Ireland's Spending Multipliers

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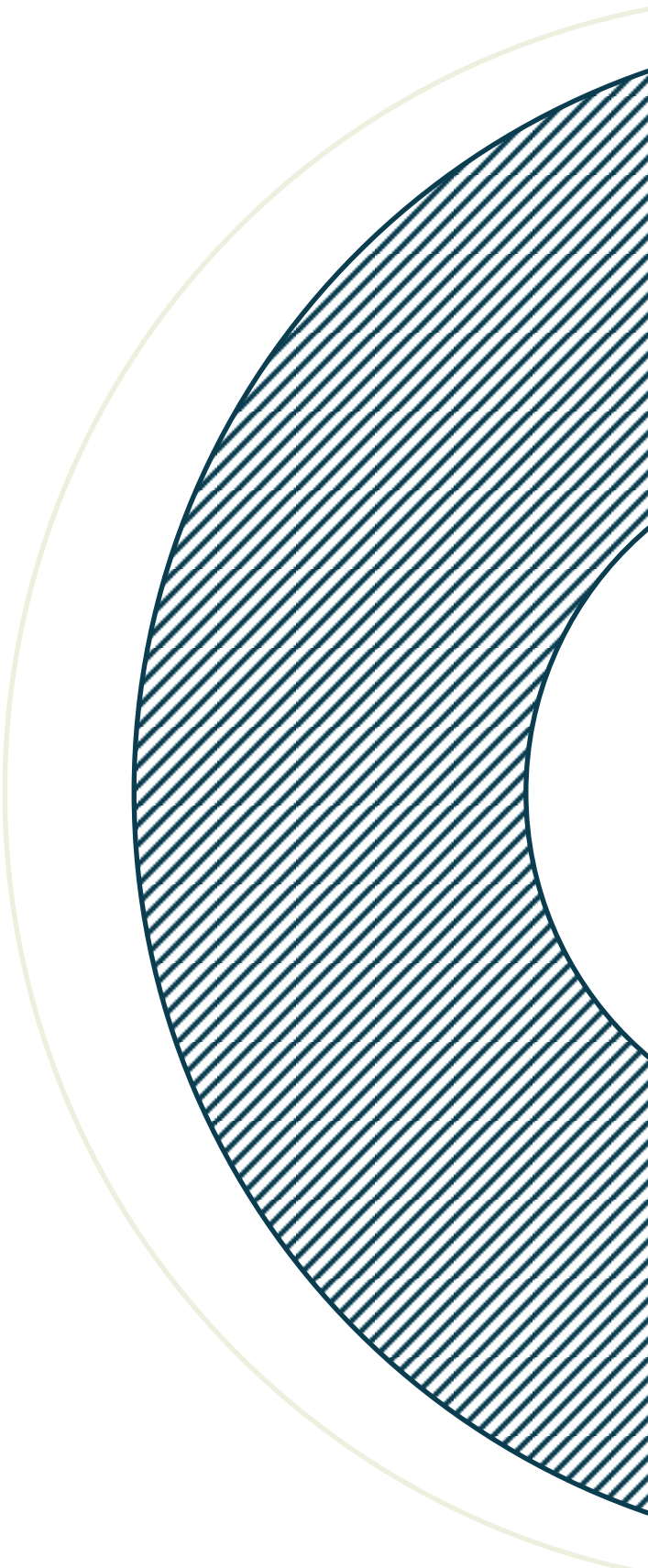

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Abstract

This paper estimates government spending multipliers for Ireland. We add to the existing literature on Ireland-specific fiscal multipliers in two key ways. First, we focus on measures of economic activity that remove distortions caused by foreign-owned multinational enterprises, thus allowing us to derive truer estimates of the impact on the domestic economy arising from changes in fiscal policy. Second, we employ a number of statistical approaches in order to sense-check the multiplier estimates we derive, including standard SVAR approaches, an Expectations-augmented VAR (EVAR) approach, and estimates based on a large-scale structural model. Our results show that fiscal policy has positive and significant initial impacts on Irish output, though these effects tend to disappear and/or become statistically insignificant over the longer term.

Keywords: Fiscal Policy, Fiscal Multipliers

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1. Introduction

The aftermath of the Great Recession saw renewed debate about the impact of discretionary fiscal policy on the real economy. The need for sound estimates of fiscal multipliers—estimates capturing this economic impact—was heightened as many countries underwent large corrections in their public finances.

The need for reliable estimates of fiscal multipliers was all the more acute in Ireland. Unsustainable banking and fiscal policies prior to 2008, including a reliance on transient revenues linked to the property bubble, meant that Ireland would ultimately embark on a €30 billion (17 per cent of GDP) correction in the public finances from 2008-2014 (Smyth, 2017; Scott and Bedogni, 2017).

Despite the importance of understanding the interaction between discretionary fiscal policy and the real economy, the literature on Irish fiscal multipliers has remained relatively limited. Moreover, estimates of Ireland's fiscal multipliers can be highly sensitive to distortions from multinational activities that effect standard measures of output.

Our paper contributes to the literature on Ireland's fiscal multipliers in two ways. First, we focus on measures of economic activity that remove distortions caused by foreign-owned multinational enterprises, thus allowing us to derive truer estimates of the impact on the domestic economy of changes in fiscal policy. Second, we use a variety of statistical approaches in order to sense-check the multiplier estimates derived.

We start by identifying spending multipliers based on a series of Structural Vector Autoregressions (SVARs) and using a Cholesky decomposition. We use Domestic Gross Value Added (GVA) as our main variable for economic activity. This helps us to strip out the distortions caused by foreign-owned multinational enterprises. These distortions, if

unremoved, can result in misleading estimates of fiscal multipliers. In particular, their activities are relatively more insulated from changes in domestic fiscal policy, and their production can vary substantially with little dependence on domestic factor inputs (Casey, 2018). Our SVAR specification includes government spending, domestic GVA, government revenue and the long-term interest rate. This contrasts with the three-variable SVAR employed by Bénétrix and Lane (2009), which includes GDP and the real exchange rate in addition to government spending. By explicitly incorporating government revenues, we control for both central components of fiscal policy. The inclusion of the interest rate acts as a control for the financial cycle, a factor which has been shown to have considerable impact on the Irish economy (Bénétrix and Lane, 2015).

We use two further techniques to produce multiplier estimates. We explore an Expectations-augmented VAR (EVAR) model similar to that outlined in Auerbach et al. (2012). This method helps to control for expectations and to isolate unexpected shocks to expenditure, thus alleviating issues in relation to the timing of shocks. Finally, we also estimate multipliers using a large-scale structural model of the Irish economy: the ESRI's COSMO model (Bergin et al., 2017).[2]

Our findings suggest that there is some evidence of positive, significant initial impacts on economic activity associated with fiscal policy, yet these effects disappear over the longer term. The estimated impacts are wide-ranging and uncertain, with limited evidence of positive impacts on the economy from government consumption as a whole. Within this, we find broadly negative—though insignificant effects—from public sector wages. Investment spending tends to have higher short-term multipliers,

[2] This publication includes results based on COSMO, the ESRI macro-economic model. Information on the design, underlying data and model construction can be found at http://www.esri.ie/publications/cosmo-a-new-core-structural-model-for-ireland. Responsibility for the results and interpretation in this document rests with the authors and not with the ESRI.

but the significance disappears over the medium to long term. This is consistent with theory and with the fact that Ireland's relatively large dependence on imports leads to high leakages of income (Cronin and McQuinn, 2014).

2. Relevant Literature

A variety of approaches to estimating Ireland-specific fiscal multipliers have been used in the literature to date.

Bergin *et al.* (2009) examine the impact on the economy of shocks to fiscal variables including a reduction in public sector pay and government investment, using the ESRI's HERMES macroeconomic model. The Bergin *et al.* paper provides multiplier estimates on the basis of GDP, a measure which since 2009 has become increasingly distorted. This paper seeks to update these estimates by using more recent data and also an alternative measure of economic activity, Domestic GVA. Additionally, while the Bergin *et al.* paper provides estimates on the basis of a structural model this paper provides estimates based on a suite of approaches including a structural model (ESRI COSMO), an SVAR and an EVAR.

Bénétrix and Lane (2009) provide estimates of the impact of five government expenditure categories on Ireland's GDP. They find that the impact of government spending shocks on the level and composition of output depends on the nature of the fiscal intervention and note important differences between government consumption and investment spending. Their paper uses data from 1970-2006, and hence excludes the most recent crisis period. The measure of output used is GDP, a measure which since the publication of their paper has become increasingly distorted by multinational activities. Our paper follows a similar SVAR approach, but uses different variables, including an alternative measure of the economy, and we employ a longer dataset which includes the recent crisis period. We also apply a range of additional methodologies, including estimates produced within a large-scale structural model and an EVAR approach based on expectations.

More recently, Cronin and McQuinn (2014) provide estimates of fiscal policy impacts at different stages of the economic cycle for Ireland. They

employ a threshold VAR using estimates of the output gap produced by the European Commission to gauge the different stages of the cycle. They estimate the impact of government consumption expenditure on GDP, private consumption and total unemployment. The findings show a positive impact multiplier for a government consumption shock at all points in the economic cycle for GDP, with a negative long-run multiplier when there is a positive output gap and the full sample is used.

Internationally, a substantial literature has been developed exploring different ways of estimating the effects of fiscal policy on economic activity. Hall (2009) examines the fiscal multipliers of US military spending under a number of approaches, including regression analysis, VAR modelling, and structural macro models. By examining military spending Hall seeks to account for issues of endogeneity in government spending for which VAR analysis has been criticised. He notes a clear advantage of this approach is the ability of VAR to account for other influences on the variable of interest in order to identify the impact of government expenditure. This is a key benefit of VAR analysis that this paper seeks to take advantage of.

VAR analysis has become increasingly popular for estimating the impact of fiscal policy since the early 2000s. A key feature in VAR analysis is the way in which shocks are identified. Some of the main methods of shock identification used in literature are the SVAR approach (Blanchard and Perotti, 2002), the narrative approach (Ramey, 2011), and the sign restriction approach (Uhlig, 2005).

The narrative approach is used by Ramey (2011) to demonstrate the impact of increases in US defence spending as a result of military events on the economy. Although appealing on face value for its simplicity, the narrative approach presents considerable challenges. It is unclear how the benchmark “no-policy change” scenario is defined, for example, and

the issue of multiple announcements/reversals of fiscal measures can impede shock identification (IMF, 2014; Corsetti et al., 2012). Recent work by Beetsma *et al.* (2017) has shown that spending-based consolidation plans tend to have weaker implementation (i.e., plans set out ex-ante not actually being followed through on) compared to revenue-based plans. Corsetti et al. (2012) demonstrate that expected spending reversals can change the short-run impact of fiscal policy. This complicates the identification of shocks under the narrative approach, as an identified shock may be only partially implemented or not implemented at all.

Other research uses both the narrative approach and Blanchard and Perotti (2002) shocks jointly. This joint approach is intended to identify shocks and a local projections method is then employed to overcome some of these weaknesses (Ramey and Zubairy, 2018, Broner et al., 2018). Another method used by Uhlig (2005), involves imposing sign restrictions on the response of prices, non-borrowed reserves, and the federal funds rate to examine the effects of monetary policy on output. However, this means restricting the qualitative response to shocks, which is a factor that this paper seeks to investigate.

