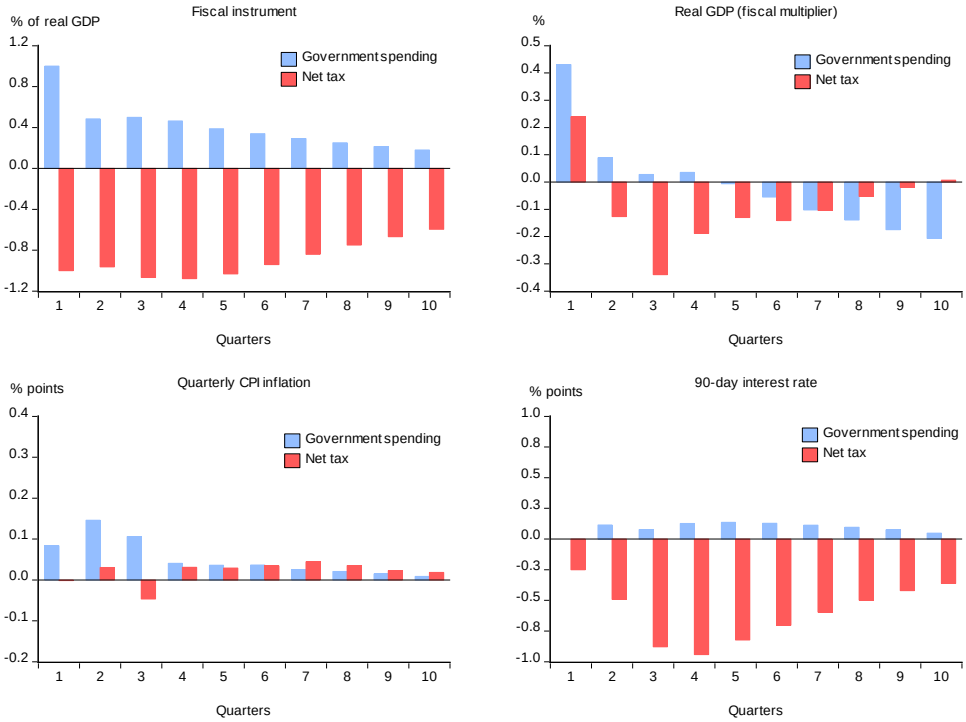
After presenting the multiplier estimates, we provide an illustration of how they can be applied in a scenario where the fiscal policy shock is persistent rather than transitory. We then discuss how the application of multiplier estimates could depend on different states of the world.

[19] Suppose we have a shock in government spending in the size of 1%. Since the share of government spending in GDP is about 30%, this size of the shock corresponds to 0.3 percent of GDP. After this shock assume that output increases by 0.6 percent. The corresponding multiplier (increase in percent of GDP due to a 1 percent of GDP increase in spending would then be 2 (0.6/0.3=2)).

3.1 Model 1: Aggregated fiscal SVAR

This sub-section presents the results of two simulations using Model 1. We first consider an exogenous increase in discretionary government spending, and second show the impact of a fall in net taxes (taxes less transfers). Both shocks are equivalent to 1 percent of GDP.[20] Figure 5 shows the response of the macroeconomic variables to each of these fiscal policy shocks.[21]

Figure 5: Response of macroeconomic variables to each fiscal shock in Model 1[22]



Note: The charts represent the impact on the level of each macroeconomic variable from a 1 percent of GDP transitory increase in government spending and a 1 percent of GDP transitory decrease in net taxes (tax cut). The impact on inflation should be interpreted as the change in quarterly CPI inflation.

For an increase in government spending (blue bars in Figure 5), the level of GDP increases in the first four quarters after the shock. Much of the increase is front loaded in the first quarter where GDP is higher by 0.43 ppts in response to the shock. The shock to government spending itself fades fairly quickly after the initial 1 percent of GDP increase. Quarterly CPI inflation increases given the increase in economic activity, peaking at around 0.15 ppts in the second quarter. Stronger inflationary pressure

[20] The results produced by the SVAR are linear such that the signs of the impulse responses are reversed for a negative fiscal shock, while the absolute magnitudes remain the same.
[21] For detailed impulse response functions, including error bands, see section IV of the appendix.
[22] We do not present confidence bands around our impulse responses in this and the following section to preserve the readability of the graphs. Section IV in the appendix shows all impulse response functions with confidence bands, and section I presents sensitivity tests to give a fuller picture of the reliability of the estimates.

prompts a rise in the short-term interest rate (i.e. monetary policy tightening), peaking at about 14 basis points in the second year. The higher path for the short-term interest rate stabilises quarterly CPI inflation beyond the first year and dampens the GDP response. The estimated multiplier for government spending is robust to alternative specifications of the variables used and sample choice, as shown by the sensitivity tests in Table A1 of the appendix. Section IV of the appendix shows that the responses of the macroeconomic variables are statistically insignificant after the first quarter.

A fall in net taxes equivalent to 1 percent of GDP generates quite different responses to the equivalent change in government spending. The GDP response is initially positive (+0.24 ppts) as one would expect. The GDP response then becomes negative, corresponding to a brief fall in quarterly CPI inflation in the third quarter (both statistically insignificant), and a persistent and large fall in the short-term interest rate that is statistically significant within the first two years. The interest rate response is unusual and should be interpreted with caution. It has the opposite sign to that of a government spending shock despite the CPI inflation response also being positive. The change in the interest rate also has a much larger magnitude than in the case of a government spending shock, contrary to the results in Parkyn and Vehbi (2014).[23] The difference relative to their result can largely be explained by the updated sample period that we use and the exclusion of a government debt constraint.

The fact that the GDP multiplier turns negative after one quarter following a fall in net taxes is a counter-intuitive, but a common finding in the empirical literature. Parkyn and Vehbi (2014) find a negative GDP response in the second and third quarter for New Zealand and Perotti (2005) had similar findings for UK, Germany and Australia. The results of section 3.2 (Model 2) show the "tax puzzle" may relate more to the presence of transfers, as the puzzle is eliminated when tax is modelled separately from transfers. It could also be the case that the correlation of taxes and GDP may not be adequately controlled for with the elasticities imposed under the B-P approach adopted in this paper — tax revenues may vary in part due to an omitted factor such as commodity price fluctuations. An alternative estimation approach, which focuses on specific tax announcements to conduct event studies may offer a more robust framework for identification.[24] Multipliers associated with tax changes using this alternative approach can differ substantially from the traditional B-P method.

While responses in Model 1 appear broadly in line with previous New Zealand studies, the results should be treated with caution, particularly for a net tax shock. Section I of the appendix shows the multiplier for net taxes is very sensitive to the variable and

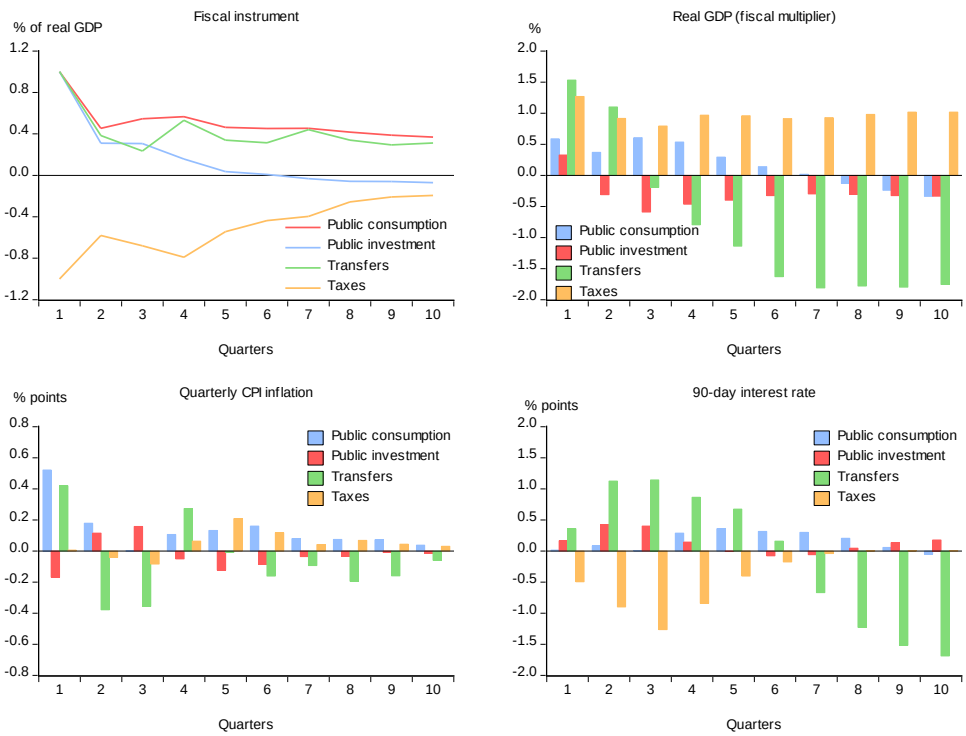
[23] The response of the long-term, 10-year interest rate in Parkyn and Vehbi (2014) to a tax cut is initially negative within the first year, but then increases by around six basis points.
[24] See Parkyn, Vehbi and Haug (2017) for an examination of tax shocks using a narrative data set constructed for New Zealand.

sample choice, more so than for a government spending shock. We will show next how the disaggregated model (Model 2) in the next section is able to offer more useful insights that may be hidden at the aggregate level.

