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Empirical estimates of fiscal multipliers for South Africa

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Abstract: Despite the frequent use of fiscal policy for stabilization purposes and the important role fiscal activism has played over the last decade, the size of budgetary multipliers (i.e. the output response following an exogenous shock to fiscal policy) has been heatedly debated at the theoretical and empirical levels, both globally and in the South African context. This paper estimates fiscal multipliers for South Africa using a variety of identification approaches and model specifications. The main findings show that the size of budgetary multipliers is sensitive to the identification strategy and modelling approach used. Keeping this caveat in mind, the estimation results show that government spending multipliers are positive, albeit generally smaller than 1. In contrast, tax multipliers are large and distortionary. It is also shown that both spending and tax multipliers are larger when the economy is in a recessionary state (or downswing).

Key words: fiscal multiplier, fiscal policy, state-dependent, structural VAR

JEL classification: B22, E62, H62, H63

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1 Introduction

Measuring the impact of fiscal policy decisions on aggregate gross domestic product (GDP) and its components was an active research area for a number of decades during the mid-twentieth century. The large Keynesian models of the 1960s included fiscal variables and numerous empirical papers investigated their effects on macroeconomic variables through the estimation of behavioural equations (Ramey 2016). However, from the 1980s to the early 2000s, most empirical research on shocks focused on monetary policy. With the onset of the 2008/09 Global Financial Crisis (GFC) and the emergence of the zero lower bound, attention shifted to the effects of fiscal policy.

Despite the strong policy response from monetary authorities during and immediately after the GFC, it soon became apparent that the standard monetary policy toolkit was insufficient to offset the dramatic fall in economic activity. While standard interest rate tools were used to aggressively loosen monetary policy in the wake of the GFC, central banks also implemented what could be referred to as 'quasi-fiscal policy'. Quasi-fiscal policy refers to policies that, instead of being innate to central banks, could have been implemented by fiscal authorities. It is defined as any policy action that affects the central banks' balance sheets, with the exception of traditional monetary policy (Park 2015).

Given the apparent inability of both standard and unconventional monetary policy tools to stimulate global demand, there was renewed debate on the role of discretionary fiscal policy in stabilizing the global economy. In the decades prior to the crisis, the consensus was one predicated on the idea of fiscal discipline. Fiscal stabilization was, broadly speaking, relegated to automatic stabilizers rather than discretionary fiscal policy. However, in the wake of the GFC, governments—as well as institutions generally viewed as sympathetic towards fiscal austerity (such as the International Monetary Fund or the European Commission)—advocated for large fiscal stimulus programmes.

While some have argued that fiscal activism had actually been practised for quite some time prior to the crisis (see, for example, Auerbach (2009) for the United States and Cecchetti et al. (2010) for several OECD countries), it was only after the crisis that activist policy was formally back on the agenda. Across the globe, fiscal policy was employed in concert with the fall in interest rates and the expansion of central bank balance sheets in an attempt to bolster economic growth.

Despite the frequent use of fiscal policy for stabilization purposes and the important role fiscal activism played in the wake of the GFC (and during the current recession), the size of budgetary multipliers, which measures the output response following an *exogenous* shock to fiscal policy, has been heatedly debated at both the theoretical and empirical levels. In fact, in the empirical literature, which is largely based on structural vector autoregressions (SVARs), there is little agreement on the size, and even the sign, of fiscal multipliers.[1] Caldara and Kamps (2008, 2017), Chahrour et al. (2012), and Ramey (2016), among others, show that the wide range of fiscal multiplier estimates found in the literature is mainly due to differences in the approaches used to identify the underlying (structural) fiscal shocks.

This general result is also true in the context of South Africa. The few studies that have attempted to estimate fiscal multipliers for South Africa provide for a relatively wide range of estimates, with results dependent on model specification and identification strategy. The same is true for the current study. Given the inherent ambiguity of multiplier estimates and the important role that model specification and identification play in the final results, caution should be applied when relying on these estimates to draw concrete policy conclusions.

[1] See Ramey (2016) for a review of the relevant literature.

Keeping in mind this important caveat, this paper estimates fiscal multipliers for South Africa using a variety of identification approaches and model specifications. The main findings show that the size of budgetary multipliers is indeed sensitive to identification strategy and modelling approach. Despite this caveat, in general the estimation results show that government spending multipliers are positive, albeit generally smaller than 1. In contrast, tax multipliers are large and distortionary. It is also shown that both spending and tax multipliers are larger when the economy is in a recessionary state (or downswing).

The rest of the paper proceeds as follows: Section 2 provides some theoretical and empirical background, including a brief overview of the literature on budgetary multipliers. Section 3 discusses the baseline empirical strategy, while Section 4 provides baseline fiscal multiplier estimates. Section 5 investigates alternative model specifications. Section 6 estimates state-dependent fiscal multipliers for South Africa, while 7 presents some caveats and concluding comments.

2 Theoretical and empirical background

2.1 Theoretical predictions

While the identification and estimation of the effects of fiscal policy changes on macroeconomic outcomes (i.e. fiscal multipliers) appear at first glance to be a purely empirical matter, economic theory tells us that there is no single government spending or tax multiplier. In fact, the effect of fiscal policy shocks on broader macroeconomic outcomes depends potentially on a range of factors. These include the persistence in the change of fiscal variables, the type of public spending, and/or taxes that changed (e.g. consumption versus investment spending, personal versus corporate taxes), how the change was financed (e.g. deficit/debt-financed or balanced-budget), how the change was distributed across economic agents, the response of monetary policy, the state of the economy at the time of the change, and various other features of the economy such as the level of development, exchange rate regime, and openness (Ramey 2019).

There are three broad theoretical frameworks that provide an underpinning for the effects of fiscal policy on macroeconomic outcomes. The Keynesian model, which assumes that the level of GDP is demand-determined over the short term, treats the government spending multiplier as the inverse of 1 minus the marginal propensity to consume (Ramey 2019). In this model, taxes enter the multiplier only through their effect on disposable income and, as such, tax multipliers are smaller (and of the opposite sign) than spending multipliers. Expanding these models to incorporate features such as the marginal propensity to import (i.e. 'opening up' the model economy), tax rates, and monetary policy leads to smaller spending multipliers.

Neoclassical models, which include variable labour supply and variable capital stock, also predict positive spending multipliers and negative tax multipliers. However, the transmission mechanism is different from the one in the Keynesian model. In the neoclassical model, a positive government spending shock generates a negative household wealth effect. This negative wealth effect induces households to work more (i.e. the shock induces a positive labour supply response), thereby raising GDP. Distortionary taxes have potentially large negative effects in these models. However, in contrast to the simple Keynesian models where tax shocks work through aggregate demand, in the neoclassical framework, tax shocks affect economic outcomes through supply-side channels (Ramey 2019).