Blanchard and Perotti (2002) provide a seminal paper on estimating fiscal multipliers using VAR and SVAR frameworks. They rely on two key assumptions: (1) fiscal shocks are exogenous to output, and (2) decision and implementation lags in policy mean that there is little or no discretionary response to unexpected contemporaneous movements in activity. Taken together, these assumptions allow for the identification of fiscal shocks by recursive ordering and by tracing dynamics to GDP and its components. They find that a shock to spending has a positive effect on output, and that a shock to tax has a negative effect on output.

The SVAR approach has been used to estimate the impact of fiscal policy in a number of different economies. While Blanchard and Perotti (2002)

apply it to the US economy, a number of papers have since used this approach to examine the effects of fiscal policy in other countries. Giordano *et al.* (2007) use an SVAR approach to examine the impact of fiscal policy on the Italian economy. They find that direct expenditures have a positive impact on the economy using a seven-variable VAR. Corsetti *et al.* (2006) use VAR analysis to examine the transmission of fiscal shocks and twin deficits for Australia, Canada, the UK and the US. They find effects vary depending on the degree of openness of the economy, a factor which is expected to be important in estimating the impact of fiscal policy in Ireland, as a small open economy. Broner et al. (2018) find that multipliers can be affected by which other economies the economy is open to, and the nature of the financing of debt. Where expansions are financed by foreign debt, multipliers may be larger due to the "crowding out" effects being exported.

The VAR approach has also been applied to a variety of spending variables. Fatás and Mihov (2001) use the VAR approach to examine the impact of government investment, wage, and non-wage spending on consumption and employment. Hall (2010) notes a higher multiplier is expected in the case of government investment than in relation to benefit spending. Lane and Perotti (2003) examine the impact of government spending, differentiating wage and non-wage components in 17 OECD economies. They find important differences in the impact of several parts of the budget on the real wages and profitability of the traded sector.

Global DSGE models can also be used to examine the impacts of fiscal policy. Clancy et al. (2016) use a DSGE model to examine the implications of a shock to government expenditure in a small open economy. They show that if a budget-neutral shock to government investment can be implemented, financed by a reduction in consumption which is not complementary to private consumption, then a small but persistent stimulus can be delivered with lower debt in the medium term.

A recent strand of the literature has focused on the idea that fiscal policy can have different impacts throughout the economic cycle. Blanchard and Leigh (2013) posit that multipliers may be higher in a recession. They note that during recessions – when output and incomes are lower – consumption and investment show an increased tendency to rely on the current values of income and profits, leading to larger multipliers for government interventions. Similarly, Owyang, Ramey and Zubairy (2013) define periods of slack in relation to threshold unemployment rates for both the US (6.5 percent) and Canada (7 percent). They examine defence spending shocks as identified using the narrative approach. They find that, in the US, fiscal multipliers are lower during times of high unemployment. Yet, for Canada, they find that fiscal policy has a greater effect in times of high unemployment. Auerbach and Gorodnichenko (2012) use a smooth transition autoregressive model to examine government spending multipliers in post-World War II US data. They find that fiscal policy is more effective in times of recession. The limited sample period available for Ireland hampers the feasibility of estimating state-dependent multipliers, though this presents a possible future extension to our analysis.[3]

Our paper contributes to the existing literature on Ireland-specific fiscal multipliers in two key ways: (1) it focuses on Ireland's measures of economic activity that remove distortions caused by foreign-owned multinational enterprises, thus allowing us to derive truer estimates of the impact on the domestic economy of changes in fiscal policy; and (2) it uses a variety of statistical approaches in order to sense-check the multiplier estimates we derive.[4]

[3] The new approach demonstrated by Ramey and Zubairy (2018) and Broner et al. (2018) using the local projections method as opposed to VAR could be used to overcome this.

[4] Using domestic GVA in this approach complements existing literature examining Irish multipliers using different measures such as private consumption (Cronin and McQuinn, 2012).

3. Methodology and Data

3.1 Data

We assess five government spending variables in addition to total government revenue. Data are obtained from the CSO Government Financial Statistics. The fiscal spending variables included, in separate versions of the specification, are government expenditure (GEXP) (i.e., government consumption plus government investment); government investment (GINV); government consumption (GC); wage government consumption (WGC); and non-wage government consumption (NWGC). Government revenue is computed net of transfers as is standard in the literature.[5] All spending variables are deflated using the government consumption deflator. Annual data are obtained for 1970 to 2016. A long-term interest rate time series is also included based on the interest rate on ten-year government bonds as sourced from the OECD Main Economic Indicators database for years 1971 to 2016.

In selecting which variables to include, we consider a number of factors. While Blanchard and Perotti (2002) show that the impact of fiscal policy depends on whether a spending or tax intervention is employed, other papers such as Bénétrix and Lane (2009), and Fatás and Mihov (2001) show the importance of distinguishing between different categories of expenditure. As such, we use five categories of expenditure to assess differences in their economic impacts. The inclusion of government revenues allows for the model to explicitly take account of both key fiscal policy levers.[6] Alternatively, tax rates can be used so as to alleviate the problem of endogeneity of government revenues (which to some extent

[5] Government Revenue (ESA Code "TR") is used net of investment income (D4), current transfer revenue excluding taxes (D7), and capital transfer revenues (D9N).

[6] The inclusion of revenues ensures that spending plans are not considered in isolation, but that tax plans are also taken account of, which could also have an impact on the economy. As such, explicitly including government revenues seeks to control for these impacts and further isolate the effect of spending changes.

depend on economic activity). However, inclusion of government revenue rather than tax rates has the advantage of allowing us to consider the effects of a spending shock on revenues associated with the increased economic activity. We also include the interest rate, which acts as a proxy for the financial cycle. The financial cycle is an important variable to control for in estimating fiscal multipliers. At times when interest rates are high or credit supply is tight, the impact of fiscal policy may be lessened. Higher interest rates would be expected to lead to a fall in the propensity to consume and an increase in the propensity to save. A tighter credit supply would be expected to lead to lower lending rates and lower investment by the private sector. Bénétrix and Lane (2015) also show the importance of the financial cycle to the Irish economy.[7]

We use Domestic GVA—a different measure of economic activity than the standard GDP measure typically used—in order to estimate fiscal multipliers. GDP has increasingly become less reflective of domestic economic activity in Ireland when compared to other countries. This reflects the high prevalence of foreign-owned multinational enterprises. As noted in Casey (2018), just 2.2 per cent of business enterprises in Ireland for 2012 are foreign-owned, yet these enterprises account for an estimated 58.4 per cent of total GVA. By contrast, resident-owned enterprises account for 97.8 per cent of enterprises, but less than half (41.6 per cent) of total GVA. The high concentration of foreign-owned multinational enterprises in production can mean substantial distortions to standard output measures like GDP. In particular, a small set of enterprises can vary their production substantially with little change in domestic capacity utilisation. Furthermore, their relatively greater integration in the global economy means that they are relatively more

[7] There may be some limitations to the use of the interest rate in the Irish context due to volatility of credit levels in the Irish financial sector throughout the period 2000-2012. A dummy variable is used to control for this in the SVARs below. A number of other variables could also be considered here, including house price inflation or the rate of credit growth.

insulated from domestic fiscal policy changes when compared to with other sectors.

Distortions caused by the activities of multinationals can lead to considerable difficulties in interpreting economic activity in Ireland and it can bias fiscal multiplier estimates that fail to take account of the differential impact of these sectors. While some of the most severe distortions changes are relatively recent, a divergence between domestic activity and GDP has been evident for several decades and this distinction may become even more important in the future.

A good solution is to use an alternative measure of economic activity that strips out the impact of foreign-owned multinational enterprises on the economy. The Domestic GVA aggregate captures gross value added in sectors of the economy that are not dominated by foreign-owned multinational enterprises.[8] In this way, fiscal multipliers estimated using Domestic GVA can give a more precise view of the impact that fiscal policy has on the domestic economy.[9]

We also explore the use of fiscal forecasts to control for expectations of fiscal policy in an augmented VAR setting. Forecast series are gathered from budget publications for 1975 to 2016. The series are constructed by taking the year t+1 forecasts of gross expenditure, excluding both social welfare (as a proxy for transfers) and interest expenditure. The growth

[8] This is an official measure of economic activity that is produced by the Central Statistics Office. The non-domestic sector is defined as sectors where foreign-owned multinational enterprise turnover on average exceeds 85% of the sector total. Although Domestic GVA offers a way of removing some of the distortionary effects of foreign-owned multinational enterprises from measurement of the economy, it is not a perfect measure. By definition, it will exclude some domestic enterprises that are operating in sectors dominated by foreign-owned multinational enterprises too.

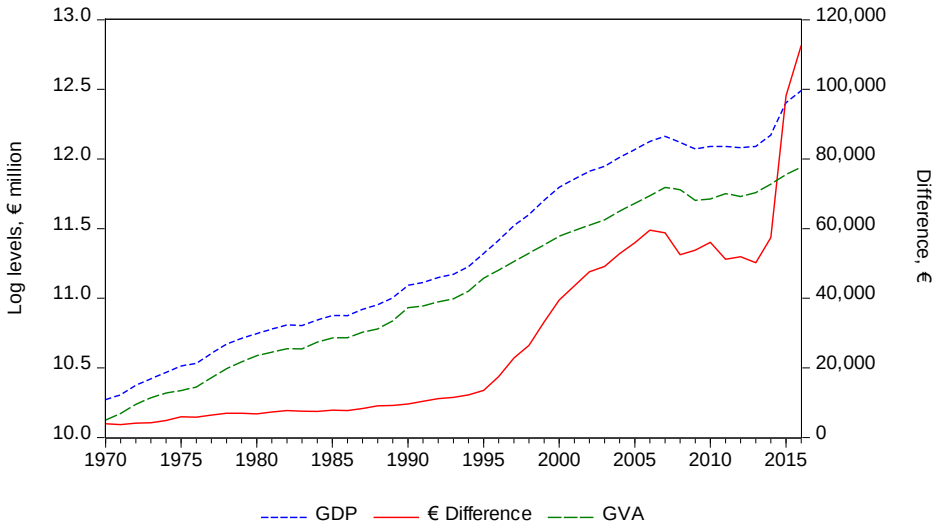
[9] While the multipliers calculated in this paper using the SVAR and EVAR approach consider the impact on Domestic GVA, the COSMO model estimates are on the basis of total GVA. As such part of the differences in these estimates may be due to differences in how foreign-owned multinational enterprises react to fiscal policy in comparison to the domestic sector.

rates of the deflated forecast of government spending (as obtained from budget documentation) are then used in an EVAR setting.

Finally, we also use the ESRI's COSMO model to estimate fiscal multipliers. The data underpinning the COSMO model are outlined in Bergin et al. (2017). The use of COSMO allows us to consider fiscal multipliers in a full, theoretically-founded structural model of the Irish economy.

Two key aggregates of Irish economic activity are shown in Figure 3.1: GDP and Domestic GVA (1970 to 2016, both in logs). A considerable divergence has clearly developed in recent decades as distortions introduced by activities associated with the foreign-owned multinational enterprises become more marked.