3.2 Model 2: Disaggregated fiscal SVAR

In the disaggregated model we separately simulate an increase in public consumption, public investment, and transfers as well as a decrease in tax revenue.[25] The responses to each shock are plotted in Figure 6. The fiscal shocks themselves display varying levels of persistence depending on the instrument, as shown in the top left hand chart of Figure 6. This likely reflects the timing of how each instrument is typically implemented. For example, public consumption includes public sector wages, where increases are generally persistent. However, all shocks dissipate and are close to zero in the fifth year after the initial shock (see section IV of the appendix). The structural shocks for each fiscal instrument appear to coincide with key policy changes over history, and indicate a similar narrative around the cyclicality of fiscal policy as the Treasury's Fiscal Impulse indicator (see section VII of the appendix for a discussion).

Figure 6: Response of macroeconomic variables to each fiscal shock in the disaggregated model (Model 2)



Note: The charts represent the impact on the level of each macroeconomic variable from a 1 percent of GDP transitory increase in public consumption, public investment and transfers, as well as a 1 percent of GDP transitory decrease in tax revenue (tax cut). The impact on inflation should be interpreted as the change in quarterly CPI inflation.

[25] As in Model 1, these changes are presented as a shock the size of 1 percent of GDP.

The response in the level of GDP to a public consumption shock is positive over the two years following the shock, with a peak of 0.61 ppts in quarter three. The response is also larger and more prolonged than the shock to *aggregate* government spending in Model 1. The rise in CPI inflation is also higher and more persistent than for a government spending shock, corresponding to more aggressive monetary policy tightening. This increase in inflationary pressure could reflect both stronger economic activity and historical spillover effects from public sector wage growth and compensation. The interest rate response peaks in the second year. However, the responses of the macroeconomic variables are statistically insignificant.

In contrast to public consumption, a discretionary increase in public investment worth 1 percent of GDP generates a more subdued GDP response. GDP only increases by 0.33 ppts in the first quarter and quickly turns negative thereafter, but the response is statistically insignificant. As the impact on output is weak, the inflationary pressures from the public investment shock is also short-lived, peaking in the third quarter. The subdued response of GDP compared to a public consumption shock may reflect the quicker response of interest rates in the first two quarters (which is statistically significant).

The weak multiplier for a public investment shock is sensitive to several assumptions so the results reported here should be treated with caution.[26] First, the GDP response is positive throughout the horizon when estimating the model using general (instead of central) government fiscal variables. Second, in samples beyond 1993Q1, the response of GDP is less negative in the first year and also becomes positive beyond that in the second and third year. The early 1990s coincided with a disinflationary period and a sharp decline in government investment, which may account for the unusual dynamics when estimating over the full sample. Third, in a variant of Model 2 we estimate the multipliers by distinguishing between construction-related investment (residential and non-residential) and 'other' investment (infrastructure, plant and machinery, and intangible assets). The subdued GDP response at the aggregate level appears partly driven by shocks to the former category, suggesting that capacity constraints may be more binding in the residential and non-residential construction sectors. In contrast, the GDP impact for public investment for the 'other' category is always positive over the five years after the shock.[27] In relation to the international evidence, the low GDP multiplier in the short term for public investment is still somewhat surprising and we return to this discussion later in section 3.3.

[26] Refer to section V of the appendix for further detail on the sensitivity tests.
[27] The time horizon considered in the SVAR model (at most five years) may be too short to pick up any long-term benefits of government investment, such as improvements to the productive capacity of the economy. See Abiad et al. (2015) from the IMF for analysis on the long term macroeconomic effects of public investment.

An increase in transfers spending equivalent to 1 percent of GDP produces a strong positive GDP response in the first two quarters that is statistically significant. CPI inflation also spikes in the first quarter, increasing 0.42 ppts. There is a large and sustained increase in interest rates following this shock, but this effect is insignificant beyond the third quarter. It is worth noting that the large interest rate response may also be correlated with an omitted factor that is not being controlled for in the model. One interpretation for the strong initial GDP response is that transfer spending over history is well targeted to households that are liquidity-constrained. These households will readily use the additional income from transfers to increase their consumption, which then stimulates private sector demand even further – generating a multiplier above 1. Another interpretation is that, Ricardian equivalence does not hold to a strong degree amongst households (at least in the short term). Overall, the dynamics suggest that while the impulse to aggregate demand from transfers spending is initially strong, the boost to activity has typically been offset by a high degree of monetary tightening.

GDP responds positively to a fall in tax revenue, as opposed to the prolonged negative response associated with a net tax shock (taxes less transfers) in Model 1. The GDP response is statistically significant in the five quarters following the shock. Therefore, it appears that the 'tax puzzle' in Model 1, and in other studies such as Parkyn and Vehbi, 2014, could relate to the exclusion of transfers in the measure of net tax. The positive impact on quarterly CPI inflation is significant in the fifth quarter — with a change of 0.21 ppts. The negative response in the interest rate is sizeable, falling as much as 126 basis points, and is statistically significant. As in Model 1, this unusually large response could suggest that the interest rate response is correlated with an omitted factor that is not being controlled for in the SVAR.

3.3 Key insights and comparison with existing literature

For ease of comparison we summarise the GDP multipliers for each fiscal shock from both models in Table 1. This table reports the estimated multiplier on impact (in the same quarter of implementation), the accumulated response over the first year,[28] and the difference between the maximum and minimum multiplier estimates given a range of sensitivity checks. There are three key observations that can be drawn about the aggregate demand impact across different fiscal instruments:

1. The timing of the GDP response differs depending on the fiscal instrument. The GDP response to a change in aggregate government spending, public investment, transfers, and net taxes (total taxes less transfers) is relatively front-loaded. The peak impact occurs in the first or second quarter before

[28] This is a common way of interpreting multiplier estimates in the literature. Section IV of the appendix also shows that the estimated GDP responses are generally less robust beyond the first year.

fading or switching signs such that the first year multiplier is lower as a result. By contrast, the demand impact from a shock to public consumption and total taxation is more persistent.

2. Aggregated measures of fiscal policy (as used in Model 1), which have been the norm in previous New Zealand studies, hide interesting compositional effects. Namely, the strong response to a public consumption shock and weaker response to public investment appear to average out at the aggregate level (total government spending). Separating net taxes into total tax and transfers also accounts for the 'tax puzzle' in the baseline model, while also giving an indication of the GDP impact from changes in transfers spending.

3. The estimated multipliers for government spending and its components appear to be more robust to sensitivity tests, such as variable choice and sample size, compared with taxes and transfer spending. The endogeneity problem between economic conditions and taxes and transfers may be more serious than it is for government spending.[29] This suggests that the B-P approach may not be sufficient for the identification of discretionary tax and transfer shocks and it is best to complement these estimates with alternative techniques and evidence.[30]

Table 1: Summary of fiscal multipliers across both models

		GDP multiplier		Spread (max less min)	
Model	Fiscal shock	First quarter	First year	First quarter	First year
Model 1: aggregated	Government spending	0.43	0.24	0.25	0.64
	Net taxes	0.24	-0.10	0.96	0.85
Model 2: dissagregated	Public consumption	0.59	0.82	0.56	1.82
	Public investment	0.33	-0.59	0.44	1.42
	Transfers	1.53	0.76	1.13	4.52
	Tax revenue	1.27	1.29	2.97	2.74

Note: For government spending and transfers, the fiscal shock is a transitory positive shock equivalent to 1 percent of GDP. For net taxes (tax revenue less transfers) and tax revenue, the fiscal shock is a decline (tax cut) equivalent to 1 percent of GDP. The minimum and maximum estimates used to calculate the spread are taken from section I of the appendix.