Finally, New Keynesian models, embodied in New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) models, combine elements of both Keynesian and neoclassical models. Standard representative agent sticky-price NK-DSGE models tend to produce small, albeit positive, government spending multipliers. In the last decade, the standard NK-DSGE model has been expanded to include, among other features, sticky wages, heterogeneous agents, and financial market frictions. In these models, agents tend to have much higher marginal propensities to consume, which can lead to larger spending multipliers. Following the GFC, a new generation of NK-DSGE models have explored the effects of fiscal policy under unconventional monetary policy arrangements, particularly in cases where policy rates are constrained by the zero lower bound. These extensions often result in large spending multipliers, in many cases larger than unity (Ramey 2019).

When estimating the impact of fiscal policy changes on macroeconomic outcomes, it is important to keep these theoretical considerations in mind. It is important to be aware of which theoretical model is being used, while also being mindful of other factors that could influence the size and/or sign of fiscal multipliers. These include the particular institutional arrangements of the economy under investigation, how the change in fiscal policy is financed, the persistence of the fiscal shock or change in the particular fiscal variable, the exchange rate regime, the openness of the economy, and so forth.

Keeping these caveats in mind, the following sections briefly discuss the empirical literature on fiscal multipliers, starting with a brief overview of the main identification methods.

2.2 Identification of fiscal shocks

The empirical literature on fiscal multipliers is primarily concerned with estimating the effects of exogenous and/or unanticipated changes in fiscal variables on macroeconomic aggregates such as GDP and/or private consumption. In principle, a fiscal policy shock is a relatively straightforward concept. Fiscal authorities often make policy decisions based on considerations that are unrelated to the current state of the economy. For example, unanticipated changes in tax policy/regime might stem from a change in political power and/or equity concerns, while unanticipated spending shocks might stem from exogenous factors such as the outbreak of war. In contrast, the idea of regularly occurring exogenous shocks to monetary policy is less plausible, given the fact that monetary policy decisions are highly dependent on the current state of the business cycle.

That being said, identifying exogenous (or structural) fiscal policy shocks in an empirical time series framework is far from straightforward. This section briefly discusses the problem of identifying fiscal shocks empirically, while also detailing some of the leading identification methods employed in the literature.

Ramey (2016) provides a simple framework for discussing the problem of identification. Consider a simple model of the relationship between fiscal variables and GDP. Suppose the structural relationships between government spending (g), taxes (τ), and GDP (y) is given by:

$$\begin{aligned} y_t &= \beta_{y\tau}\tau_t + \beta_{yg}g_t + \varepsilon_{yt} \\ g_t &= \beta_{g\tau}\tau_t + \beta_{gy}y_t + \varepsilon_{gt} \\ \tau_t &= \beta_{\tau g}g_t + \beta_{\tau y}y_t + \varepsilon_{\tau t} \end{aligned} \tag{1}$$

ε are the structural macroeconomic shocks of interest: $\varepsilon_{\tau t}$ is the tax shock, ε_{gt} captures an exogenous shock to government spending, and ε_{yt} captures business cycle shocks such as technological progress.

This simple model can be used to illustrate the main identification problem. Based on theoretical predictions, government spending might be expected to increase GDP (i.e. $\beta_{yg} > 0$) and an increase in taxes might be expected to lower it ($\beta_{y\tau} < 0$). However, the presence of automatic stabilizers implies that the fiscal variables might also respond to developments in GDP (i.e. $\beta_{gy} < 0$ and $\beta_{\tau y} > 0$). As a result, a simple ordinary least squares (OLS) regression will lead to biased estimates of the parameters of interest ($\beta_{y\tau}$ and β_{yg}) because g_t and τ_t are correlated with ε_{yt}. Without further assumptions, neither the parameters nor the structural shocks are identified (Ramey 2016).

This simple model can be expanded to a dynamic setting.[2] Consider the same model as above with three endogenous variables, Y_1, Y_2, and Y_3. In the context of fiscal policy, these might be GDP, government spending or investment, and tax revenue or marginal tax rates. Suppose that the dynamic behaviour of the vector of endogenous variables, $Y_t = [Y_{1t}, Y_{2t}, Y_{3t}]$, is given by:

$$Y_t = B(L)Y_t + \Omega\varepsilon_t \tag{2}$$

where $B(L) = B_0 + \sum_{k=1}^{p} B_k L^k$. The elements of B_0 are the same as the β from Equation (1) with $\beta_{jj} = 0$. As has become standard practice in the SVAR literature, the dynamics of the system can be investigated by rewriting Equation (2) in its reduced form representation:

$$A(L)Y_t = \eta_t \tag{3}$$

where $A(L) = I - \sum_{k=1}^{p} A_k L^k$, and $\eta_t = [\eta_{1t}, \eta_{2t}, \eta_{3t}]$ is the reduced form VAR innovations. The reduced form innovations can then be linked to the (unobserved) structural shocks, ε, as follows:

$$\eta_t = B_0\eta_t + \Omega\varepsilon_t \tag{4}$$

or

$$\eta_t = H\varepsilon_t \tag{5}$$

where $H = [I - B_0]^{-1}\Omega$. If one assumes that Ω is an identity matrix and that the structural shocks, ε_t, have unit effects, the system can be written as:[3]

$$\begin{aligned} \eta_{1t} &= \beta_{12}\eta_{2t} + \beta_{13}\eta_{3t} + \varepsilon_{1t} \\ \eta_{2t} &= \beta_{21}\eta_{1t} + \beta_{23}\eta_{3t} + \varepsilon_{2t} \\ \eta_{3t} &= \beta_{31}\eta_{1t} + \beta_{32}\eta_{2t} + \varepsilon_{3t} \end{aligned} \tag{6}$$

This set of equations is the dynamic equivalent of Equation (1). The only difference is that the structural relationships are written in terms of the reduced form VAR innovations, $\eta_{.t}$, as opposed to the endogenous variables themselves. The interpretation of the coefficients remains the same. As discussed above, these coefficients, and the associated structural shocks, cannot be identified without additional restrictions.

The above discussion at the hands of a relatively simple model highlights the fact that the identification of fiscal shocks is far from straightforward. Several of the leading approaches used to deal with the identification issue are discussed below.[4]

Cholesky decomposition

The most common identification scheme is based on the Cholesky (or recursive) decomposition, first introduced by Sims (1980). The most common variant of this identification method assumes that the policy variable does not respond contemporaneously (within the month, quarter, or year) to the other endogenous variables in the system.

Suppose that, in the simple model discussed above, Y_1 is the policy variable (e.g. government consumption spending). The recursive identification scheme involves setting $\beta_{12} = \beta_{13} = 0$ in Equation (6).

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[2] Stock and Watson (2016) provide a more detailed treatment of identification issues in a dynamic setting.