Figure 3.1: Measures of the Irish Economy GDP and GVA
1970-2016

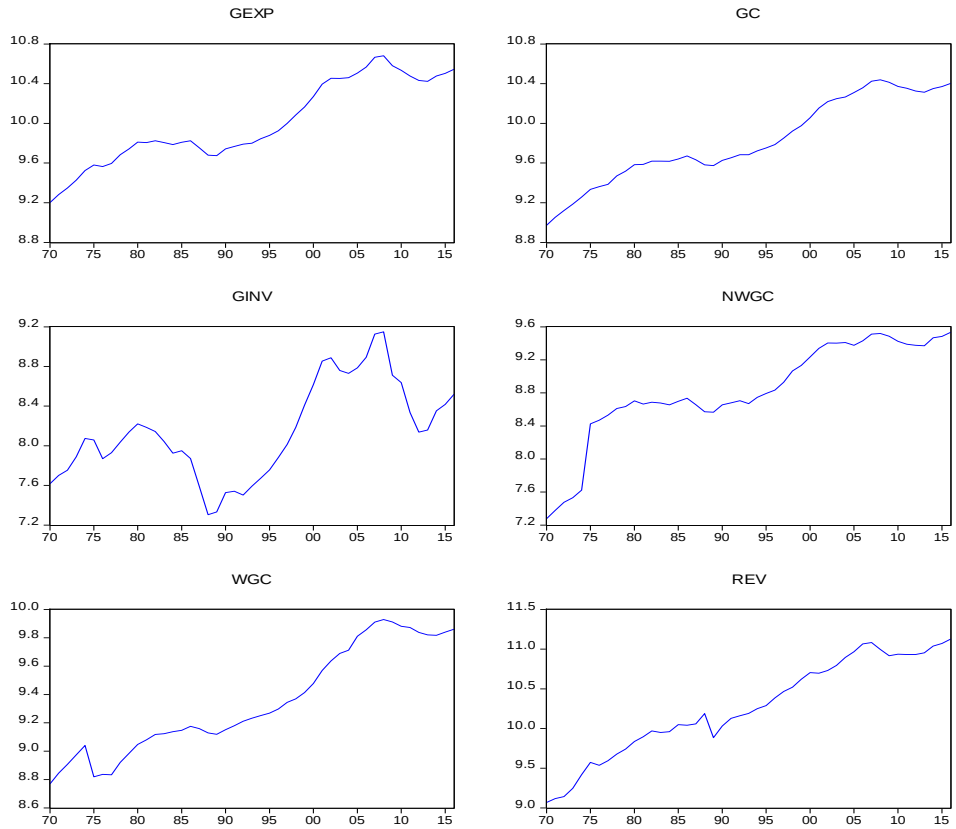


Sources: CSO; and authors' own calculations.
Note: Difference, secondary axis, is the euro difference between GDP and Domestic GVA.

Figure 3.2 shows a graph of the government expenditure and revenue variables, all of which are measured in log levels. All government expenditure variables were impacted to some extent by the fiscal consolidation following the recent crisis. The most considerable fall evident in the years following the 2008 crisis appears in government

investment (GINV). This is in part due to the less rigid nature of investment expenditure as much of this category will be large one-off projects.

Figure 3.2: Fiscal Variables
Log levels, 1970-2016



Sources: CSO; and authors' own calculations.
Note: Data are deflated using the government spending deflator.

An important consideration in estimating the impact of fiscal policy is whether or not annual or quarterly data is more appropriate to use (Beetsma et al., 2008, Blanchard and Perotti, 2002). One of the most common criticisms of annual data is that government expenditure is likely to react at the same time as shifts in output. However, due to publication lags and the fact that the budget is set in the October of the prior year, it is unlikely that Irish output will contemporaneously

determine government expenditure.[10] National accounts data are produced with a time lag of about three months. By the time policymakers are notified that an unexpected change in economic growth has occurred and a policy response is formulated and approved, it is less likely that there will be in-year policy responses. As the budget is set annually, annual data will provide a more accurate representation of shocks to spending (Beetsma et al., 2008). While annual data allows for a longer time period to be used in the Irish case, there may still be concerns regarding anticipation effects. We seek to control for such effects in an expectations-augmented VAR (Section 4.6). Considering these factors, we find that it is preferable to use annual data in the scope of this paper.

3.2 Methodology

A variety of approaches have been used in the literature to estimate fiscal multipliers. This paper uses the SVAR approach popularised by Blanchard and Perotti for estimating fiscal multipliers (Blanchard and Perotti, 2002). We then control for expectations in an attempt to further isolate unanticipated shocks using an EVAR approach similar to that used in Auerbach and Gorodnichenko (2012). In addition, we employ a large-scale structural model of the Irish economy, COSMO, as another means of deriving multiplier estimates.

A number of SVAR specifications are employed. In each specification, a separate SVAR is undertaken for each of the government spending categories; government expenditure, government consumption, government investment, wage government consumption and non-wage

[10] While in some years (for example 2009) there have been supplementary budgets, which allow for changes within year, this is to a certain extent taken account of in the expectations-augmented VAR.

government consumption. All SVAR specifications control for Ireland's entry to the EMU in 1999.[11]

The initial specification takes the form of a three-variable SVAR, with the following ordering: the government spending variable, Domestic GVA and government revenue. Note that in all SVAR specifications we use log levels of the variables specified. The SVAR is then extended to a four-variable specification with the long-term interest rate included as the final variable. Shock identification is achieved through a Cholesky decomposition, in which some variables are restricted from having a contemporaneous effect on others. Importantly, government expenditure is restricted so it does not react contemporaneously to shocks in output.

The structural specification is as follows:

$$A_0 Z_t = A(L) Z_{t-1} + C X_t + \varepsilon_t \qquad (1)$$

Where Z_t is the vector of endogenous variables, government spending (g_t), the measure of the economy (i.e. Domestic GVA) (y_t), government revenue (T) and the long-term interest rate(r_t). CX_t is a vector and parameter matrix for the intercept and a linear trend. A_0 is the matrix of contemporaneous relations between government spending, Domestic GVA, government revenue and the interest rate. $A(L)$ is a polynomial lag operator matrix that gives the relationship between these endogenous variables and their lags. ε_t is a vector of the structural shocks where $var(\varepsilon_t) = \Omega$.

[11] To control for the effect of joining the EMU, a dummy variable is introduced, which takes the value of one from the year 1999 on, and zero otherwise. This variable is interacted with all variables in the SVAR and then the interaction terms and the original dummy variable are included as exogenous variables in the SVAR specification.

$$Z_t = \begin{bmatrix} g_t \\ y_t \\ T_t \\ r_t \end{bmatrix}, A_o = \begin{bmatrix} 1 & -\alpha_{yg} & -\alpha_{Tg} & -\alpha_{rg} \\ -\alpha_{gy} & 1 & -\alpha_{Ty} & -\alpha_{ry} \\ -\alpha_{gT} & -\alpha_{yT} & 1 & -\alpha_{rT} \\ -\alpha_{gr} & -\alpha_{yr} & -\alpha_{Tr} & 1 \end{bmatrix}, X_{i,t} = \begin{bmatrix} c \\ t_t \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^T \\ \varepsilon_t^r \end{bmatrix}$$

The reduced form specification is derived by pre-multiplying (1) by A_o^{-1} to attain the following:

$$Z_t = B(L)Z_{t-1} + DX_t + \epsilon_t \qquad (2)$$

where $B(L) = A_o^{-1}A(L), D = A_o^{-1}C$, $\epsilon_t = A_o^{-1}\varepsilon_t$ and $var(\epsilon_t) = \Sigma$.

In order to identify structural shocks, we employ a recursive ordering and Cholesky decomposition. This limits the contemporaneous response of some variables to shocks in other variables. The Cholesky decomposition ordering used takes the government spending variable first, followed by the measure of economic activity (Domestic GVA), then government revenues and, finally, the interest rate. As such, the recursive ordering imposes that: $\alpha_{yg} = \alpha_{Tg} = \alpha_{rg} = \alpha_{Ty} = \alpha_{ry} = \alpha_{rT} = 0$ in matrix A_o. This ordering has three implications. First, it means that spending is assumed to not be affected contemporaneously by shocks in economic activity, government revenues, or the interest rate.[12] Second, Domestic GVA is assumed to be unaffected contemporaneously by shocks to government revenues or the interest rate. Third, government revenues are assumed to be unaffected contemporaneously by the interest rate.

Following the extension of the SVAR for the interest rate, which allows the model to control for the financial cycle, another extension is employed to

[12] On rare occasions, it may be argued that government revenues do have an impact on fiscal policy within year. For instance, 2016 saw an increase in expenditure after an increase in tax yield, this is not very common. Additionally, the SVARs were estimated below with alternative ordering so revenue could impact within year spending; however this ordering had little effect on the response of output. Blanchard and Perotti (2002) also found that the ordering of tax and expenditure has little effect on multipliers. Furthermore, there is a strong influence of GDP on government revenues within year, through all tax heads including VAT, Income Tax, Corporation Tax and Excise the four biggest tax heads in Ireland. Therefore, this ordering is deemed reasonable.

control for the recent financial crisis. A dummy variable is introduced to control for the impact of the crisis, taking the value of zero up to 2008 and one for all years thereafter. This dummy variable is interacted with all variables in the SVAR and both the dummy and interaction terms are included as exogenous variables in the specification to control for the impact of the crisis. The trend variable is not interacted with the financial crisis variable, thus ensuring that the fundamental trend dynamics underlying the relationship between expenditure shocks and the outcome variables, which did not necessarily change with the crisis, are included. This method of accounting for the financial crisis allows for a longer time period to be included in the SVAR and it allows us to account for the fundamental dynamics of the post crisis period.

We conduct a number of robustness checks:

First, we consider the inclusion of an additional variable to control for correlated fiscal shocks: the “complement” government expenditure variable. The complement variable takes the form of government expenditure minus the spending variable included in the SVAR, for example for the government investment (GINV) the complement would be given by GINVCOMP=GEXP-GINV. In this way the SVAR will control specifically for the other components of Government Expenditure. This is important as often shocks will be correlated across budgets with, for example, a shock to consumption at the same time as a shock to investment. Including the complement variable ensures that these other shocks are controlled for.

Second, we explore a number of alternative orderings of the SVAR and of the contemporaneous relations. In particular, the SVAR is reordered so that revenue is the first variable. This allows for revenue decisions to be taken before spending decisions.

We also extend our analysis to two alternative methods as a further set of robustness checks. First, we explore an Expectations-augmented VAR (EVAR) approach, which includes a forecast variable in the government consumption specification in order to take account of expectations. Second, we consider estimates in a large-scale structural model of the Irish economy.

Expectations-augmented VAR (EVAR) approach

Cimadomo (2012) notes the potential for considerable differences in terms of how fiscal plans pan out as compared to the plans that were originally laid out. This can lead to actual fiscal measures having different timings, when compared to plans. As Ramey (2011) and Auerbach *et al.* (2012) note, the timing of a fiscal shock can have a considerable role in determining how effective it is. A key aspect of this is the role of expectations.[13] In order to account for expectations, we use a similar method to Auerbach *et al.* and use official forecasts to account for the role that expectations can play.

We compile one-year-ahead forecasts for government consumption from Department of Finance budget documentation (1975 to 2016). A series of forecast growth rates of real government spending in year t is denoted $\Delta G^{F}_{t|t-1}$. The series is then placed first in a Z vector of the VAR to form an EVAR (Expectations augmented Vector Auto Regression). The forecast growth rate is ordered first so that an unanticipated shock in government consumption at time t is assumed to not have any contemporaneous effect on the forecasts which were made at time t-1. The vector of variables in the VAR is now $Z_t = \left[\Delta G^{F}_{t|t-1}, G_t, Y_t, T_t, r_t\right]$. An innovation in G_t orthogonal to $\Delta G^{F}_{t|t-1}$ therefore represents an unanticipated shock.