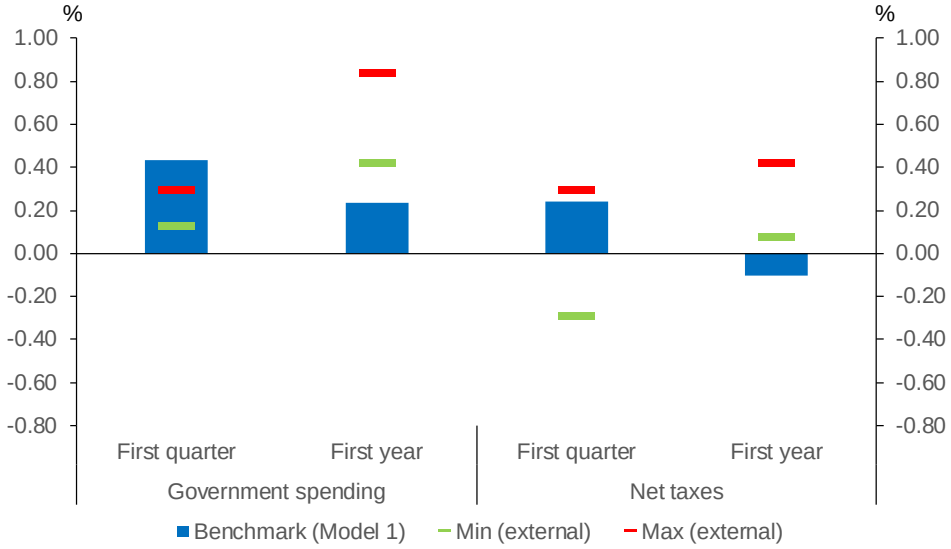
The results of Model 1 are broadly similar to estimates from other studies using New Zealand data. The estimated GDP multiplier for government spending is higher on impact, but below the range of other estimates for New Zealand when looking at the multiplier over the first year (Figure 7). For a shock to net taxes, the positive response

[29] Changes in tax revenue and transfer payments due to discretionary decisions are the exception rather than the rule, and so more difficult to identify, while the opposite is the case for government spending.

[30] In the case of tax shocks in particular, a shock to tax revenues is hard to interpret given most policy changes are to the tax structure (e.g. tax rates). A narrative data set of tax shocks as shown in Parkyn, Vehbi and Haug (2017) can provide a useful alternative.

of GDP on impact is within the range of previous studies, although we find a negative multiplier over the first year, while others find a positive multiplier.

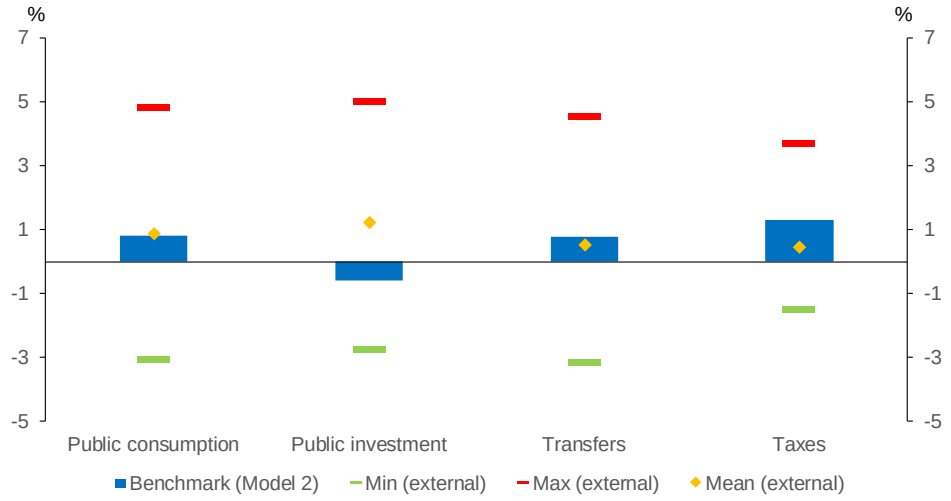
Figure 7: Comparison of GDP multipliers (Model 1) with previous New Zealand studies



Note: The external studies used to calculate the minimum and maximum estimates are Claus et al. (2006), Dungey and Fry (2007), Murray (2013), IMF (2009), Parkyn and Vehbi (2014). For further detail of each individual study, see Table A6 in the appendix.

We next compare our fiscal multiplier estimates for individual fiscal variables with the international evidence compiled by Gechert and Rannenberg (2014) in Figure 8. Gechert and Rannenberg conduct a meta-regression analysis on a dataset of 98 empirical studies of fiscal multipliers. Our estimated multipliers are well within the range of these other studies and are not at the extremes. This is consistent with New Zealand being a small open economy, with a floating exchange rate and an inflation-targeting central bank. Ilzetzki, Mendoza, and Végh (2011) undertake analysis over 44 countries, and conclude that multipliers are lower ("essentially zero") in countries with flexible exchange rates, and that the response of central banks, and a country's openness to trade is "crucial" when determining multiplier size. This means that the multiplier effects of a positive fiscal shock can be offset by both monetary policy tightening and an upward adjustment in the exchange rate. Such features of New Zealand's economy are an important consideration when interpreting the multiplier estimates.

Figure 8: Comparison of GDP multipliers (Model 2) with empirical literature



Note: Multipliers are cumulative over the first year following the fiscal shock. The min, max and median of external cross-country multiplier estimates are sourced from Gechert and Rannenberg (2014).

The estimated multipliers for public consumption and transfer shocks are close to the mean of these studies. The multiplier on public investment, as alluded to earlier, is quite different from the mean internationally but lies within the (wide) range of multipliers reported. There are at least four plausible explanations for the weak short-term response of GDP to a government investment shock in New Zealand:

1. Public investment is often associated with imported goods, such as capital equipment, particularly in the early stages of a project. As imports are deducted from GDP, this may be driving the negative GDP multiplier.

2. Public investment may be 'crowding out' private investment through the rationing of credit, as interest rates are estimated to respond more quickly than in the case of public consumption, or through consuming other scarce resources that private investment requires, such as labour.

3. The model could be improperly specified. This model assumes that the contemporaneous elasticity of public investment to GDP is zero (due to information, decision, and implementation lags). However, in 2010-11 the Christchurch earthquakes prompted large-scale public investment and lower GDP growth. The assumption that government investment does not contemporaneously respond to GDP may be less valid in this instance, and the model may interpret government investment in that period as causing the lower GDP growth, rather than responding to it. Interestingly, the multipliers for a government investment shock are slightly larger when the sample

excludes the period of earthquake-related reconstruction post-2010Q2 (see Table A2, appendix).

4. Data quality. The data for central government investment has been suppressed by Statistics New Zealand since 2015 due to concerns around data quality, and our constructed public investment variable could be mis-measured. Another factor is that public investment is small relative to other fiscal variables — 4 percent of GDP whereas public consumption is around 17 percent. Its small size may make it more difficult to identify the precise impact on the economy.

In contrast to the public investment multiplier, the estimated tax multiplier appears to be larger in New Zealand (at 1.30) than elsewhere (around 0.44). One reason could be the composition of taxes in New Zealand, with a greater proportion of tax receipts from personal and corporate income than from sales tax compared to the OECD average. This may increase the weighted elasticity of the behavioural response to tax shocks, such that the income effect is felt more strongly.[31] Examining the different macroeconomic effects of different tax instruments would be a useful extension of the model and is left for future work.

3.4 A persistent change in fiscal policy

To aid in the application of our results, we show how GDP would respond if the change in fiscal policy was instead more persistent over a three-year horizon. The results so far in section 3 illustrate only a transitory shock in fiscal policy where changes are assumed to occur in the first quarter and then gradually phased out. However, the implementation of newly-announced fiscal spending and tax decisions tend to be spread out over several years, rather than implemented up front in the first quarter.