[3] These two simplifying assumptions are widely used in the SVAR literature. The first implies that each structural shock enters only one equation, while the second implies that the diagonal elements of H are unity.

[4] See Ramey (2016) for further details.

This is equivalent to ordering the policy variable first in a VAR set-up. Alternatively, one could assume that the other endogenous variables do not respond contemporaneously to the policy shock—that is, $\beta_{21} = \beta_{31} = 0$ in Equation (6).

Other coefficient restrictions

Another approach, first introduced by Blanchard and Watson (1986) and Bernanke (1986), nests the Cholesky decomposition and is known as a *structural* VAR, or SVAR. This approach uses outside estimates and/or economic theory to constrain the contemporaneous responses of the endogenous variables. In a seminal paper by Blanchard and Perotti (2002), they use this approach to identify both government spending and net tax shocks. With reference to the simple framework discussed above, assume that Y_1 is government spending, Y_2 is net taxes, and Y_3 is real GDP. The authors proceed to identify the government spending shock by using a recursive decomposition with government spending ordered first in the Cholesky ordering (i.e. $\beta_{12} = \beta_{13} = 0$). In contrast, net tax shocks are identified by using an outside estimate of the elasticity of tax revenue to GDP to constrain β_{23} in Equation (6).

A second related approach uses long-run restrictions to identify policy shocks as opposed to constraining contemporaneous coefficients/responses. The most common form of long-run restriction is the infinite horizon restriction, introduced by Shapiro and Watson (1988) and popularized by Blanchard and Quah (1989). Instead of imposing zero contemporaneous restrictions on the system, the approach assumes that the policy variable(s) does not affect other endogenous variables (or set of endogenous variables) in the long run. In the simple framework discussed above, this is achieved by re-casting Equation (2) in its moving average (MA) representation, $Y_t = C(L)\eta_t$ and combining it with Equation (5) to express Y as a function of the structural shocks:

$$Y_t = D(L)\varepsilon_t \tag{7}$$

where $D(L) = C(L)H$. By placing restrictions on the elements of D, the structural shocks can be identified.

Narrative methods

Narrative methods involve constructing a series of shocks based on historical documents and/or information reflecting the reason for and/or quantities associated with a particular change in the policy variable of interest (Ramey 2016). These series are then used as exogenous inputs in a standard regression framework. Early examples of the use of narrative methods to identify policy shocks include Friedman and Schwartz (1963), Hamilton (1985), and Hoover and Perez (1994). Examples of the use of narrative methods to identify *fiscal* policy shocks include Poterba (1986), Ramey and Shapiro (1998), Romer and Romer (2010), and Ramey (2011b).

External instruments/proxy SVARs

The external instrument or proxy SVAR method is a relatively new method for incorporating external information to aid in the identification of fiscal policy shocks. The method was developed by Stock and Watson (2008) and was extended by Stock and Watson (2012) and Mertens and Ravn (2013). The approach uses information external to the VAR, such as the narrative series discussed above, and uses it to identify the policy shock in question (see Ramey (2016) for more details). The approach has been extended to incorporate non-fiscal series as possible instruments to aid in the identification of fiscal shocks (see Caldara and Kamps (2017) for an example).

Sign restrictions

Several researchers have noted the circularity in the analysis of VAR specifications in practice. A particular specification and/or identification method is often deemed acceptable only if the impulse responses they produce are judged to be reasonable—that is, consistent with the researchers' priors (Ramey 2016). Faust (1998) and Uhlig (2005) developed the sign-restriction (SR) approach, which incorporates reasonableness without undercutting the scientific process. The authors identified structural shocks to a particular variable Y by placing restrictions on the impulse responses of the other endogenous variables in the system (see Section 3.2 for details of the implementation of the approach). The SR approach was initially used in the identification of monetary policy shocks, but has since been applied to the identification of other types of shocks, including total factor productivity (or technology) shocks and fiscal policy shocks.

Estimated structural models

A different approach to the identification of fiscal policy shocks relates to estimated dynamic stochastic general equilibrium (DSGE) models, introduced by Smets and Wouters (2003, 2007) and extended by numerous authors since. These models identify structural shocks by imposing a theoretically motivated structure on the model economy. The approach involves estimating a fully specified structural, general equilibrium model and extracting the set of implied structural shocks from those estimates. A variation on the standard procedure involves first estimating impulse responses in a standard SVAR set-up and then calibrating the parameters in the DSGE model to match these responses (see Christiano et al. (2005) for an example of this approach).

The problem of nonfundamentalness

In a SVAR, linear combinations of structural shocks are estimated as residuals of an unrestricted VAR and the structural shocks are then identified by rotating the VAR innovations in a suitable way—that is, by imposing restrictions. However, if the *structural* model has an MA component, the VAR representation is admissible only under some conditions that may not be verified in the structural model. In particular, the VAR representation is admissible only if no root of the determinant of the matrix of the MA is inside the unit circle. If at least one root is smaller than one in modulus, there is a problem of nonfundamentalness of the structural shocks: VAR estimation will not recover them because of the need to invert the MA (Alessi et al. 2008). This is a consequence of the fact that the agents' information set is bigger that the econometrician's one. In the context of the identification of fiscal policy shocks, Leeper et al. (2013) show that failure to account for fiscal foresight (i.e. the broader information set of economic agents) in the estimation set-up could lead to nonfundamentalness and biased estimates for tax multipliers.

One way to deal with the problem of nonfundamentalness is to enlarge the econometrician's information set. While it is not possible to include future observations, the cross-sectional dimension could be increased. To handle the ensuing problem of dimensionality, one might assume a factor structure in the data. Indeed, as shown by Alessi et al. (2008), dynamic factor models are able to retrieve the structural shocks even when a SVAR, because of nonfundamentalness, cannot. A second alternative is to estimate the nonfundamental representations associated with the VAR, but this approach comes with its own set of difficulties.

2.3 Empirical literature

This section gives a brief overview of the empirical literature, with reference to the different identification approaches discussed above. Most of the literature has focused on the United States, while a limited number of studies have focused on other regions.[5]

[5] See Ramey (2016, 2019) for detailed literature overviews.

Government spending shocks

Since the seminal work by Sims (1980), VAR models have become one of the primary tools to study macroeconomic dynamics. One of the first examples of a VAR-type analysis of the effects of fiscal shocks on macroeconomic outcomes is that by Rotemberg and Woodford (1992). The authors analyse the effects of changes in military spending and employment on macroeconomic variables in the United States. The method consists of estimating three-variable VAR-type models with military spending, military employment, and the macroeconomic variable of interest as endogenous variables. Building on the work of Hall (1980, 1986) and Barro (1981), the authors achieved identification by arguing that significant changes in defence spending are not driven by macroeconomic developments, but rather by military events, thereby providing an exogenous shock to government spending.