[13] In the Irish context, Cronin and McQuinn (2018) show that fiscal policy can be procyclical. It is therefore important to consider the role of expectations and whether outturns reflect more procyclical changes in policy mid-year.

Estimates using COSMO: a Structural Model of the Irish Economy

Finally, we also avail of the ESRI's structural model of the Irish economy, COSMO, to produce estimates of the impact of government consumption and government investment on economic activity. COSMO is a large-scale structural model of the Irish economy which is used for medium-term projections and policy analysis (Bergin et al., 2017). The model is used to generate multipliers on total GVA, as opposed to Domestic GVA. This reflects the specification of the model, albeit that the model does separate GVA into the traded and non-traded sectors of the economy, thus allowing for some differential responses to fiscal policy.

Three shocks are implemented: (1) a shock to government spending (which is the amalgamation of a 5 per cent shock to government investment, a 1 per cent shock to government consumption and 1.3 per cent shock to transfers); (2) a shock to government investment of 10 per cent; and (3) a shock to government consumption of 2 per cent. Each shock is implemented so the specific spending variable is 'x' per cent higher each year than in the baseline case.

There are a couple of limitations. First, COSMO model uses total GVA as opposed to Domestic GVA. This may limit the comparability of estimates, but it may also highlight the potential differences in the response of domestic sectors and sectors that are dominated by foreign-owned multinational enterprises. Second, COSMO does not explicitly model direct improvements in productivity from investment through a "productivity channel", rather the improvements occur via the internal demand channel (Garcia-Rodriguez, 2018).

Calculation of Multipliers

We calculate multipliers as cumulative multipliers. The cumulative change in the economic activity measure (GVA) is divided by the cumulative change in government spending (GS) as in equation (1). This

is then divided by the average ratio of the government spending variable to domestic GVA in the sample to correct for the fact that variables are in logs (Gonzalez-Garcia et al., 2013).

$$Cumulative\ Multiplier = \frac{\sum_{h=1}^{H} \Delta GVA_h}{\sum_{h=1}^{H} \Delta GS_h} = \frac{\sum_{h=1}^{H} \Delta gva_h}{\sum_{h=1}^{H} \Delta gs_h} \div \frac{\overline{GS}}{\overline{GVA}} \qquad (1)$$

The use of cumulative multipliers allows us to consider the impacts from spending shocks over time. It also allows us to take account of endogenous changes in spending which take place after the shock and changes in domestic GVA. We consider both short-run (year 1, “impact”) multipliers and long-run (year 5) multipliers.

4. Results

We first present the results for the SVAR estimates of fiscal multipliers before subjecting these estimates to some robustness checks. Next, we consider estimates based on an Expectations-augmented VAR approach. Finally, we consider estimates based on the use of the ESRI's structural model of the Irish economy, COSMO.

4.1 Three-Variable SVAR Specification

The first model we consider is a three-variable SVAR model that includes a measure of government spending, Domestic GVA, and government revenue. This three-variable model is estimated separately for each government spending variable considered. We later extend the model to include the interest rate, thus forming a four-variable SVAR. The interest rate is ordered last in the SVAR specification, as it is assumed to be the most endogenous variable as is standard in the literature (Fatás and Mihov, 2001).

All of the VARs we estimate are tested for stability. Some of the VARs are found to be unstable, particularly the wage government consumption specifications and some of the government consumption specifications. These estimates may be less reliable.[14] However, Ramey (2016) notes that as long as stationarity is not required for identification, an SVAR in log levels will give consistent estimates.

[14] In order to test the stationarity of the SVAR models, the unit roots of the inverse characteristic equations were examined. The stability of each SVAR is verified once the roots are found to not be outside the unit circle. This ensures that the dynamics of the SVAR are non-explosive and convergence occurs. In some of government wage consumption specifications and the government consumption extension 2 SVAR specification, one root of the inverse characteristic equation was found to be just outside the unit circle. Roots outside the unit circle affect the estimation of standard errors and add a degree of caution to interpretation of results. However, under the five-variable preferred specifications, the government consumption SVAR is found to be stable. As annual data is employed it is deemed appropriate to use a lag length of two. Undertaking the LM test for serial correlation fails to reject the null hypothesis of no serial correlation at this lag length. Additionally, this lag length is used in much of the literature to date examining government spending multipliers with annual data (Bénétrix and Lane, 2009, Beetsma et al., 2008).

Figure A.1 shows the impulse-response functions of Domestic GVA and revenue to a one per cent of Domestic GVA shock to government spending in the Three-Variable SVAR model.[15]

Looking at the year 1 impacts, the government spending shocks are found to have a positive and statistically significant (at the 95 per cent confidence level) impact on domestic GVA for total government expenditure as well as for both public investment and government consumption. However, when we split government consumption into non-wage government consumption and wage government consumption, we find that the impact is not significantly different from zero in either case as of the first year.

In terms of the longer-run effects of government spending on Domestic GVA, we can see that effect from shocks tends to disappear by the fourth to sixth year. Typically, effects tend not to be statistically significant beyond three years. This is evident for total government expenditure, and also for both government investment and government consumption. We also find positive short-run impacts on government revenues from spending shocks, but this is insignificant in most cases and the results tend to dissipate over the long run.

Our results suggest that government spending shocks can have positive contemporaneous impacts. Yet, in the case of total government spending, public investment and government consumption, there is no evidence to suggest that positive impacts may be sustained over the medium to long term. As outlined below, this may be due to a number of factors including the small, open economy nature of the Irish economy

[15] Over the sample period, the average levels of each component of government expenditure (expressed as a share of GVA) were, 35.0, 5.8, 29.1, 18.2 and 10.9 per cent for government expenditure, investment, consumption, wage consumption and non-wage consumption, respectively. Therefore, a one per cent of GVA shock would represent a relatively large shock for investment but small for total government expenditure.

and the high propensity to import which can lead to net leakages of income (Cronin and McQuinn, 2014).

4.2 Four-Variable SVAR Specification (including interest rates)

Figure A.2 shows the impulse-response functions obtained when the SVAR is augmented with the interest rate as a proxy for the financial cycle, an important factor in determining the impact of fiscal policy in Ireland (Bénétrix and Lane, 2015). The introduction of the interest rate variable to the SVAR leads to qualitatively similar results for the impact on GVA, but it improves the overall statistical significance of the impulse responses. In particular, the GVA impact response to a shock in non-wage government consumption becomes both significant and positive. The impact response to a wage government consumption shock remains insignificant. Including the interest rate improves the estimation in most cases.

A shock to government expenditure leads to a positive contemporaneous response in domestic GVA of 1.4 percent, which falls in subsequent periods and becomes insignificant. The response of revenue is broadly similar to the three-variable case. There is a positive contemporaneous impact on the long-term interest rate, though this is not significant.

The response of GVA to a shock in investment is once again positive in the year of the shock and the point estimate is slightly higher at its peak in the second year at 3.1 per cent. The response falls thereafter but remains positive and statistically significant until the third year. Similarly, the response of government consumption is both positive contemporaneously, at some 1.8 per cent, and significant until the third period, becoming insignificant thereafter. The investment and consumption shocks on government revenues are similar to the three-variable case. The response of the interest rate to a shock in investment is not statistically significant. A shock to government consumption has a

positive impact on the interest rate in the year of the shock, though this is also not statistically different from zero.

In terms of the sub-components of government consumption, responses differ. In the case of a shock to wage government consumption, the response of GVA is broadly the same as in the three-variable case, though it is slightly more negative throughout, and still not significant. In contrast, the effect of a shock to non-wage government consumption, which was not significant in the three variable case, changes considerably, an impact of 0.6 is seen, remaining positive and significant until the third year. The responses of revenues and the interest rate, to a shock in wage government consumption, are generally not statistically different from zero. The response of revenue to a shock in non-wage government consumption follows a broadly similar pattern to the three-variable case, although the impacts are lower throughout.

Augmenting the SVAR with the interest rate as a proxy for the financial cycle leads to some improvements in significance across the SVAR specifications. More positive impacts are seen for expenditure, investment, consumption and non-wage consumption shocks. This supports the view that the financial cycle affects fiscal outcomes. In particular, it may be the case that multipliers are higher due to lower interest rates in recent years, decreasing the propensity to save and increasing demand for credit and investment in the private sector.

4.3 Four-Variable SVAR Specification (including interest rates and financial crisis period dummies)

The recent financial crisis had a substantial impact on the Irish economy and fiscal policy in Ireland. To control for this atypical period, we include a dummy variable for the financial crisis period and interaction terms with the four endogenous variables. This ensures that estimates are based on a longer period of data, rather than just estimating the SVAR for the pre-crisis period. It also allows for the underlying dynamics of fiscal

policy to be included, while recognising the atypical impact of the financial crisis.

Figure A.3 compares the response of the GVA under the four-variable SVAR with and without the financial crisis control variables. A shock to government expenditure once again leads to a positive GVA contemporaneous response (1.2 per cent), which is statistically significant until the third year. The short-run impact of an investment shock is higher when the crisis is controlled for, with a contemporaneous impact of 2.5 per cent (2.2 per cent previously). The response is statistically insignificant after the fourth year. The response of GVA to a shock in consumption is similar when the financial crisis is controlled for, with some overlap of the error bands, although the impact is slightly lower. The qualitative response of wage government consumption is broadly the same when the financial crisis is controlled for, although it is slightly more negative throughout.[16] Similarly, the response of non-wage government consumption becomes slightly lower in the first year.

The inclusion of a dummy variable to control for the financial crisis further improves the statistical significance of the SVAR. Government expenditure, investment, and non-wage government consumption are found to have positive contemporaneous responses which are sustained in the following years to varying degrees. The response to an investment shock of one percent of GVA remains higher than the response of consumption. The response of GVA to a shock in wage government consumption is broadly negative, although the result is not necessarily significant. One possible explanation for this may be that labour is withdrawn from the private sector as a result of an increase in wage government consumption, increasing the capital-labour ratio. This, in

[16] Error bands may be affected by stability of this VAR and caution is warranted in determining significance in both case of the government consumption and wage government consumption VARs.

turn, decreases the return to capital and causes an outflow of capital from the economy until the return to capital converges again to the world rate (Corsetti et al, 2006). This fall in labour and capital in the private sector reduces productivity in the economy over the medium term.

4.4 Robustness Checks on SVAR Models

Complementary Government Spending

We next explore some robustness checks for our SVAR models. The first of these entails including the government spending complement as a separate variable. For example, in the case of government investment (GINV), we define the complementary spending variable as GINVCOMP=GEXP-GINV (i.e., all other non-investment expenditure). As government budgets for specific categories of spending are set at the same time, there may be a correlation of shocks across budgets. Including the complementary spending variable ensures that the shock of interest, the shock to the specific government spending variable, is orthogonal to the rest of the budget. All specifications control for entry to the EMU and the 2008 financial crisis as above.

Figure A.4 compares the impulse response functions of Domestic GVA in the four- and five-variable cases. While the response of GVA is qualitatively similar to the five-variable cases, there are quantitative differences in some models, suggesting that the shocks to fiscal spending variables are somewhat correlated.

In line with the four-variable specification, the response of GVA to a shock in government investment is positive contemporaneously, although it is approximately 1 percentage point lower in magnitude. The positive response is only statistically significant as far as the second year. For government consumption, the impact is no longer statistically different from zero across the entire time horizon. This may be due to the strong correlation observed between consumption and investment shocks,

where in the four-variable SVAR the response to a shock in government consumption is in fact being driven by a contemporaneous shock to investment. The responses to wage and non-wage government consumption shocks are qualitatively similar in both the four and five-variable cases, although the immediate response to a shock in wage government consumption is now positive. We would caution that the standard errors are still very large.