Using the results from Model 2, we illustrate a scenario where the change in each fiscal instrument (equivalent to 1 percent of GDP) is phased in gradually over the first year, and then persists in years two and three.[32] In Figure 9, the impact on GDP in this scenario for each fiscal instrument are plotted against the impulse responses to a transitory shock that were shown in Figure 6. As the positive response of GDP to a transitory shock in public consumption and tax revenue is more long-lasting, the level of GDP can deviate even higher over the horizon when the policy change is sustained.[33] For a persistent change in transfers spending, the impact on GDP starts weakening

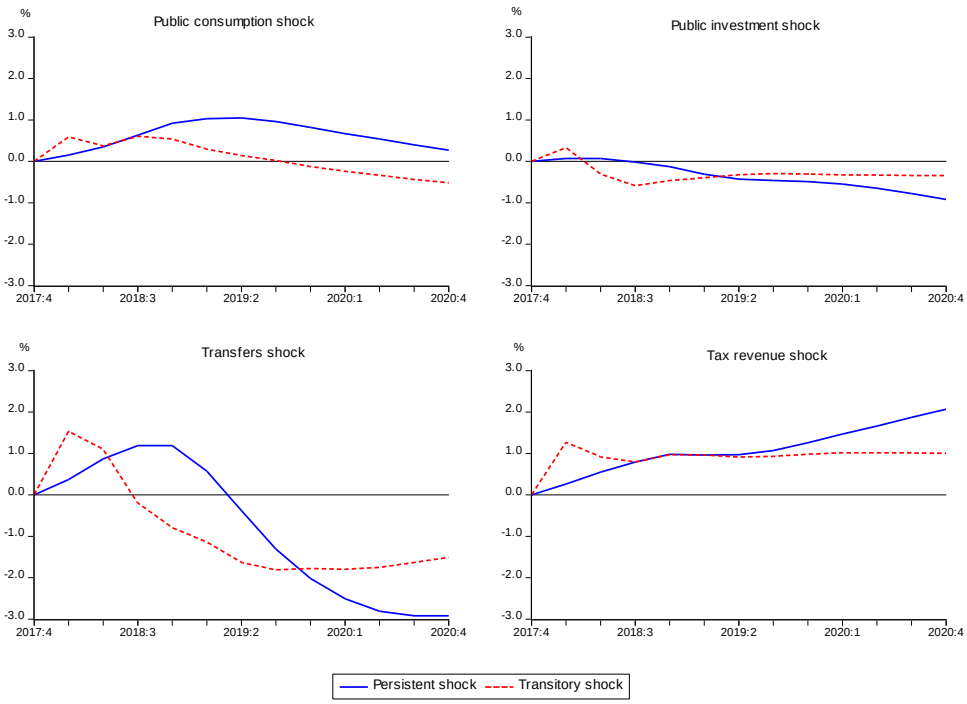
[31] See OECD revenue statistics (2016): https://www.oecd.org/tax/revenue-statistics-new-zealand.pdf

[32] Note that the persistent fiscal shock presented here should be distinguished from a 'permanent' shock as the latter may alter the steady-state path of the variables and therefore the long-run dynamics in the model could change.

[33] Despite the persistence of some of the GDP responses, some may settle back to zero beyond the 3-year horizon considered here. Figures A3-A6 of the appendix show the impulse responses to a transitory shock over a five-year period.

after the first year, given the front-loaded nature of the multiplier under a transitory shock. For public investment, given that the multiplier was found to be negative beyond the first quarter under a transitory shock, the level of GDP is largely unchanged in the first year and eventually turns negative.

Figure 9: Impact on GDP to a persistent fiscal shock equivalent to 1 percent of GDP



Note: The charts represent the impact on the level of GDP from each fiscal shock, using 2018Q1 as the start date for policy implementation. The persistent shock illustrates a 1 percent of GDP stimulus in fiscal spending and tax revenue that is phased in gradually over the first year and then persistently higher at that level thereafter. The transitory shock corresponds to a 1 percent of GDP shock in the first quarter which then dissipates beyond that.

We caution against over-interpreting the output dynamics in this illustrative scenario given the robustness issues with Model 2 highlighted earlier. The impact on output is also originally estimated in response to one-off, non-persistent fiscal shocks. To fully examine different fiscal policy scenarios such as the duration of policy changes, a structural model is required that is able to generate internally-consistent dynamics in the macroeconomic variables, supported by economic theory.[34]

4 State-dependency of multipliers

As the SVAR is estimated from observed outcomes across previous business cycles, they illustrate the dynamics that one would expect *on average*. For instance, as interest rates often move in response to fiscal policy over past business cycles, the estimated multiplier from the SVAR model captures the average of this monetary policy

[34] For example, see Coenen et al. (2012) for a survey of fiscal policy transmission in structural policy models.

accommodation or offset. Fiscal multipliers have been shown to be state-dependent, namely, multipliers are more positive in severe downturns than in strong expansions (Auerbach & Gorodnichenko, 2012), and when nominal interest rates are unable to respond if they are constrained at the effective lower bound (Christiano, Eichenbaum, & Rebelo, 2011; Eggertson, 2010; Murray, 2013). The influence of these different states on the economic effects of fiscal policy may account for the high degree of sensitivity of our estimated multipliers to different sample periods as illustrated in section I of the appendix. For example, the first year multipliers in Model 2 for fiscal expenditure components were found to be considerably higher in the restricted sample of 2002Q1-2017Q4 relative to estimates using the full sample. Estimating the state dependency of fiscal multipliers in New Zealand could be usefully explored with alternative VAR methods.[35]

5 Conclusion

This Analytical Note estimates the impact of discretionary fiscal policy on the macroeconomy for New Zealand using SVAR analysis. We update multipliers for aggregate government spending and net taxes and find that these sit broadly in line with previous New Zealand studies. Our analysis also represents a first attempt at quantifying the economic impacts of public consumption, public investment, transfers and taxes for New Zealand in one model. In terms of the cumulative impact on GDP over the first year in response to a 1 percent of GDP stimulus in the fiscal instrument, tax revenue has the largest impact (1.29 ppts), followed by public consumption (0.82 ppts), transfers (0.76 ppts) and public investment (-0.59 ppts). These short-term multiplier estimates sit within the range of international studies, although the sign of the public investment multiplier is puzzling.

Taking a more granular view of fiscal policy reveals offsetting dynamics that were disguised in the aggregate model. We find that the tax puzzle (where the response of GDP is negative during the first year in response to a tax cut) disappears when taxes are examined separately from transfers. The small multiplier for aggregate government spending also appears to disguise the offsetting multiplier effects for public consumption and investment.

The wide confidence intervals around the generated impulse response functions indicates considerable parameter uncertainty. Further, the results are somewhat dependent on researcher choice of sample, variables, and identification. The output responses to public consumption and public investment shocks appear to be the most robust to these choices. This Note has tried to make the decisions around all three as

[35] These include non-linear VAR models such as smooth transition and Markov switching VARs.

transparent as possible, and displayed the impacts of variation to these choices in the appendices.

Disaggregating the fiscal shocks has been fruitful and can provide a useful input for calibrating structural models to understand how future policy changes could affect the economy. More work could be done to further understand the macroeconomic impact of fiscal policy. One of the main reasons multipliers are thought to be smaller in New Zealand is due to the exchange rate regime. Including the external sector would help increase understanding of this dynamic. Disaggregating taxes further, or separating GDP into private consumption and investment could be equally worthwhile.

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APPENDIX

I. Sensitivity of fiscal multiplier estimates

In this section, we vary the specifications for each model from the benchmark described in section 2 in the main text to assess the sensitivity of the fiscal multipliers. The variations that we consider one by one in Tables A1 and A2 include:

- Using fiscal expenditure data of the general government rather than just central government;
- Scaling the variables by working-age population rather than total population;
- Using production GDP instead of expenditure GDP;
- Using the expenditure GDP deflator for the quarterly inflation variable in the SVAR as opposed to headline CPI inflation as in Parkyn and Vehbi (2014);
- Deflating the nominal variables using CPI inflation instead of the GDP deflator;
- Reversing the order of fiscal policy decisions. For example in Model 2, we change it so that tax decisions are made first and decisions on public consumption made last;
- Varying the number of lags in the SVAR to 2 and 4 lags instead of using 3;
- Restricting the sample size to when interest rates were stationary prior to the GFC (1993Q1-2008Q4), when interest rates have been trending down[36] (2002Q1-2017Q4) and the period prior to the 2010-11 Canterbury earthquakes (1990Q3 – 2010Q2).

Table A1: Variations to Model 1

Specification	Government Spending		Net taxes	
	First quarter	First year	First quarter	First year
Benchmark	0.43	0.24	0.24	-0.10
General government	0.36	0.34	0.08	-0.17
Working age population	0.40	0.22	0.26	-0.06
Production GDP	0.21	0.04	0.09	-0.13
GDP deflator as inflation variable	0.33	0.14	0.18	-0.03
Deflating nominal variables with CPI	0.42	0.24	0.61	0.20
Reversing the ordering of variables	0.43	0.24	0.25	-0.10
2 lags	0.35	0.17	0.37	0.09
4 lags	0.46	0.46	0.36	-0.12
Sample: 1993Q1 - 2008Q4	0.43	-0.18	-0.01	-0.48
Sample: 2002Q1 - 2017Q4	0.21	0.06	-0.35	-0.65
Sample: 1990Q3 - 2010Q2	0.45	0.06	0.25	-0.28
Min	0.21	-0.18	-0.35	-0.65
Median	0.41	0.19	0.24	-0.11
Max	0.46	0.46	0.61	0.20
Range (max less min)	0.25	0.64	0.96	0.85

[36] This downward trend reflects a decline in the neutral Official Cash Rate, see Williams (2017).