Subsequent research expanded on the idea of using military events to identify the effects of unanticipated shocks to government spending. The seminal contribution by Ramey and Shapiro (1998) used the narrative method to create a dummy variable related to major military build-ups. The authors used news reports to identify political events that led to large military build-ups and construct a series orthogonal to the business cycle. Several follow-up papers, including Edelberg et al. (1999) and Burnside et al. (2004), embedded these 'war dates' in VARs, with the narrative series ordered first in a Cholesky decomposition, creating so-called expectations-augmented VARs (or EVARs).[6] EVARs have been expanded to include other measures of expectations, such as forecast errors of professional and/or public sector forecasters, in order to account for the predictable and/or anticipated element of government spending; examples include Auerbach and Gorodnichenko (2012) and Alichi et al. (2019), among others. Most of these narrative-based studies found that shocks to government spending (as proxied by changes in military spending) led to increases in GDP and hours worked, at least in the short run, but that it lowered private consumption and investment.

This stands in marked contrast to results from the broader SVAR literature. In their seminal contribution, Blanchard and Perotti (2002) used a SVAR to identify both government spending and net tax shocks. In contrast to the military news identification scheme, they found that shocks to government spending raised not only real GDP, but also induced positive responses from private consumption, hours worked, and real wages. Subsequent studies in this tradition found similar results (see Caldara and Kamps 2008; Fatás and Mihov 2001; Galí et al. 2007; Pappa 2009; Perotti 2005, among others). In contrast, using the SR approach, Mountford and Uhlig (2009) found only weak expansionary effects of government spending on real GDP and no significant effect on consumption.

In an attempt to reconcile the apparently contradicting results from the narrative and SVAR approaches, Ramey (2011b) argued that changes in government spending are more often than not anticipated at least several quarters in advance. This implies that the SVAR method does not identify unanticipated shocks to government spending. In order to capture the 'news', or unanticipated, part of government spending shocks, Ramey (2011b) created a quantitative series of estimates of changes in the expected present value of government purchases caused by military events. Embedding this news series in a VAR framework, with the news variable ordered first in a standard Cholesky decomposition, the author found results that were broadly similar to those obtained from the simple war date series.

Ramey's (2011b) results emphasized the importance of foresight and highlighted the difficulty in identifying *unanticipated* shocks to government spending and/or taxes. Follow-up work created richer narrative measures in an attempt to control for anticipation effects. Important contributions include those of Fisher and Peters (2010), Owyang et al. (2013), Zeev and Pappa (2017), and Ramey and Zubairy (2018). One caveat is that since all these measures of anticipation are constructed with reference to mil-

[6] The term EVAR was coined by Perotti (2011).

itary events, there are likely confounding effects that might contaminate the results (examples include rationing, price controls, and what Ramey (2016) calls 'patriotic increases in labour supply').

Proxy VARs have become popular following the seminal work by Stock and Watson (2008, 2012), with several different instruments employed as proxies for spending shocks. Notable recent examples include Mertens and Ravn (2013), Caldara and Kamps (2017), and Arias et al. (2018). These papers found persistent and often large effects of government spending on output.

As mentioned above, a more structural and theoretically sound method for identifying exogenous government spending shocks is through estimated DSGE models. Notable contributions in this tradition include those of Forni et al. (2009), Cogan et al. (2010), Christoffel et al. (2011), Leeper et al. (2012), Coenen et al. (2013), and Leeper et al. (2017).

Broadly speaking, the literature focuses on two key aspects of government spending multipliers. As expected, a significant share of the literature is devoted to estimating the size of the spending multiplier. Not wholly unrelated to this, many studies also attempt to reconcile the apparent contradiction in results from the empirical literature relative to theoretical predictions of the effects of government spending shocks.

Most standard theoretical models predict that an increase in government spending should raise GDP and hours worked but decrease private consumption and real wages. It is only through the inclusion of other elements in the model set-up, such as rule-of-thumb consumers, that one can generate positive responses in private consumption and real wages (see, for example, Galí et al. (2007)). In contrast, SVARS in the Blanchard and Perotti (2002) tradition typically predict an increase in private consumption and real wages following shocks to government spending, while EVARs (and SVARS that include news shocks) typically produce qualitatively similar results to those of estimated DSGE models. This divergence once again highlights the importance of controlling for expectations in the model set-up.

Apart from attempting to match empirical results with theoretical predictions, the literature is also concerned with estimating the size of government spending multipliers. In a survey of the literature, Ramey (2016) found that most estimates of the government spending multiplier in the developed world vary between 0.6 and 1.5. Much less evidence is available for the developing world, but the scarce empirical literature suggests that multipliers are smaller in emerging- and low-income economies (see, for example, Alichi et al. 2019; Batini et al. 2014; Estev ao and Samaké 2013; Gnip 2014; Ilzetzki 2011; Ilzetzki et al. 2013; IMF 2008; Kraay 2012). Empirical research into spending multipliers for South Africa is even more scarce. A notable exception is Jooste et al. (2013), who found a (peak) spending multiplier of around 0.8 using a variety of methods. Jooste and Naraidoo (2017) extended the analysis using a DSGE model with fiscal foresight and found that household consumption (and aggregate output) increases when fiscal spending increases despite accounting for foresight. However, the result depends crucially on the inclusion of elastic labour supply and sticky wages in the model set-up. While not directly investigating spending multipliers, Kotze (2017) showed that an unexpected increase in the volatility of a particular fiscal instrument reduces economic output by close to a half a percentage point per annum and that the effects of such shocks last for almost three years. Using similar methods to the current study, Nuru (2019) finds relatively small spending multipliers over the business cycle. Table A5 in the Appendix provides a selection of estimated government spending multipliers across both the developed and developing world.

Ramey (2016, 2019), among others, noted that there are two potential biases in the way that many researchers estimate spending multipliers that makes direct comparison difficult. First, following Blanchard and Perotti (2002), many researchers calculate multipliers by comparing the *peak* output response to the *initial* government spending shock. While this method is useful when directly comparing impulse responses, it is not the correct way to calculate multipliers and could produce biased estimates.

As argued by Mountford and Uhlig (2009) and Fisher and Peters (2010), among others, the multiplier should instead be calculated as the ratio of the cumulative output response to the cumulative government spending response. This quantity more closely resembles its theoretical counterpart. In many cases, the Blanchard and Perotti method produces higher values for fiscal multipliers than the above-mentioned cumulative approach (Ramey 2016).

The second potential bias stems from the *ex post* scaling of impulse responses to calculate spending multipliers. Most researchers estimating VARs specify the models in terms of natural logarithms. To calculate the implied multipliers, estimates are then multiplied by the sample mean of the ratio of GDP to government spending.[7] However, as shown by Owyang et al. (2013), this can lead to substantial biases, particularly in samples with significant trends in the GDP-to-spending ratio.