These specifications point to some correlation across spending shocks. Differences in the response to shocks across four- and five-variable specifications, in particular, suggest that shocks to government consumption and investment are correlated and that the consumption response of output may be influenced by investment spending.

Alternative Orderings

A common concern with the SVAR method and the Cholesky decomposition reflects how the ordering of the SVAR can affect multiplier estimates (Perotti, 2005). The ordering used in our previous specifications starts with the spending variable, which is then followed by our output measure, revenue and the interest rate. This ordering is standard in the literature (Bénétrix and Lane, 2009, Blanchard and Perotti, 2002).

However, to examine the robustness of the estimates, we reorder the variables and we run each spending specification again. The alternative ordering involves the revenue variable being placed first in the SVAR. This allows us to consider the order in which decisions are made when formulating fiscal policy. Ordering revenue first implies that revenue decisions are made before spending decisions. Figure A.5 shows this alternative ordering gives similar impulse response functions to the four-variable SVAR case. Table 4.1 shows the multipliers obtained from these orderings.

Table 4.1: Alternative Ordering Multiplier Estimates

	GEXP	GINV	GC	NWGC	WGC
Four-Variable Specification with Alternative Ordering (Revenue first)					
Impact	1.3*	2.5*	1.2*	0.5	-0.2
Long Run	0.9	2.3	0.7	1.7	-8.4

Sources: CSO; and authors' own calculations.
Note: Cholesky ordering of Revenue, Government Spending, GVA and Interest Rate, so the revenue decision is made before the spending decision.

Changing the ordering to allow revenue decisions to be taken first has very little impact on the multipliers. There are marginal differences in some of the specifications.[17] For instance, the impact response to a shock in government consumption is 0.1 percentage points higher.

4.5 Summary of SVAR Model Results

The SVAR model results show that shocks to fiscal spending can have a positive impact on economic activity in the case of total government expenditure, government investment and government consumption, there is no evidence to suggest that it may be sustained over the medium to long term. These estimates are also inherently uncertain.

The estimated short-run (impact) and long-run multipliers are summarised in Table 4.2 for our four-variable SVAR specification and for our preferred five-variable SVAR specification. Figures A.6 and A.7 show multipliers estimated for the two specifications. Central estimates are shown (in blue) along with the range of multiplier estimates under the 95 per cent confidence intervals (shaded in pink). All multipliers are calculated as cumulative multipliers (Section 3.2). Note that we favour the five-variable specification of our SVARs, given that there is likely to be

[17] Once again caution is warranted in relation the government consumption and wage government consumption standard errors, effecting determination of significance.

a strong correlation between spending shocks over time. This correlation could bias our estimates of multipliers if not controlled for.

In terms of the four-variable specification, the short-run "impact" (i.e., year 1) multipliers are found to be positive and significant for total expenditure and investment.[18] In the preferred five-variable specification, the impact multiplier is found to be significant for government investment and non-wage government consumption.[19] In all cases, however, we find that the long-run (i.e., year 5) multipliers are insignificant. In other words, we cannot say that the effects of these spending shocks are statistically different from zero at the 95 per cent level of confidence over the long term.

Table 4.2: Domestic GVA Multiplier Estimates (SVAR)

	GEXP	GINV	GC	NWGC	WGC
Four-Variable Specification					
Impact	1.2*	2.5*	1.1*	0.5	-0.2
Long Run	0.9	2.3	0.9	1.7	-8.8
Five-Variable (Preferred) Specification					
Impact	-	1.4*	0.5	1.0*	1.2
Long Run	-	2.0	-0.9	1.7	-4.8

Sources: CSO, and authors' own calculations
Note: Impact multipliers are calculated at year 1; long-run multipliers are calculated at year 5.
* denotes that the multiplier is statistically different from zero at the 95 per cent confidence level based on Monte Carlo simulations with 1,000 replications.

The magnitude of spending shock impacts varies widely depending on the category of spending. Investment is found to have a greater impact on economic activity than other types of government spending (impact multiplier of 1.4), but it is not significantly different from zero over the

[18] While the government consumption multiplier appears to be significant for the impact multiplier, one of unit roots of the inverse characteristic equation lies outside the unit circle. As such, standard errors of the impulse response function may be affected and significance should not be relied upon.

[19] For the wage government consumption SVAR, one of unit roots of the inverse characteristic equation lies outside the unit circle. As such, standard errors of the impulse response function may be affected and significance should not be relied upon.

long run. By comparison, government consumption has an impact multiplier of 0.5 and a long-run multiplier that is negative at -0.9 (also statistically insignificant). This is partly driven by wage government consumption, which does not increase output in the four-variable case at any horizon, nor in the long run for the five-variable specification.

4.6 Controlling for Expectations: an EVAR Approach

Ramey (2011) and Auerbach *et al.* (2012) note that the timing of fiscal shocks and expectations can play a major role in determining how effective they are. We use a similar method to Auerbach *et al.* to account for the role of expectations.

Figure A.8 shows the impulse-response functions for a 1 per cent of Domestic GVA shock to government consumption, which is ordered second in the EVAR specification. The response of Domestic GVA remains similar to the four-variable SVAR estimates, although it is not found to be statistically significant at any horizon. As such, we cannot say that government consumption shocks have significant (non-zero) impacts on Domestic GVA. It is possible that this may indicate anticipation effects to the response of Domestic GVA.

Table 4.3: EVAR Government Consumption Multipliers
(Based on Domestic GVA)

	GC
Controlling for Expectations – EVAR	
Impact	1.2
Long term	0.4
Four-Variable SVAR	
Impact	1.1*
Long term	0.9

Sources: CSO; Department of Finance; and authors' own calculations.
Note: Sample period for EVAR 1976-2016, for Baseline VAR 1971-2016.

Table 4.3 shows the estimated multipliers for government consumption controlling for expectations, along with the earlier four-variable SVAR

estimates. While estimates are relatively similar in the short run, the divergences over the medium term and the wide error bands computed highlight the uncertainty of the multipliers estimated.

4.7 Estimates using COSMO: a Structural Model of the Irish Economy

To further sense-check the multipliers that we calculate, we also avail of the ESRI's structural model of the Irish economy: COSMO. Three shocks are studied:

1. a shock to overall government spending. This comprises a 5 per cent shock to government investment, a 1 per cent shock to government consumption and a 1.3 per cent shock to transfers.
2. a shock to government investment of 10 per cent; and
3. a shock to government consumption of 2 per cent.

Each shock is calibrated so that the specific spending variable is 'x' per cent higher each year than in a baseline scenario. The magnitude of the shocks is chosen so as to ensure the shocks are similar nominal amounts. There is no "solvency rule" included in the model, which would automatically bring the public finances back to a baseline balance position. Table 4.4 provides impact and long-term multipliers based on the three shocks assessed. The multipliers are cumulative as before (i.e., the change in GVA is divided by the change in the government spending variable).

The COSMO impact multipliers for government consumption and government spending are relatively similar to the four-variable SVAR estimates. However, the investment multipliers estimated using COSMO are considerably lower than in the four-variable SVAR case across all horizons (about half the corresponding impact multiplier, and two-thirds the long-run estimate). It is not possible to determine the statistical significance of these results, though standard confidence intervals for

other approaches would suggest that they are unlikely to be significant in the long run. Moreover, the differences in estimates produced when using alternative approaches further highlights the uncertainty surrounding the impact of fiscal policy on the economy. This, again, stresses the need for caution when using these estimates.

Table 4.4: Estimates of Multipliers Using COSMO

	Shock 1 GEXP	Shock 2 GINV	Shock 3 GC
COSMO Estimates			
Impact	0.8	1.2	1.2
Long Run	1.4	1.6	1.7
Four-Variable SVAR Estimates			
Impact	1.2	2.5	1.1
Long Run	0.9	2.3	0.9

Sources: Results based on analysis by IFAC using COSMO, the ESRI macro-economic model.
Note: The impact multiplier refers to year 1, 2019; the long run multiplier is year 5, 2023. It is not possible to determine the statistical significance of COSMO estimates, but confidence intervals for other approaches would suggest they are unlikely to be significant in the long run.

4.8 Summary Multiplier Estimates

Table 4.5 provides a summary of the multiplier estimates that we have estimated. It focuses on the preferred specifications for each of the modelling approaches used.

Table 4.5: Summary of Multiplier Estimates
(Based on Domestic GVA unless stated)

		GEXP	GINV	GC	NWGC	WGC
Four-Variable SVAR Specification						
	Impact	1.2*	2.5*	1.1*	0.5	-0.2
	Long Run	0.9	2.3	0.9	1.7	-8.8
Five-Variable (Preferred) SVAR Specification						
	Impact	-	1.4*	0.5	1.0*	1.2
	Long Run	-	2.0	-0.9	1.7	-4.8
COSMO-Based Estimates (Total GVA)						
	Impact	0.8^	1.2^	1.2^	-	-
	Long Run	1.4^	1.6^	1.7^	-	-
Controlling for Expectations – EVAR						
	Impact	-	-	1.2	-	-
	Long Run	-	-	0.4	-	-

Sources: CSO, authors' own calculations, Department of Finance, COSMO estimates based on analysis by authors using COSMO, the ESRI macro-economic model.
Note: GEXP = Government Expenditure; GINV = Government Investment; GC = Government Consumption; WGC = Wage Government Consumption; and NWGC = Non-Wage Government Consumption. Impact multipliers are calculated at year 1; long-run multipliers are calculated at year 5. Sample period for SVARs 1971–2016; EVAR 1976–2016.
* denotes that the multiplier is statistically different from zero at the 95 per cent confidence level based on Monte Carlo simulations with 1,000 replications.
^ It is not possible to determine the statistical significance of COSMO estimates, but confidence intervals for other approaches would suggest they are unlikely to be significant in the long run.

A range of estimates can be seen for Ireland's fiscal multipliers depending on the method employed. These differences suggest caution is warranted. Wide error bands are found in most of the estimates we obtain, and there is limited evidence of a lasting effect in the medium to long run. This demonstrates the uncertainty in relation to multipliers and the value of employing a suite of approaches to better understand fiscal multipliers.

5. Conclusions

This paper contributes to a relatively limited literature on Ireland-specific government spending multipliers. We make two major contributions. First, we account for distortions caused by the impact of multinational activities on standard output measures. These distortions could otherwise bias multiplier estimates. By stripping out these activities, we are able to derive truer estimates of the impact on the domestic economy of changes in fiscal policy. Second, we use a variety of statistical approaches, including various specifications of SVARs, an Expectations-augmented (EVAR) VAR approach, and estimates based on a structural model of the Irish economy. This enables us to provide a better sense-check of the multiplier estimates that we derive.

Our results show that fiscal policy can have a positive short-run effect on the economy, yet, over the longer term, we find very limited evidence that the impacts are significantly different from zero. This likely reflects the fact that the Irish economy is highly open in nature. In particular, high net leakages of income can result, given Ireland's propensity to import.

Our results show that fiscal policy impacts depend on the type of intervention. This supports previous findings for Ireland and other countries (Bénétrix and Lane, 2009; Hall, 2010; Giordano *et al.*, 2007). We find that public investment has a stronger initial impact on activity compared to other types of government spending, yet the estimated impacts are wide-ranging and they are not significantly different from zero over the long run. By contrast, government consumption spending is found to have relatively more limited effects on output, partly driven by weaker estimates for the impact arising from wage consumption.