Table A2: Variations to Model 2

Specification	Public consumption		Public investment		Transfers		Tax revenue	
	First quarter	First year	First quarter	First year	First quarter	First year	First quarter	First year
Benchmark	0.59	0.82	0.33	-0.59	1.53	0.76	1.27	1.29
General government	0.61	0.88	0.43	0.50	1.17	-0.02	0.67	0.77
Working age population	0.60	0.85	0.25	-0.79	1.60	1.16	1.29	1.41
Production GDP	0.24	0.02	0.15	-0.17	0.65	-0.25	0.57	0.59
GDP deflator as inflation variable	0.31	0.84	0.36	-0.51	1.69	1.08	1.51	1.68
Deflating nominal variables with CPI	0.80	1.31	0.32	-0.52	1.73	0.91	2.93	2.18
Reversing the ordering of variables	0.45	0.83	0.22	-0.70	1.78	1.02	1.23	1.27
2 lags	0.67	1.03	0.07	-0.91	1.56	0.42	1.39	1.56
4 lags	0.77	0.67	0.43	-0.16	1.22	0.53	1.49	1.10
Sample: 1993Q1 - 2008Q4	0.43	-0.51	0.50	-0.13	1.58	0.28	1.18	0.21
Sample: 2002Q1 - 2017Q4	0.56	1.00	0.17	0.17	1.04	4.24	-0.04	-0.56
Sample: 1990Q3 - 2010Q2	0.54	0.24	0.41	-0.13	1.31	-0.28	1.48	0.97
Min	0.24	-0.51	0.07	-0.91	0.65	-0.28	-0.04	-0.56
Median	0.57	0.84	0.32	-0.34	1.54	0.65	1.28	1.18
Max	0.80	1.31	0.50	0.50	1.78	4.24	2.93	2.18
Range (max less min)	0.56	1.82	0.44	1.42	1.13	4.52	2.97	2.74

II. Identification strategy

Elasticity of government spending with respect to inflation

The price elasticity of government spending is set to -0.5 in line with the assumptions used by Perotti (2005). The majority of nominal public consumption is typically fixed within the quarter and invariant to contemporaneous changes in price (i.e., a price elasticity of 0). For instance, public sector wages tend to be fixed up to a year. Therefore, if CPI inflation increased by 1 percent and nominal public consumption does not respond within the quarter then *real* public consumption decreases by 1 percent implying a price elasticity of -1 ($a_{c\Delta p} = -1$). Public investment may be fixed in nominal terms in the quarter or could be effectively indexed to inflation, implying the price elasticity of nominal government investment is likely to be closer to one, and therefore real government investment would be unchanged ($a_{k\Delta p} = 0$). As the sum of public consumption and investment, the price elasticity of real total government spending ($a_{G\Delta p}$) seems likely to lie below 0 but above -1. Therefore, an elasticity of -0.5 is used as a compromise in Model 1.

Elasticity of transfers with respect to GDP (a_{try})

Elasticity of transfers with respect to GDP is calculated as the weighted average of the elasticities for social benefits, unemployment benefits and superannuation (see Table A3).

Table A3: Elasticities between transfers and GDP

Transfer type	(1) Share of total transfers	(2) Elasticity w.r.t GDP	(3) Weighted elasticity=(1)×(2)
Social benefits	0.47	-1.09	-0.51
Unemployment benefit	0.08	-3.37	-0.27
Superannuation	0.45	0	0
Total transfers			-0.78

Note: Transfers data is sourced from Treasury. The elasticities with respect to GDP are from Price et al. (2015).

Elasticity of transfers with respect to inflation ($a_{tr\Delta p}$)

Many transfers are indexed to CPI, others effectively indexed to wages (NZ Superannuation), and some are not linked to prices at all. Those that are indexed are evaluated yearly and applied usually April 1st each year based on inflation data from the previous December quarter. Therefore, it is reasonable to assume inflation does not impact nominal transfer spending contemporaneously within one quarter. Thus, as with pubic consumption, we assume the elasticity of *real* transfers to price is -1 ($a_{tr\Delta p} = -1$).

Elasticity of tax revenue with respect to GDP (a_{Ty})

The elasticity of tax revenue with respect to output is calculated as the weighted average of output elasticities for individual tax, corporate tax and indirect tax (see Table A4).

Table A4: Elasticities between tax and GDP

Tax type	(1) Share of total tax	(2) Elasticity w.r.t GDP	(3) Weighted elasticity=(1)×(2)
Individual tax	0.46	1.23	0.56
Corporate tax	0.14	2.38	0.33
Indirect tax	0.37	1.22	0.45
Total tax			1.35

Note: The tax data is sourced from Treasury tax receipt outturn data. The elasticities with respect to GDP are from Price et al. (2015).

Elasticity of net tax (taxes less transfers) with respect to GDP (a_{NTy})

$$= 1.35 \times \frac{total\ taxes}{total\ taxes + total\ transfers} - (-0.78) \times \frac{total\ transfers}{total\ taxes + total\ transfers}$$

$$= (1.35 \times 0.74) - (-0.78 \times 0.26)$$
$$= 1.20$$

Elasticity of tax revenue with respect to price ($a_{T\Delta p}$)

The elasticity of tax revenue with respect to price is calculated as the weighted average of price elasticities for individual tax, corporate tax and indirect tax (see Table A5). The price elasticity of nominal corporate tax and indirect tax are assumed to be one, as corporate tax has an uncertain relationship with price and indirect taxes (e.g. GST) are largely proportional. The elasticity of real corporate and indirect taxes with respect to price are therefore assumed to be zero.

Table A5: Elasticities between tax and prices

Tax type	(1) Share of total tax	(2) Elasticity w.r.t price	(3) Weighted elasticity=(1)×(2)
Individual tax	0.46	0.38	0.17
Corporate tax	0.14	0	0
Indirect tax	0.37	0	0
Total tax			0.17

Note: The tax data is sourced from Treasury tax receipt outturn data. The elasticities with respect to price are from Price et al. (2015).

Elasticity of net tax (taxes less transfers) with respect to price ($a_{NT\Delta p}$)

$$= 0.17 \times \frac{total\ taxes}{total\ taxes + total\ transfers} - (-)1 \times \frac{total\ transfers}{total\ taxes + total\ transfers}$$

$= (0.17 \times 0.74) - (-1 \times 0.26)$
$= 0.39$

Below we report the A and B matrices for Model 1 and 2 after substituting in the assumed contemporaneous elasticities (calculated above) as well as the estimated coefficients (with p-values in parenthesis).

Model 1: Aggregated fiscal SVAR

$A =$

1	0	0	0.50	0
0	1	-1.20	-0.39	0
-0.09	0.04	1	0	0
(0.02)	(0.28)			
-0.02	0.00	0.03	1	0
(0.25)	(0.95)	(0.48)		
0.00	-0.04	0.07	-0.02	1
(0.92)	(0.03)	(0.18)	(0.84)	

$B =$

0.02	0	0	0	0
(0.00)				
0.00	0.03	0	0	0
(0.90)	(0.00)			
0	0	0.01	0	0
		(0.00)		
0	0	0.0	0.00	0
			(0.00)	
0	0	0	0	0.00
				(0.00)

Model 2: Disaggregated fiscal SVAR

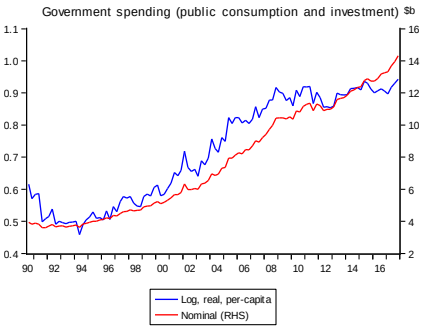
$A =$

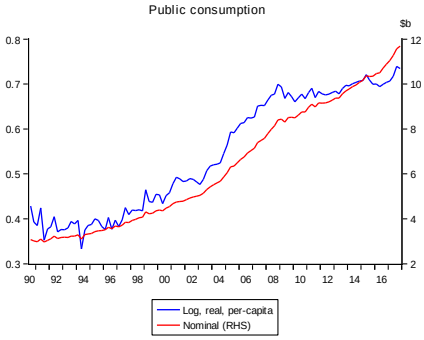
1	0	0	0	0	1	0
0	1	0	0	0	0	0
0	0	1	0	0.78	1	0
0	0	0	1	-1.35	-0.17	0
-0.16	-0.01	-0.24	0.39	1	0	0
(0.08)	(0.54)	(0.00)	(0.00)			
-0.10	0.01	-0.05	0.02	0.01	1	0
(0.00)	(0.13)	(0.04)	(0.57)	(0.91)		
0.02	-0.01	-0.01	-0.11	0.04	-0.12	1
(0.34)	(0.07)	(0.77)	(0.00)	(0.30)	(0.19)	