Finally, a relatively new strand of the literature investigates the possibility of state-dependent multipliers. Using a stock-and-flow-consistent CGE model with a detailed financial sector for South Africa, Makrelov et al. (2018) find peak spending multipliers of between 2 and 3.5 under conditions of a large negative output gap. Further empirical evidence for state-dependent multipliers can be found in, among others, Auerbach and Gorodnichenko (2012, 2013a,b, 2017); Bachmann and Sims (2012); Callegari et al. (2012); Fazzari et al. (2015); Figueres (2017); Gnip (2014); Owyang et al. (2013); Ramey and Zubairy (2018); Tagkalakis (2008). Studies dealing with the zero lower bound include Christiano et al. (2011); Eggertsson (2011); Eggertsson and Woodford (2003); Fernández-Villaverde et al. (2015); Leeper et al. (2017); Woodford (2011).

Most of these studies into state-dependent multipliers found that spending multipliers are higher during times of slack and/or constrained monetary policy. Exceptions include Owyang et al. (2013) and Ramey and Zubairy (2018), who found no evidence for larger multipliers during recessions in the United States.[8] Caggiano et al. (2015) reconciled the apparent contradiction by showing that an increase in government spending during a downturn can accelerate the exit from the recession, with the duration of downturn being much shorter than assumed in most of the literature. As such, the discounted returns from an increase in government spending (i.e. present-value multipliers) are lower and statistically equivalent to those in the boom phase. However, the authors showed that in extreme events (such as the GFC) the spending multiplier can be much larger. The bottom line is that not all recessions are alike, with increases in government spending delivering higher returns during deep recessions (Castelnuovo and Lim 2019).

Tax shocks

Both time series models and estimated DSGE models have been used in the literature to investigate the effects of unanticipated tax shocks on macroeconomic outcomes. Table A6 in the Appendix provides a brief overview of some of the results in the literature.

Blanchard and Perotti (2002) imposed an estimate of the elasticity of net taxes to GDP in a SVAR framework in order to identify exogenous shocks to net taxes and estimated an impact multiplier of -0.78. Several studies have followed in the footsteps of Blanchard and Perotti (2002) in using identified SVARS to estimate the impact of unanticipated tax shocks (see Table A6). However, several authors have demonstrated that the results of these studies are highly dependent on the underlying elasticity assumptions. Caldara and Kamps (2017), for instance, demonstrated that small changes in the assumed tax revenue-to-GDP elasticity can result in significant changes in estimated multipliers.

[7] This stems from the fact that $\frac{dY}{dG} \simeq \frac{d\ln Y}{d\ln G}\frac{\bar{Y}}{G}$ where $\frac{\bar{Y}}{G}$ is the sample average of the GDP-to-government spending ratio.

[8] Much less evidence is available for emerging and developing economies. Examples include Gnip (2014), who provides evidence for asymmetric multipliers in Croatia, and Jooste et al. (2013), who provide evidence for South Africa.

While the SVARs are by far the most popular framework for measuring the impact of fiscal policy innovations, several authors have questioned its use as a tool for measuring the effects of tax policy (including Auerbach and Gorodnichenko 2012). First, unexpected changes in tax revenue may not be the result of an exogenous change in fiscal policy, but are more often than not the result of a change in the elasticity of tax revenues with respect to aggregate economic activity—that is, the size of automatic stabilizers. Second, the effects of tax policy are expected to work through the structure of the tax system (i.e. marginal tax rates) rather than through the level of tax revenue. Finally, the identification of tax shocks in time series models depends crucially on the ability to purge innovations in tax revenues of automatic responses to output. As discussed by Blanchard and Perotti (2002) and mentioned above, the key assumption in this regard is the assumed elasticity of revenue with respect to output. Several authors, including Auerbach and Gorodnichenko (2012), Ramey (2016), and Caldara and Kamps (2017), have pointed to the sensitivity of estimated tax multipliers to assumptions regarding this elasticity.

Mountford and Uhlig (2009) used sign restrictions to identify tax and spending shocks and estimate present-value multipliers. Their estimates suggest that the output response peaks (or bottoms) at -5 three years following a tax cut.

Using narrative methods, Romer and Romer (2010) identify tax shocks and obtain tax multipliers ranging between -2.5 and -3 at three years. Leigh et al. (2010) used similar narrative measures to investigate the impact of tax increases across countries, while Cloyne (2013) applied this method to the United Kingdom. In a series of papers, Mertens and Ravn (2012, 2013, 2014) utilized the Romer and Romer narrative series in creative ways. Mertens and Ravn (2012) decomposed the series into anticipated and unanticipated shocks, while Mertens and Ravn (2013) further decomposed the unanticipated parts of the series into changes relating to personal income tax (PIT) and corporate income tax (CIT), respectively. The authors found that while cuts in either tax have mild expansionary effects, cuts to PITs induce a larger positive response than cuts to corporate tax rates.

Gechert (2015) conducted a meta-analysis of various types of multipliers across various identification methods and found tax and transfer multipliers of around 0.6–0.7. Importantly, the author highlighted the fact that estimated multipliers vary substantially with study design. As such, the influence of the particular design choice should be made clear when making policy recommendations based on the results.

The empirical literature on revenue multipliers in emerging- and low-income economies seems to suggest that tax multipliers are broadly similar to spending multipliers. For example, Ilzetzki (2011) found that spending multipliers range from 0.1 to 0.3, while short-term revenue multipliers are somewhat higher, lying between 0.2 and 0.4. Using a variety of methods, Jooste et al. (2013) found relatively large tax multipliers for South Africa. However, in general, tax multipliers appear to be smaller in emerging markets than in the developed world (see Table A6).

3 Estimates of fiscal multipliers in South Africa

The empirical analysis of fiscal multipliers is based on three popular identification strategies. The first two approaches, namely the recursive and Blanchard and Perotti (2002) identification approaches, are implemented in a standard SVAR framework, while the third is based on the Uhlig (2005) SR approach. Government spending and tax shocks are identified simultaneously while keeping in mind the associated caveats with identifying tax shocks within the (S)VAR framework.

3.1 The SVAR approach

The baseline reduced form fiscal VAR model with p lags is described by the system

$$Y_t = \mu_0 + C(L)Y_{t-1} + \eta_t \tag{8}$$

where Y_t is the vector of endogenous variables, μ_0 is a constant, $C(L)$ is a polynomial lag operator, and η_t is the vector of reduced form residuals. Following Blanchard and Perotti (2002) and Caldara and Kamps (2017), among others, the baseline model contains three endogenous variables, namely government spending (g_t), output (y_t), and government tax revenue (t_t), that is $Y_t = [g_t \quad y_t \quad t_t]$.