These findings are robust to a number of different specifications. In addition to the SVAR approaches, we examine a technique that controls for expectations in an EVAR setting. The approach shows similar

estimates for the magnitude of impact of government consumption over the short run, but this is statistically insignificant. The estimated long-run effects on economic activity are also not statistically different from zero. This further underscores the uncertainty of the estimates.

We also estimate multipliers using the ESRI's large-scale structural model of the Irish economy, COSMO. Smaller investment multipliers are estimated and slightly larger consumption multipliers, when compared to the SVAR and EVAR approaches. It is not possible to determine whether the estimates produced using COSMO are statistically significant at any horizon. Given the typical confidence intervals found, it is not clear that the COSMO estimates significantly differ from alternatives.

Our research emphasises the fact that no single estimate of a fiscal multiplier is likely to be correct. The width of the confidence bands on our estimates points to the weak statistical power of estimates produced across a variety of techniques. We find large differences in fiscal multiplier estimates, and we find very limited evidence that the effects are significant in the medium to long run. While this is to be expected in the case of a small open economy such as Ireland, where higher imports can offset the overall impact on output, it underscores the need for caution in drawing strong inferences from the results.

In terms of future considerations, there are other factors that determine the size of multipliers, which could be explored further. These include, for example, financing considerations, debt sustainability considerations, the response (if any) of monetary policy, and the behavioural response of individuals to the specific measures introduced (i.e., the extent to which their response may be said to be Ricardian). Further work on state-dependent multipliers may be warranted, albeit that data availability and satisfactory estimates of the cycle over a sufficiently long time horizon are still in relatively short supply for Ireland.

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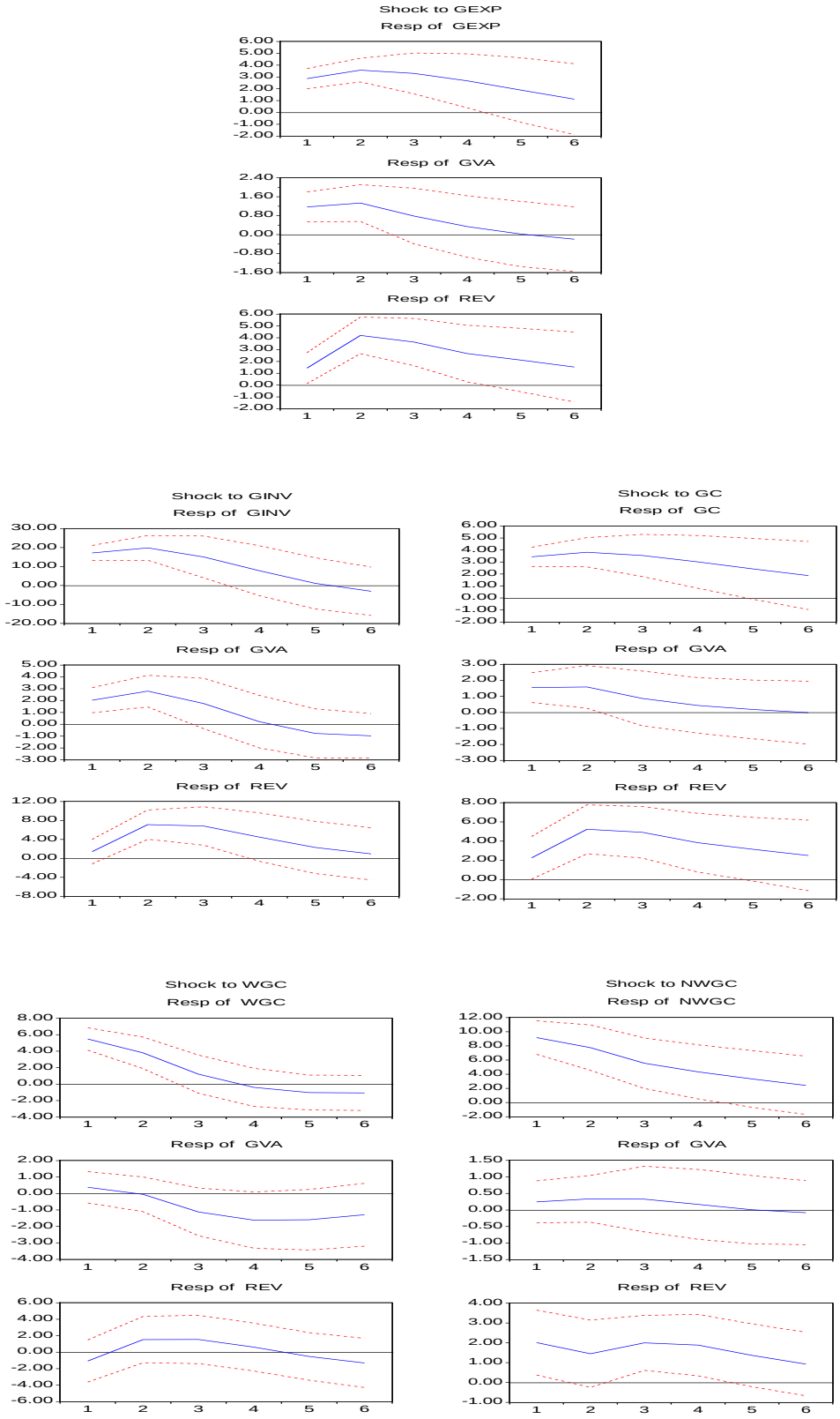
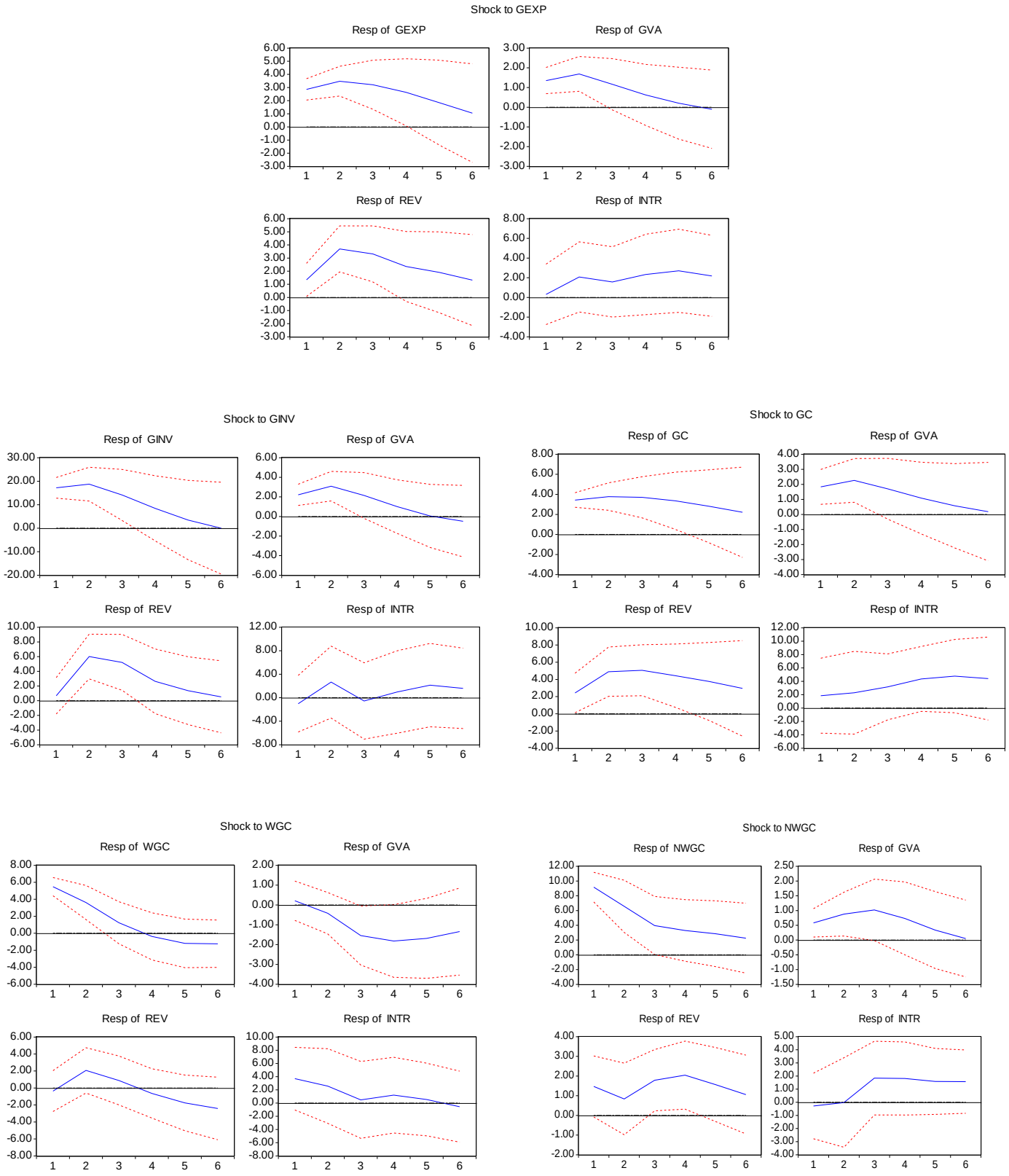
Figure A.1: Three-Variable SVAR. Response to 1 Per Cent of Domestic GVA Government Spending Shock



Note: Solid lines show the point estimates of the Impulse-Response mean. Dotted lines are the +/- 2 standard errors from Monte Carlo simulations with 1000 replications.

Figure A.2: Four-Variable SVAR. Response to 1 Per Cent of Domestic GVA Government Spending Shock

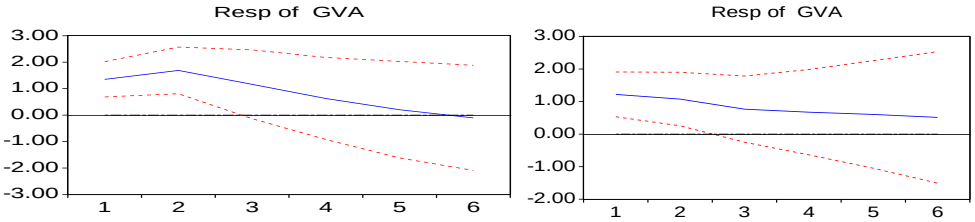


Note: Solid lines show the point estimates of the Impulse-Response mean. Dotted lines are the +/- 2 standard errors from Monte Carlo simulations with 1000 replications.