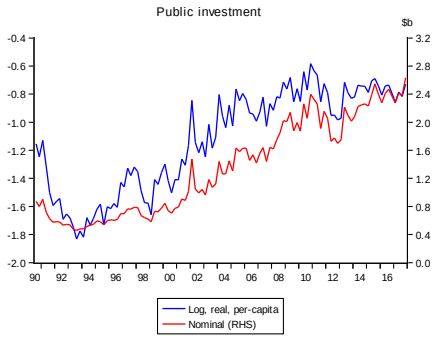
$B =$

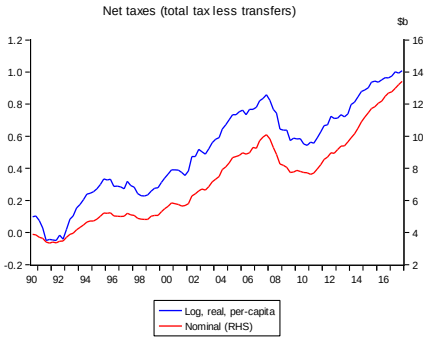
0.02	0	0	0	0	0	0
(0.00)						
0.01	0.10	0	0	0	0	0
(0.29)	(0.00)					
0.00	0.00	0.02	0	0	0	0
(0.36)	(0.66)	(0.00)				
0.00	0.00	0.00	0.02	0	0	0
(0.95)	(0.38)	(0.56)	(0.00)			
0	0	0	0	0.01	0	0
				(0.00)		
0	0	0	0	0	0.00	0
					(0.00)	
0	0	0	0	0	0	0.00
						(0.00)

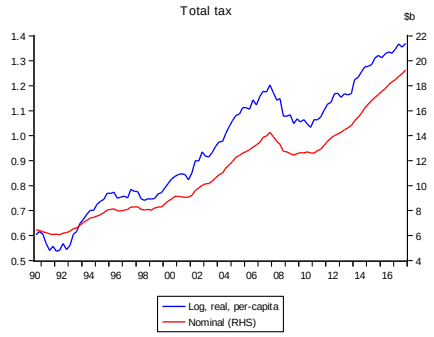
III. Data used in benchmark estimations

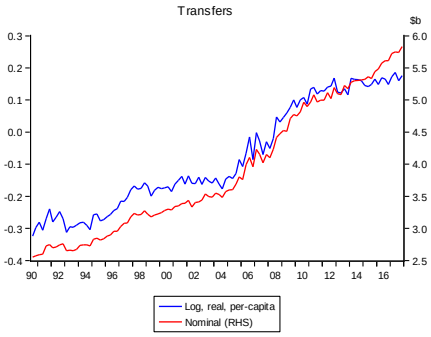


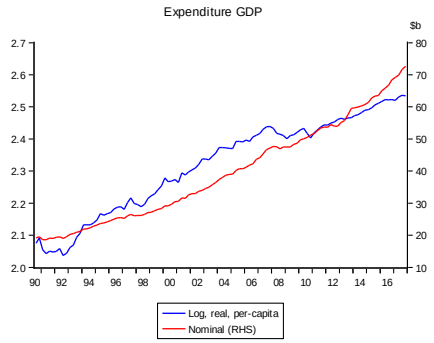


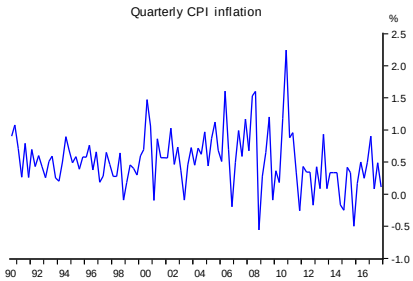


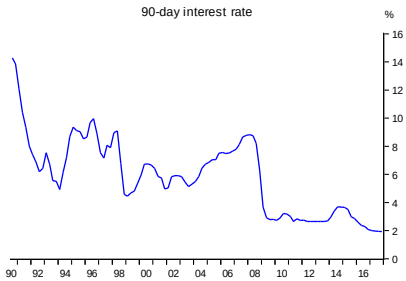












Variable	Description	Code	Source
G	Log of real government spending (central government, seasonally-adjusted, per-capita, net of weapons systems purchases)	LNGSC_TZQ	Statistics NZ
c	Log of real public consumption (central government, seasonally-adjusted, per-capita)	LNCGC_TZQ	Statistics NZ
k	Log of real public investment (central government, seasonally-adjusted, per-capita net of weapons systems purchases) – series after 2015 is constructed using historical ratio of central government to general government expenditure.	LNIGC_TZQ	Statistics NZ
NT	Log of real net taxes (central government, seasonally-adjusted, per-capita) – Total tax revenue less transfer spending	LNETTAXC_TDZQ	Treasury
T	Log of real total tax revenue (central government, seasonally-adjusted, per-capita)	LTAXC_TDZQ	Treasury
tr	Log of real transfer spending (central government, seasonally-adjusted, per-capita)	LTRNC_TDZQ	Treasury
y	Log of real GDP (expenditure-based, seasonally-adjusted, per-capita)	LNGDP_TZQ	Statistics NZ
Δp	Quarterly growth rate of CPI: all groups	CPI	Statistics NZ
i	90-day bank bill rate	INT90	RBNZ

IV. Detailed impulse response functions

Note: The charts represent the impact on the level of each variable from a transitory fiscal shock equivalent to 1 percent of GDP. The impact on inflation should be interpreted as the change in quarterly CPI inflation. The dotted lines represent the ± 2 standard error interval. The frequency of the time horizon is quarterly.

Model 1: Aggregated fiscal SVAR

Figure A1: Response to a government spending shock

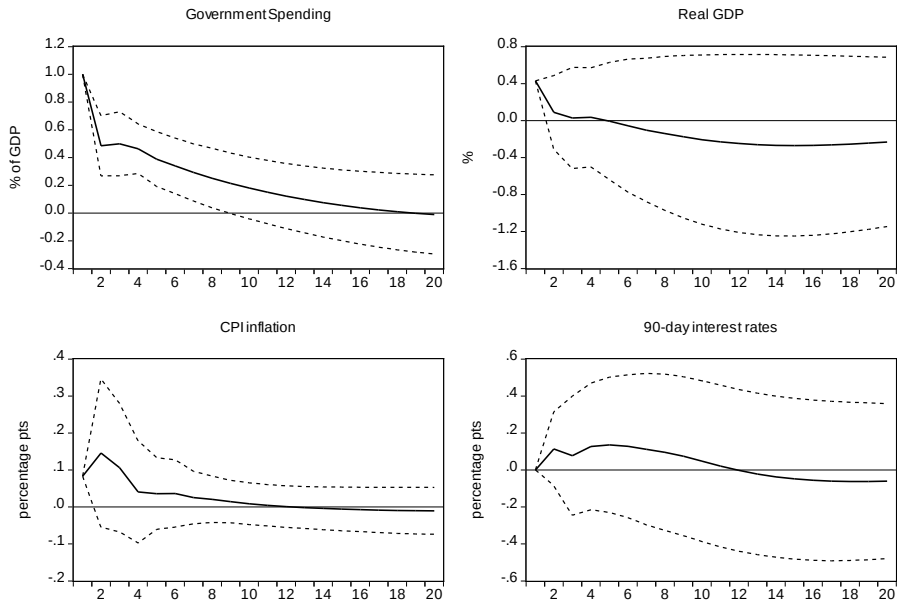
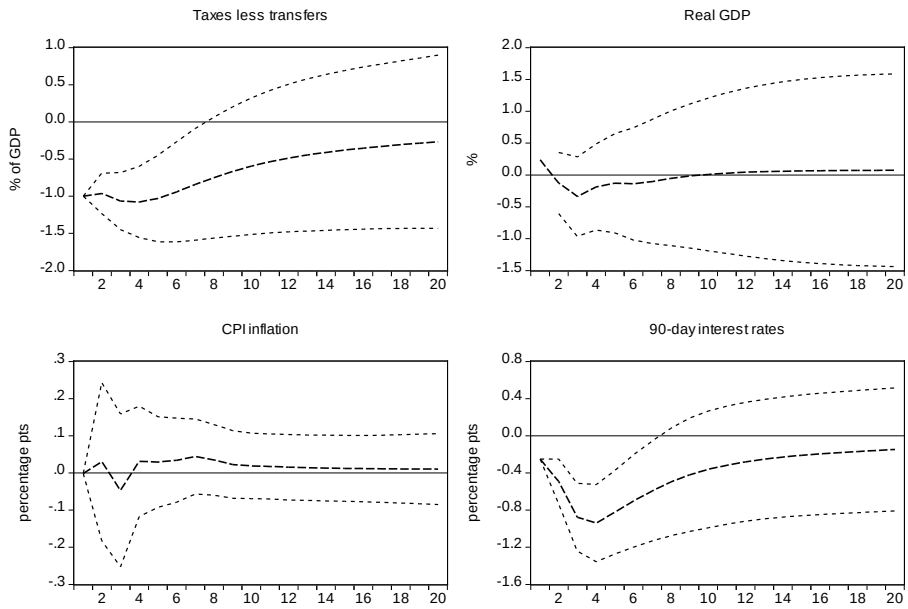