The data for per capita log real GDP, log real government spending, and log real taxes for the sample period 1970Q1 to 2018Q4 are sourced from the South African Reserve Bank (SARB) Quarterly Bulletin.[9] Government spending is the sum of current spending (wage expenditure and expenditure on goods and services) and public sector fixed investment (general government and public corporations), while total taxes is the sum of PIT, CIT, value added tax (VAT), and other indirect taxes.[10] The tax variables are deflated using the implicit GDP deflator. All variables are expressed in natural logarithms and seasonally adjusted. Following Caldara and Kamps (2017), among others, all variables are detrended by removing a deterministic trend via OLS regression. The reduced form VAR contains four lags and a constant.

The structural form of the system to be estimated is:

$$A_0Y_t = A_0\mu_0 + A_0C(L)Y_{t-1} + B\varepsilon_t \tag{9}$$

where $B\varepsilon_t = A_0\eta_t$. The matrix A_0 describes the contemporaneous relationships among the endogenous variables. The reduced form residuals η_t are correlated and, therefore, not purely exogenous. Following Blanchard and Perotti (2002) and Perotti (2005), among others, the set of equations can be written in matrix notation as:

$$\begin{pmatrix} 1 & -a_{gy} & -a_{gt} \\ -a_{yg} & 1 & -a_{yt} \\ -a_{tg} & -a_{ty} & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^t \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & b_{gt} \\ 0 & b_{yy} & 0 \\ b_{tg} & 0 & b_{tt} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^t \end{bmatrix} \tag{10}$$

Additional restrictions on the parameters in A_0 and B are required to achieve identification and recover the uncorrelated structural shocks.

Recursive identification

Following Caldara and Kamps (2008), among others, the first identification method considered is the recursive approach. In this approach, B is restricted to be a diagonal matrix, while A_0 is assumed to be lower triangular with a unit diagonal. In the baseline model, government spending is ordered first, output is ordered second, and tax revenue is ordered third. As such, the relationship between the reduced form innovations η_t and the structural shocks ε_t is given by the following expression:

$$\begin{pmatrix} 1 & 0 & 0 \\ -a_{yg} & 1 & 0 \\ -a_{tg} & -a_{ty} & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^t \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 \\ 0 & b_{yy} & 0 \\ 0 & 0 & b_{tt} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^t \end{bmatrix} \tag{11}$$

The recursive approach implies that the specific ordering of the model variables have a causal interpretation. Ordering government spending first assumes that it does not react contemporaneously to any of

[9] The Quarterly Bulletin contains data from various different sources for government variables, including National Revenue Fund data, Government Financial Statistics, and the System of National Accounts (SNA). In order to obtain as long a sample as possible, and given the fact that only aggregate variables are considered, data for this paper was sourced from the SNA dataset.

[10] See Table A1 for detailed variable definitions and sources.

the other endogenous variables in the system, in this case output and tax revenue. This can be justified by the fact that government spending is largely predetermined. As such, changes in government spending are, in general, unrelated to the current state of the economy. Output is ordered second, implying that output does not react within the quarter to tax shocks, but is allowed to respond to shocks to government spending. Finally, by placing taxes third in the VAR, it is assumed that tax revenues are affected contemporaneously by both government spending and output shocks. Ordering output before taxes is not a trivial assumption. However, the assumption can be justified on the grounds that shocks to output have a contemporaneous impact on the tax base and, hence, on tax revenue. A drawback of this particular ordering is that it rules out (potentially important) contemporaneous effects of tax shocks on output.

The Blanchard–Perotti approach

In contrast to the simple recursive structure embedded in the Cholesky decomposition, the identification approach introduced by Blanchard and Perotti (2002) relies on institutional information about the tax system and assumptions regarding the timing of tax collections to identify effects of automatic stabilizers on government revenue.

Unlike the recursive approach, the Blanchard–Perotti (BP) approach does not involve imposing (only) zero restrictions on the model parameters in order to achieve identification. In fact, a key element of the approach is imposition of additional non-zero restrictions on the contemporaneous relationships between variables. In the current application, as in their original paper, the output elasticity of tax revenue is calibrated using outside information. Following Perotti (2005), among others, this elasticity is estimated by regressing individual revenue items on their respective tax bases. An aggregate value for the output elasticity of government revenue equal to 1.27 is obtained—that is $a_{ty} = 1.27$.[11] Furthermore, it is assumed that $a_{gy} = 0$. This assumption rests on the assumption that, because the government spending variable in question is defined net of transfers, government expenditure is acyclical. Additionally, it is assumed that fiscal variables do not react contemporaneously to shocks in other fiscal variables (i.e. $a_{gt} = a_{tg} = 0$). The latter two assumptions rest on the fact that governments cannot react within the same quarter to changes in the macroeconomic and/or policy environment due to the nature of fiscal policy decisions. Changes in fiscal policy requires the input and involvement of many different economic and political agents (including parliament, government, and civil society) and, therefore, can have long implementation lags. Finally, it is assumed that $b_{gt} = 0$, implicitly assuming that government spending decisions are taken before decisions on taxes.

In matrix notation, the set of restrictions can be expressed as:

$$\begin{pmatrix} 1 & 0 & 0 \\ -a_{yg} & 1 & -a_{yt} \\ 0 & -1.27 & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^t \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 \\ 0 & b_{yy} & 0 \\ b_{tg} & 0 & b_{tt} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^t \end{bmatrix} \tag{12}$$

3.2 The SR approach

Uhlig (2005) pioneered the use of the SR approach in identifying monetary policy shocks, while Mountford and Uhlig (2009) applied the approach to the identification of fiscal policy shocks. The SR approach entails imposing restrictions directly on the shape of structural impulse responses of the various model variables (Caldara and Kamps 2008). This stands in contrast to the two approaches discussed above, which impose linear restrictions on the contemporaneous relationships between model variables.

[11] See the Appendix for details on the calculation of the elasticity of government revenue with respect to output.