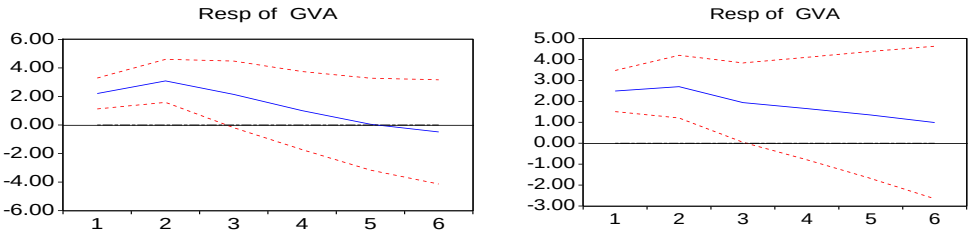
Figure A.3: Four-Variable SVAR with Financial Crisis Dummy. Response to 1 Per Cent of Domestic GVA Government Spending Shock

Four-variable VAR | Including Financial Crisis

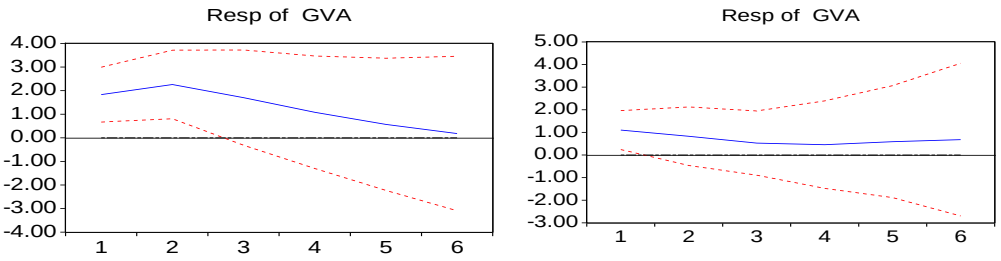
Shock to GEXP



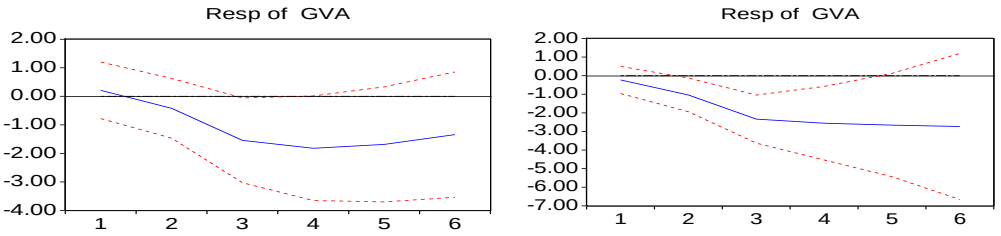
Shock to GINV



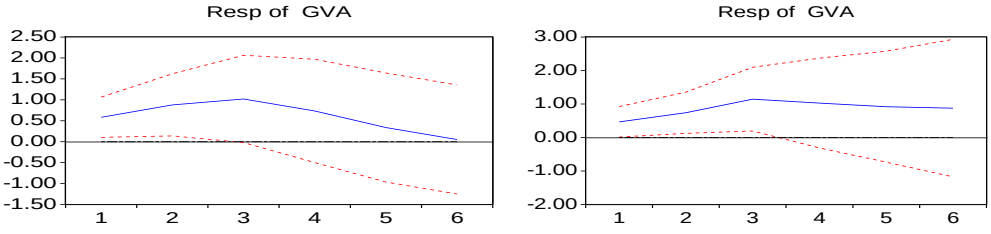
Shock to GC



Shock to WGC



Shock to NWGC

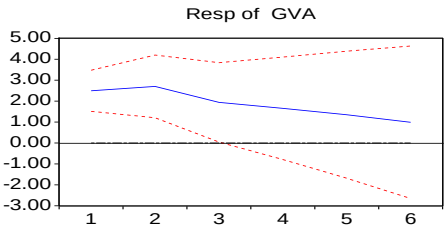


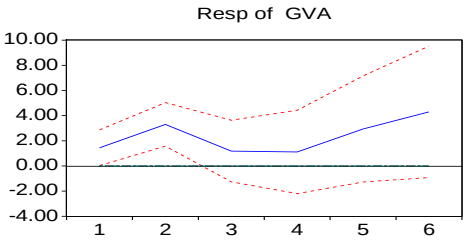
Note: Solid lines show the point estimates of the Impulse-Response mean. Dotted lines are the +/- 2 standard errors from Monte Carlo simulations with 1,000 replications.

Figure A.4: Controlling for Other Spending, Five-variable SVAR, Shocked Variable Ordered Second. Response to 1 Per Cent of Domestic GVA Government Spending Shock

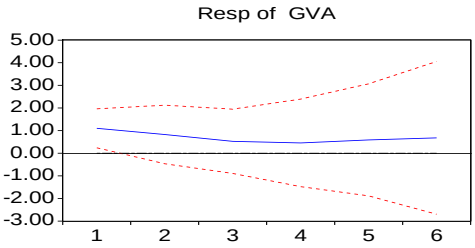
Four-variable inc. Financial Crisis (Baseline) | Five-variable