Figure A2: Response to a net tax shock



Model 2: Disaggregated fiscal SVAR

Figure A3: Response to a public consumption shock

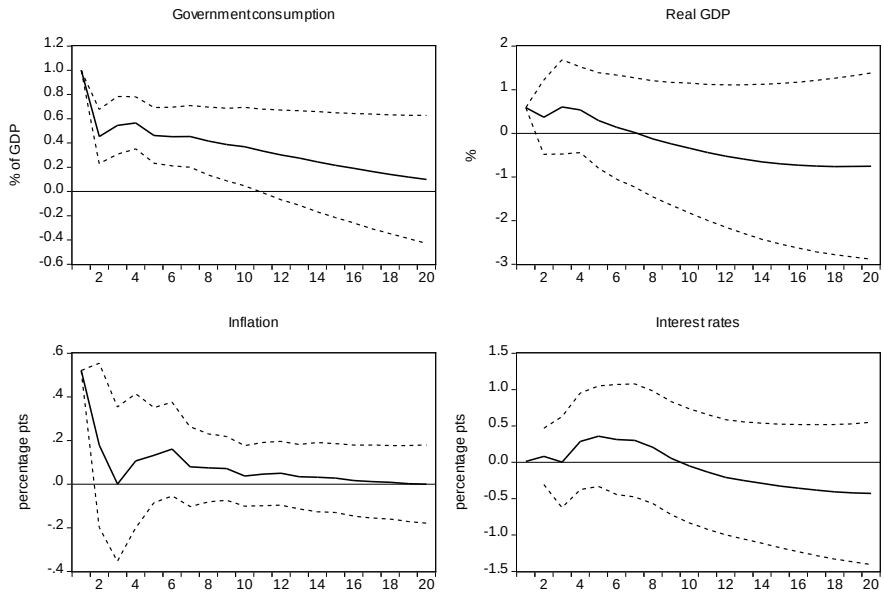


Figure A4: Response to a public investment shock

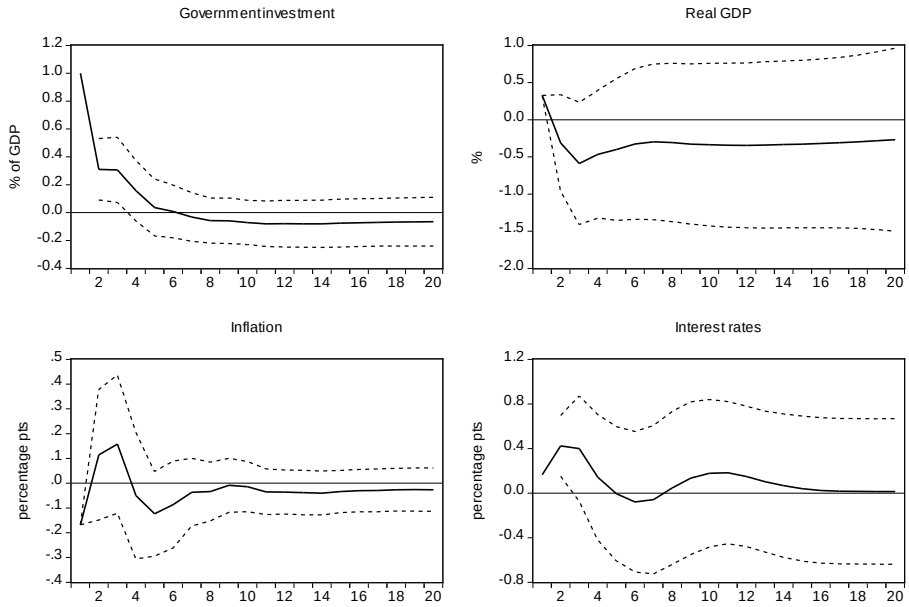


Figure A5: Response to a transfers shock

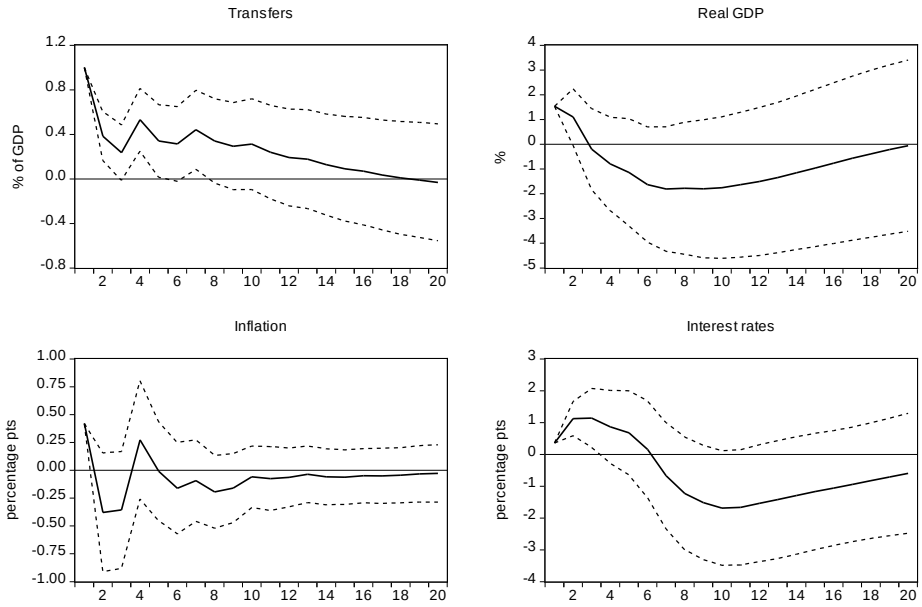
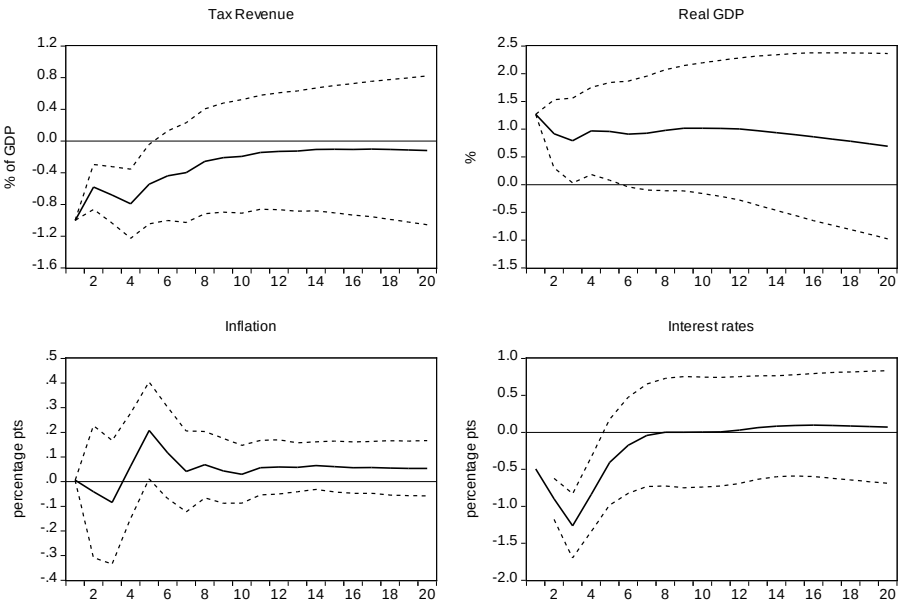