To illustrate the intuition behind the SR approach, consider a VAR(1) in reduced form (ignoring deterministic terms for ease of exposition):

$$Y_t = A_1 Y_{t-1} + \eta_t \tag{13}$$

Write Equation (13) in its MA representation:

$$Y_t = \sum_{i=0}^{\infty} \phi_i \eta_{t-i} \tag{14}$$

Here, ϕ captures the reduced form impulse responses with $\phi_o = I$ and $\phi_i = \sum_{j=1}^{i} \phi_{i-j} A_j$. A Cholesky decomposition with $\sum_\eta = PP'$ would obtain structural impulses, $\psi_i = \phi_i P$ since with $Y_t = \sum_{i=0}^{\infty} \phi_i PP^{-1} \eta_{t-i}$, the structural variance–covariance matrix $\sum_\varepsilon = P^{-1} E(\eta_t \eta_t') P^{-1'} = P^{-1} \sum_\eta P^{-1'} = P^{-1} PP' P^{-1'} = I$. In contrast to the Cholesky decomposition, which imposes a recursive structure on the VAR, the SR approach identifies the structural shocks by imposing restrictions on the signs of ψ_i over a specific horizon i. Importantly, in contrast to other identification techniques, including the Cholesky decomposition, the contemporaneous impact matrix is not defined. As such, different orthogonalizations of the reduced form models could potentially be consistent with the sign restrictions. Importantly, the full set of orthogonalizations needs to be considered in order to arrive at more reliable estimates and to satisfy the relatively broad set of identifying restrictions embodied in the approach. To obtain another orthogonal representation of the impulse responses (e.g. $\bar{\psi}_i$), one can simply multiply $\psi_i = \phi_i P$ by a random matrix Q with the property $Q'Q = I$, since then it still holds that $\bar{\sum}_\varepsilon = E(Q' P^{-1} \eta_t \eta_t' P^{-1'} Q) = I$ (Breitenlechner et al. 2019).

Mountford and Uhlig (2009) used a ten-variable VAR and identified four shocks, namely a business cycle shock, a monetary policy shock, a government spending shock, and a tax shock. In the baseline three-variable VAR used in this paper, three shocks are identified, namely a business cycle shock, a government spending shock, and a tax shock. Following Mountford and Uhlig (2009) and Caldara and Kamps (2008), the business cycle shock is identified by the requirement that the impulse responses of output and taxes are positive for at least four quarters following the shock. Similarly, the government spending and tax shocks are separately identified by the requirement that their respective impulse responses are positive for at least four quarters following the shock. Finally, both fiscal shocks are required to be orthogonal to the business cycle shock. In practice, this assumption ensures that whenever taxes and output move in the same direction, the co-movement is attributed to a change in the business cycle—that is, it eliminates cases where positive output responses are erroneously attributed to positive tax shocks (Caldara and Kamps 2008).

Table 1 shows the sign restrictions on the impulse responses for each identified shock. A '+' means that the relevant impulse is restricted to be positive for four quarters following the shock.

Table 1: Identifying sign restrictions

	Real GDP	Government spending	Tax revenue
Business cycle shock	+		+
Government spending shock		+	
Tax shock			+

Source: author's compilation.

Estimation is carried out using Bayesian techniques as implemented in the ZeroSignVAR package for MATLAB (Breitenlechner et al. 2019).[12]

[12] The algorithm is based on Arias et al. (2014).

4 Baseline results

This section presents empirical results for pure government spending and tax shocks in the baseline three-variable VAR.[13] Following Caldara and Kamps (2008), among others, the impulse responses in the rest of the paper are scaled as follows: The responses of the endogenous variables are transformed so as to give the rand (R) response of each variable to a R1 shock in one of the fiscal variables. To this end, following the procedure of Blanchard and Perotti (2002), the original impulse responses are first divided by the standard deviation of the fiscal shock in order to have shocks of size 1 per cent. These impulse responses are then divided by the sample mean of the ratio of the macroeconomic variable of interest and the shocked fiscal variable. The rescaled impulses can be interpreted as constant, non-accumulated rand multipliers. That is, the impulse response functions (and the associated multipliers) demonstrate the rand change in government spending, output, and taxes over time after a R1 increase in government spending or taxes.[14]

4.1 Pure spending shock

Figure 1 presents the impulse responses for a pure spending shock, with each column representing a different identification approach. The identified government spending shock is similar across all three identification approaches. Under the recursive and BP approaches, impulse responses are virtually identical. This follows from the fact that the spending shock is identified in the same way for both approaches, namely by ordering government spending first in the SVAR. The results also show that taxes only partly offset the increase in government spending, suggesting that the pure spending shock can be interpreted as a deficit-financed spending shock. For all approaches, real GDP persistently increases following the government spending shock, displaying a hump-shaped pattern.

Table 2 presents implied spending multipliers associated with the different identification schemes. For the recursive and BP approaches, the implied impact multiplier measures 0.11. The spending multiplier peaks at around 0.36 in the fourth quarter after the shock. For the SR approach, both the impact and peak multipliers are significantly larger, measuring 0.32 and 0.78 (four quarters after the shock) respectively. However, the estimates are much less precise, as reflected in the wider confidence bands.

Table 2: Output multipliers in the baseline model

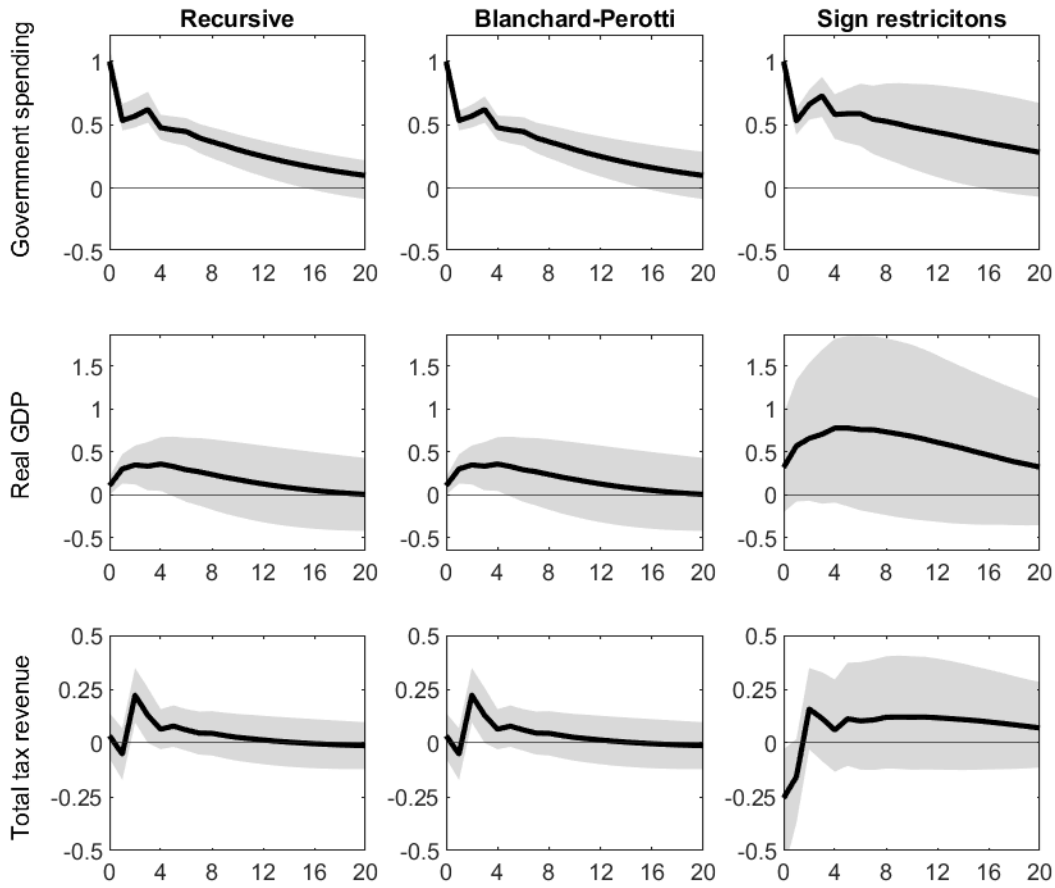
	Q1	Q4	Q8	Q12	Q20	Maximum
Government spending multiplier						
Recursive	0.11	0.36	0.24	0.13	0.01	0.36 (Q4)
Blanchard–Perotti	0.11	0.36	0.24	0.13	0.01	0.36 (Q4)
Sign restriction	0.32	0.78	0.73	0.61	0.32	0.78 (Q4)
Tax multiplier						
Recursive	0.00	–0.16	–0.29	–0.35	–0.30	–0.35 (Q12)
Blanchard–Perotti	–0.20	–0.50	–0.63	–0.65	–0.50	–0.65 (Q10)
Sign restriction	–0.27	–0.59	–0.76	–0.77	–0.56	–0.78 (Q10)