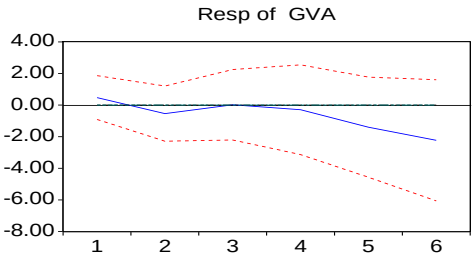
Shock to GINV



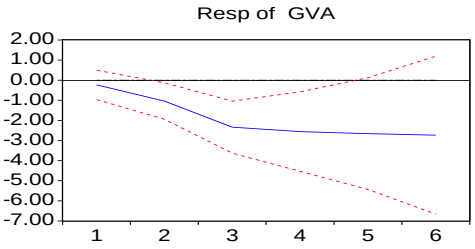


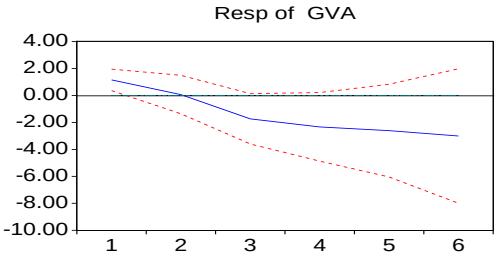
Shock to GC



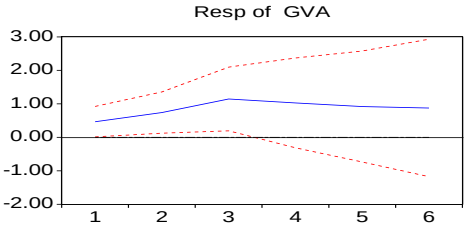


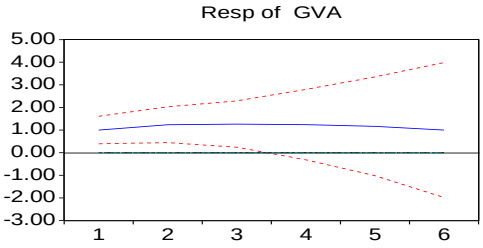
Shock to WGC





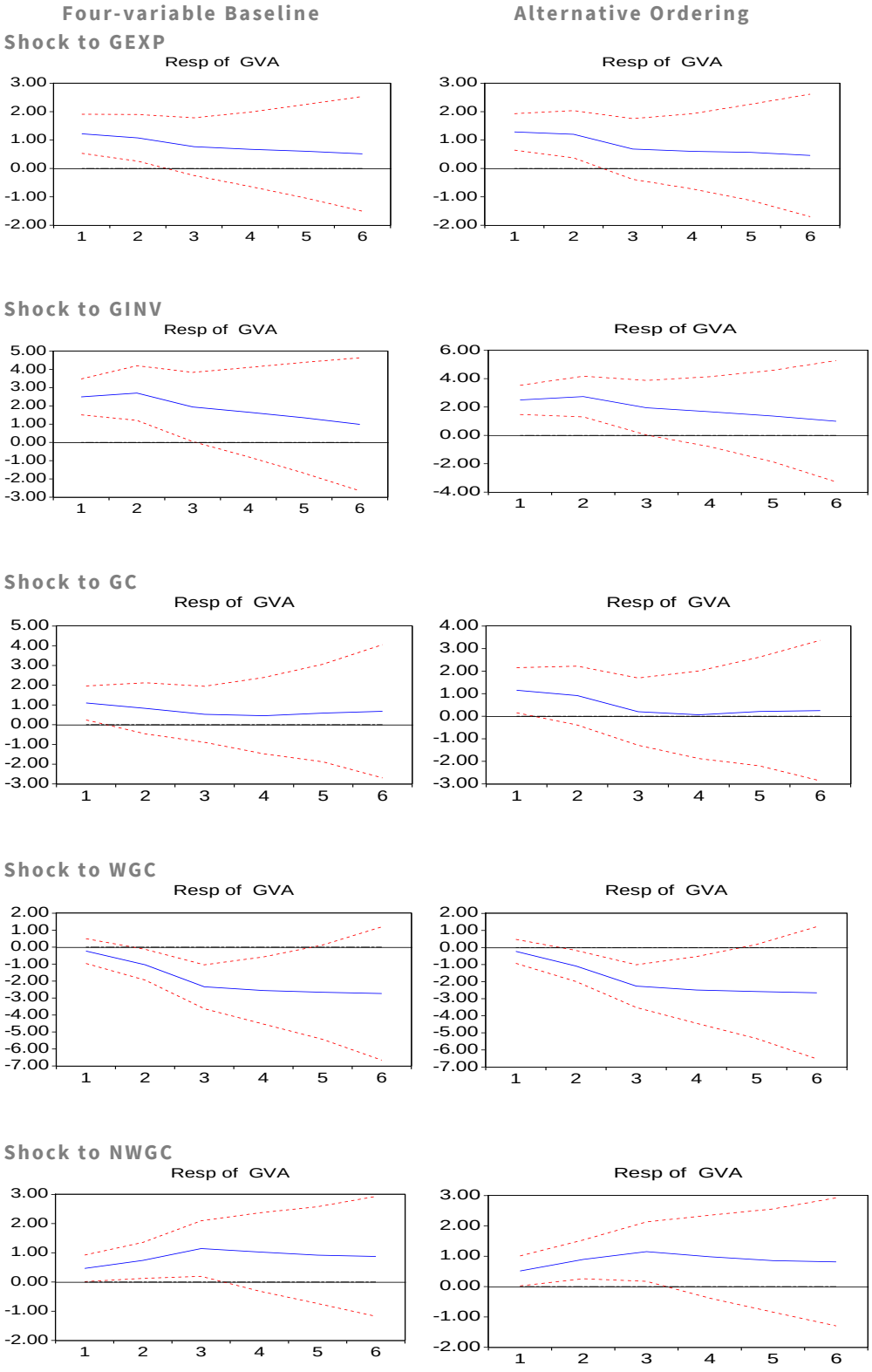
Shock to NWGC





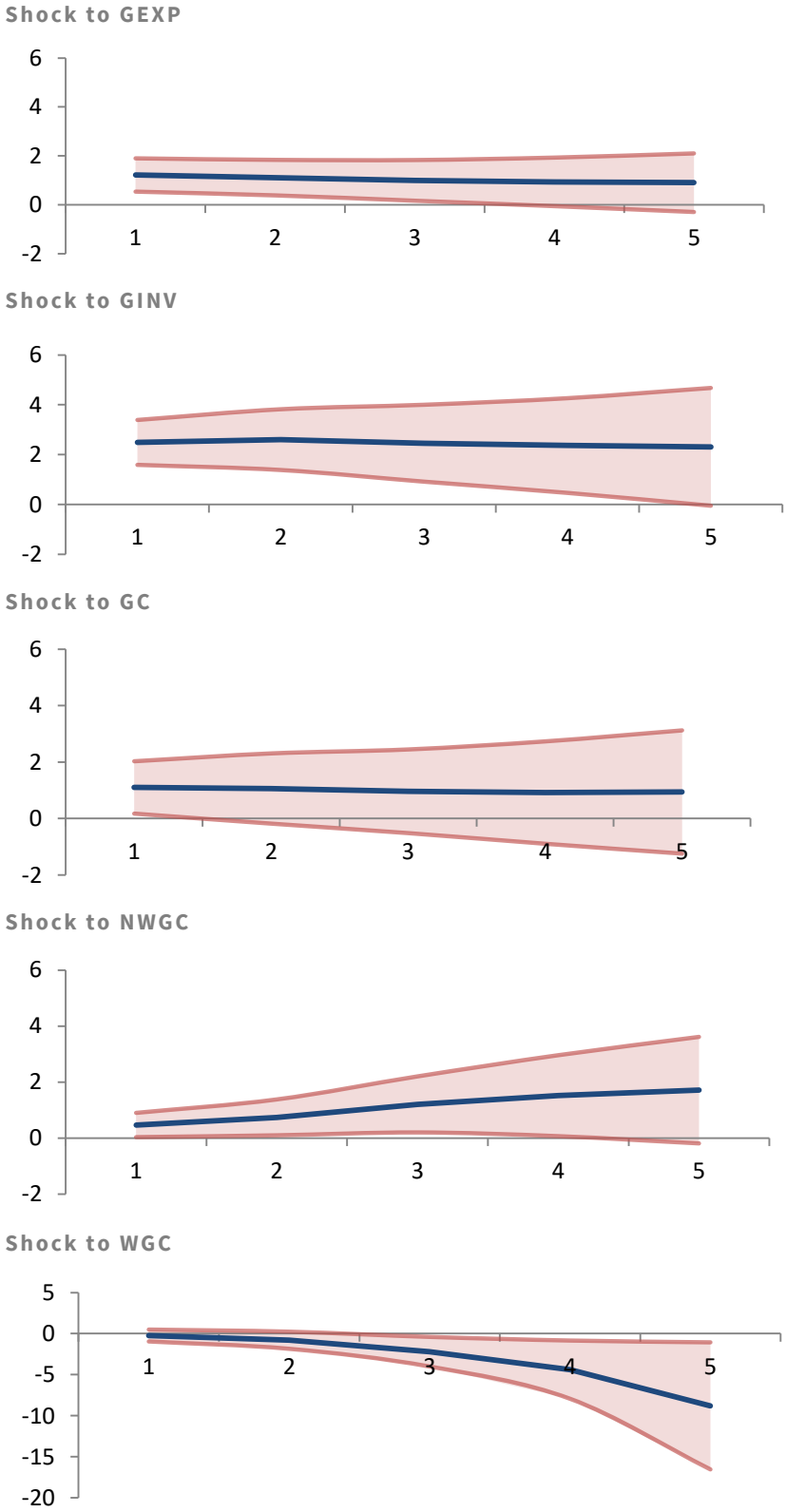
Note: Solid lines show the point estimates of the Impulse-Response mean. Dotted lines are the +/- 2 standard errors from Monte Carlo simulations with 1,000 replications.

Figure A.5: Alternative Ordering SVAR, Revenue Ordered First. Response to 1 Per Cent of Domestic GVA Government Spending Shock Ordered Second.



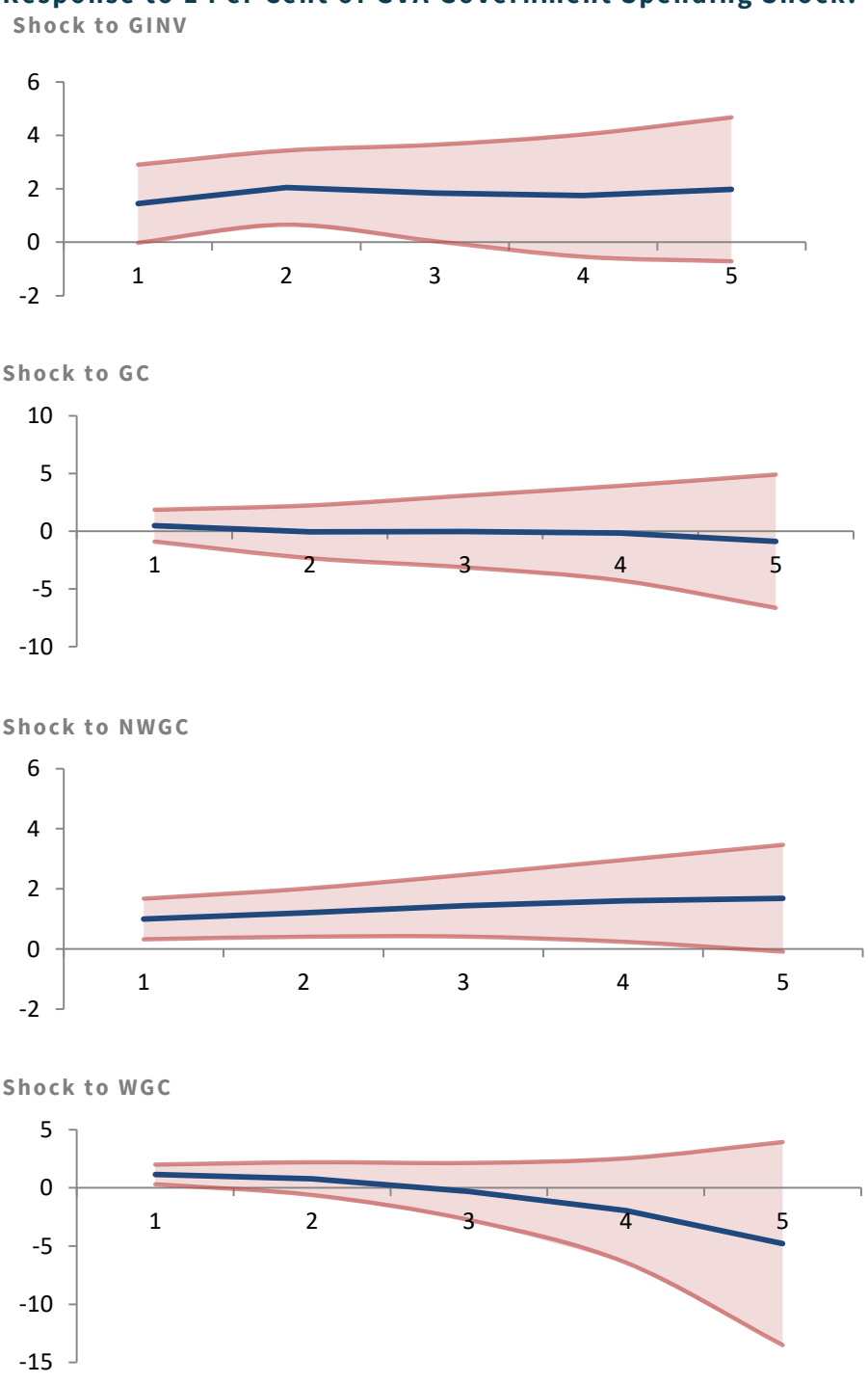
Note: Solid lines show the point estimates of the Impulse-Response mean. Dotted lines are the +/- 2 standard errors from Monte Carlo simulations with 1,000 replications.

Figure A.6: Fiscal Multiplier Estimates, Four-Variable SVAR. Response to 1 Per Cent of Domestic GVA Government Spending Shock.



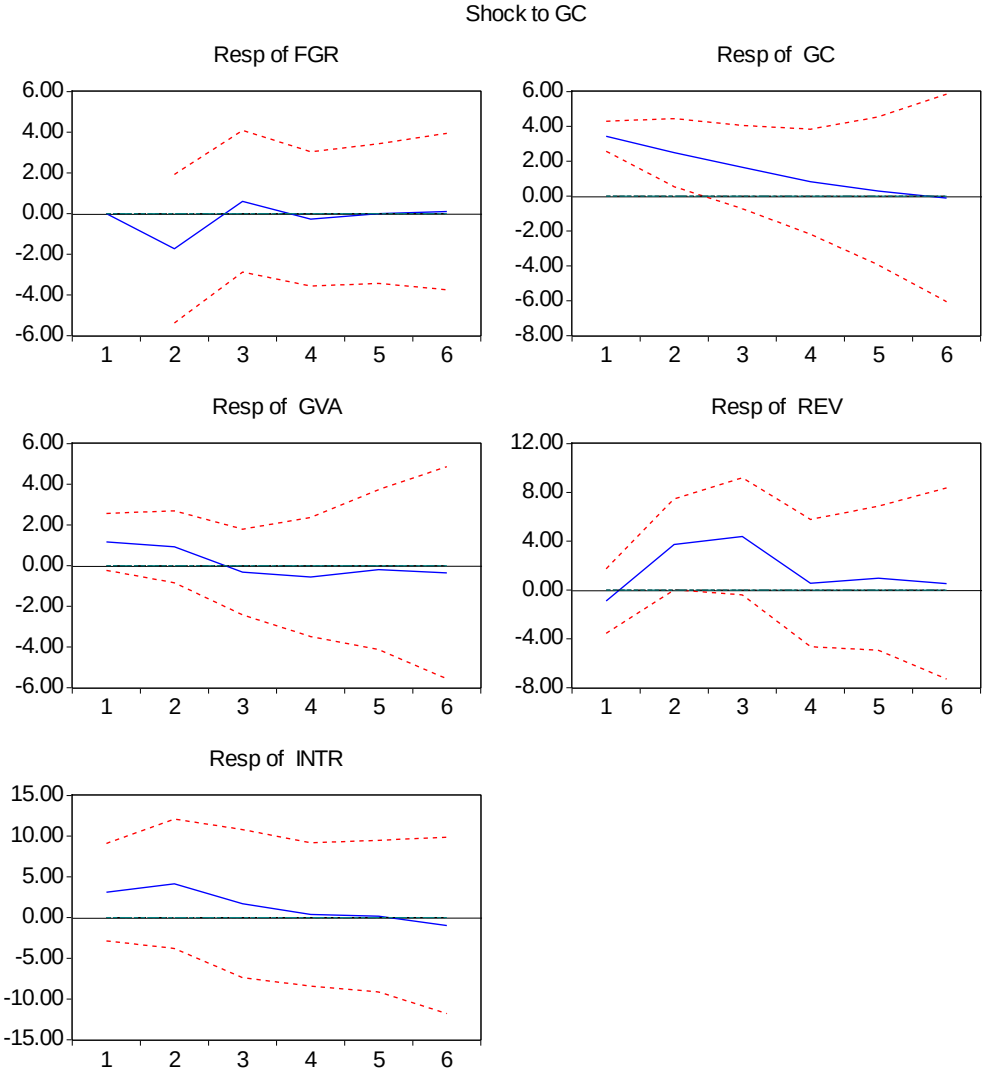
Note: Blue lines show the point estimates of the Impulse-Response mean. Shaded are show the +/- 2 standard errors bands from Monte Carlo simulations with 1,000 replications. Note, the WGC estimates are not stable and so standard error bands may be affected.

Figure A.7: Fiscal Multiplier Estimates Five-Variable SVAR. Response to 1 Per Cent of GVA Government Spending Shock.



Note: Blue lines show the point estimates of the Impulse-Response mean. Shaded are show the +/- 2 standard errors bands from Monte Carlo simulations with 1,000 replications. Note, the WGC estimates are not stable and so standard error bands may be affected.

Figure A.8: Controlling for Expectations, Five-Variable SVAR, Shocked Variable Ordered Second. Response to 1 Per Cent of Domestic GVA Government Consumption Shock



Note: Solid lines show the point estimates of the Impulse-Response mean. Dotted lines are the +/- 2 standard errors from Monte Carlo simulations with 1,000 replications.