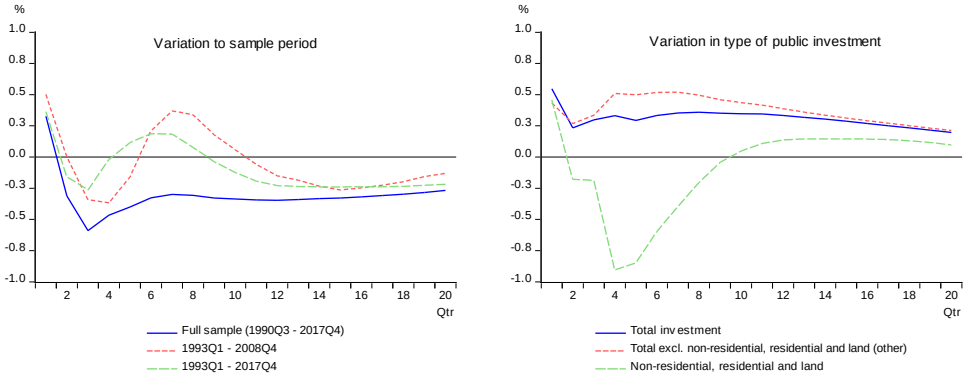
Figure A6: Response to a tax revenue shock



V. Additional sensitivity checks for a public investment shock

Figure A7 shows the sensitivity of the GDP impact of public investment shocks to variations in the sample period and type of investment using Model 2. The variation in sample period shown in the left-hand figure considers a change in public investment by central government only, which is the benchmark specification in the main text. The right-hand figure considers different types of investment by replacing total public investment with investment in non-residential, residential and land improvements and 'other' types of investment, largely comprised of other construction, plant, machinery and equipment and intangible assets. The breakdown by type of investment is for general government only as the central government breakdown is unavailable.

Figure A7: Response of GDP to a public investment shock under different specifications



Note: The charts represent the impact on GDP following a transitory increase in public investment equivalent to a 1 percent of GDP. The sample period used for estimating the response by type of public investment is 1990Q3 - 2017Q4, although the results are also similar when estimated over 1993Q1 - 2017Q4.

VI. Comparison of fiscal multiplier estimates with empirical literature

Table A6: Fiscal multiplier estimates from previous studies for New Zealand

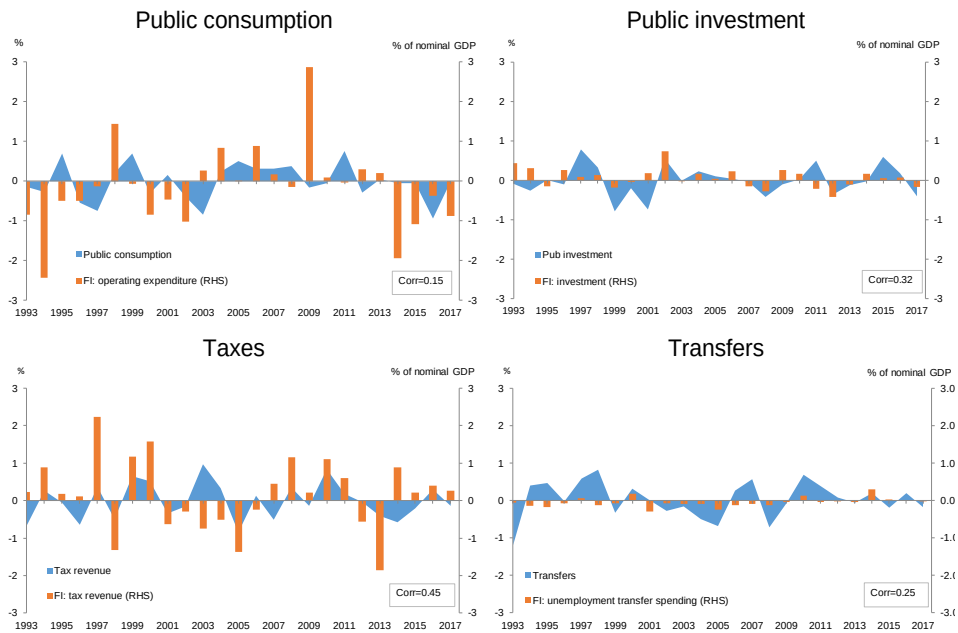
		Claus et al (2006)[37]	Dungey & Fry (2007)	Murray (2013)[38]	IMF (2009)	Parkyn & Vehbi (2013)	Hamer-Adams & Wong (2018)
	Sample	1989-2003	1983-2006	1993-2012		1983-2010	1990-2017
	Model	SVAR	SVAR	DSGE	GIMF	SVAR	SVAR
	Multiplier						
Govt spending	Impact	0.13	0.24[39]	0.3		0.26	0.43
	Cumulative (one-year)[40]	0.80[41]			0.58 to 0.84[42]	0.42	0.24
Net tax (tax cut)	Impact	0.24	-0.29	0.3		0.23	0.24
	Cumulative (one-year)	0.15[43]			0.08 to 0.42[44]	0.10	-0.10

[37] Displayed results are for their deterministic specification.
[38] Murray (2013) does not differentiate between government spending and taxation.
[39] This number is approximate given the specific figure was not reported in their original paper.
[40] $\sum_{t=1}^{t=4} \frac{\Delta Y_t}{\Delta S_t}$, where S is the shock.
[41] It is not clear in the original paper whether this multiplier is the cumulative sum of the GDP response, or the cumulative sum of the GDP response divided by the cumulative sum of the shock.
[42] Percentage difference in GDP from a year ago following a 1 percent shock.
[43] It is not clear in the original paper whether this multiplier is the cumulative sum of the GDP response, or the cumulative sum of the GDP response divided by the cumulative sum of the shock.
[44] Percentage difference in GDP from a year ago following a 1percent shock.

VII. Discretionary fiscal policy shocks: SVAR vs Fiscal Impulse

In Figure A8, we illustrate the discretionary policy shocks for each fiscal instrument identified from Model 2. These shocks broadly coincide with several key policy changes that have occurred historically. The negative shocks in public consumption and public investment broadly reflect periods of restrained government spending in the mid-1990s to early 2000s, as well as fiscal consolidation after 2011. Spending was structurally higher in the mid-2000s consistent with the observations by Mears et al. (2010). Public investment also appeared to be boosted immediately following the GFC, and after the 2010-11 Canterbury Earthquakes. Reductions in incomes taxes in 1996 and 2008-11 can also be observed by the positive shocks to tax revenue, while the negative shock from 2011 may be due to fiscal drag. Positive shocks to transfers occurred when the Working for Families scheme was introduced and following the GFC. Figure A8 also compares the fiscal policy shocks from the SVAR to components of the Fiscal Impulse produced by the Treasury. The correlation indicated in the charts suggest that the similarities for tax revenue and public investment shocks are closest.

Figure A8: Discretionary fiscal policy shocks by instrument (June years): Fiscal Impulse (FI) vs SVAR[45]



Source: The Treasury Fiscal Impulse data is sourced from the 2018 Budget Economic and Fiscal Update.
Note: The structural shocks for each instrument from the SVAR are presented as a 4-quarter moving average.

[45] Crown accounting information used for the Fiscal Impulse were prepared on a more consistent basis beyond 1997, so the indicator should be more reliable in the sample 1997 to 2017. The correlations for the period 1997 to 2017 are 0.18, 0.42, 0.37 and 0.49 for public consumption, public investment, transfers and tax respectively.

The discretionary policy shocks from Model 2 are consistent with the narrative regarding the cyclicality of fiscal policy when compared against the Fiscal Impulse and previous accounts in the New Zealand literature.[46] Table A7 presents the correlation of discretionary fiscal stimulus with GDP across different business cycles. A negative correlation would indicate counter-cyclical fiscal policy while a positive correlation is considered pro-cyclical. The correlations across both measures show that fiscal policy has tended to be more counter-cyclical in the current cycle since 2009 relative to previous cycles since 1993. The main difference lies in the 1993 to 1998 cycle, although the comparison in this period may be affected by changes in the Crown accounting framework used to calculate the Fiscal Impulse after 1997.

Table A7: Correlation of fiscal policy changes and the business cycle

Sample	Fiscal impulse vs GDP growth	SVAR fiscal stimulus vs output gap
1993-2017	-0.44	0.13
1993-1998	-0.42	0.58
1999-2008	0.11	0.12
2009-2017	-0.83	-0.58

Note: The output gap is sourced from the May 2018 Monetary Policy Statement. As the Fiscal Impulse is a change indicator, it is compared to GDP growth as opposed to the level of the output gap. The SVAR fiscal stimulus is the sum of the structural shocks to public consumption, public investment, transfers, and tax revenue from Model 2.

[46] See Williams (2017) for a discussion on the role of fiscal policy across business cycles in New Zealand.