Source: author's calculations.

[13] That is, results are shown for shocks to one fiscal variable at a time without constraining the response of the other fiscal variable(s).

[14] Since the data enter the estimated equations in logs, the estimated impulse response functions are scaled by the sample average values to convert percent changes into rand changes.

Figure 1: Response to a pure spending shock (baseline three-variable VAR)



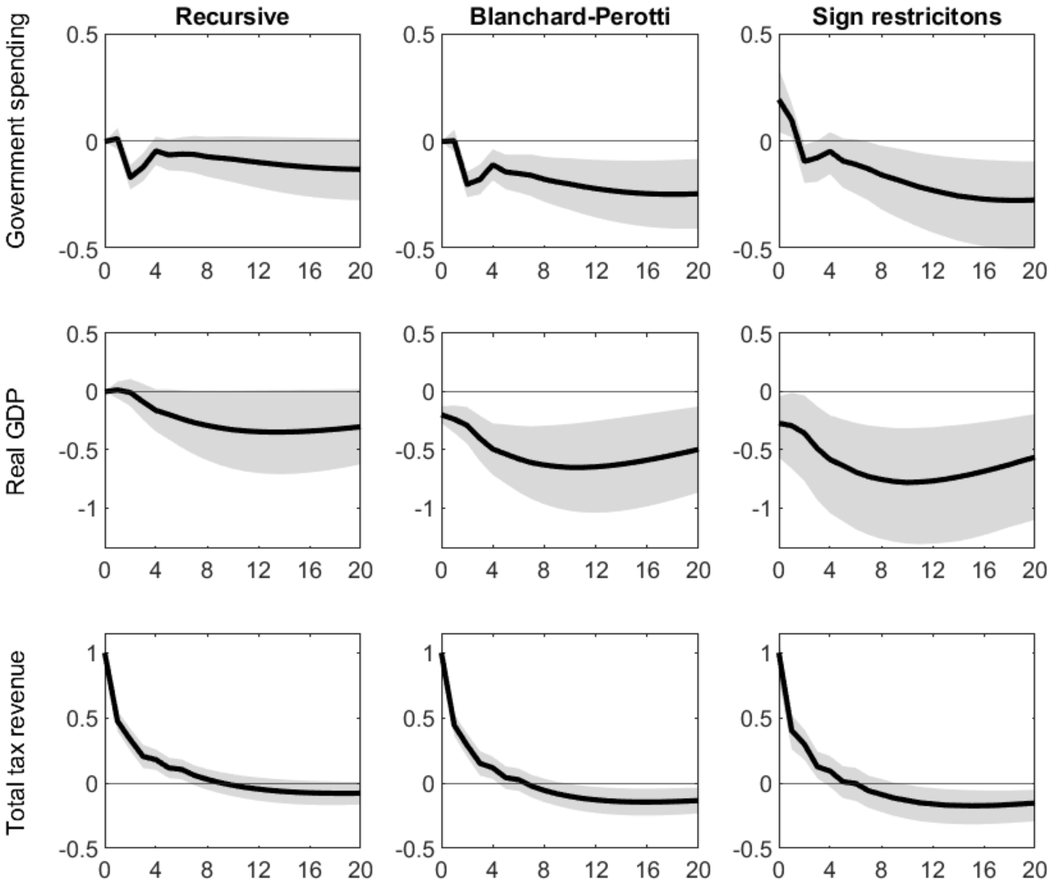
Notes: the figures show impulse responses to a R1 increase in government spending. For the recursive and BP approach, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: authors' calculations.

4.2 Pure tax shock

Figure 2 presents the impulse responses for a pure tax shock, while implied multipliers are presented in Table 2. Results for both the BP and SR approaches suggest that unanticipated tax increases have strong distortionary effects. In the case of the BP approach, the decline in real GDP peaks at around 0.65 after ten quarters. As was the case for the pure spending shock, the response is larger under the SR approach, with the decline in real GDP peaking at 0.78 after ten quarters. In contrast, there is not statistically significant GDP response under the recursive identification approach. The tax response peaks in the quarter when the shock occurs and then monotonically declines, turning negative after about 8–12 quarters as the decline in output weighs on tax receipts. Government spending declines over the medium term under all three identification approaches, although the initial response is positive (and significant) under the SR approach. Importantly, over the medium term tax shocks have a much larger effect on real GDP than government spending shocks.

Figure 2: Response to a pure tax shock (baseline three-variable VAR)



Notes: the figures show impulse responses to a R1 increase in taxes. For the recursive and BP approach, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: author's calculations.

4.3 Alternative multiplier definition

The calculation of the fiscal multipliers in Table 2 is based on the Blanchard and Perotti (2002) approach—that is, multipliers are computed by comparing the output response in a specific period to the *initial* government spending shock. While it is a useful way to directly compare impulse responses, as mentioned earlier, the multiplier should instead be calculated as the ratio of the cumulative output response to the cumulative government spending response. This quantity more closely resembles its theoretical counterpart.

To that end, cumulative present-value multipliers for the baseline are presented in Table 3. These present-value multipliers are calculated as follows (following Mountford and Uhlig 2009, among others):

$$\text{Present-value multiplier at horizon } k = \frac{\sum_{j=0}^{k}(1+r)^{-j}y_{t+j}}{\sum_{j=0}^{k}(1+r)^{-j}f_{t+j}}\frac{1}{f/y} \tag{15}$$

where y_{t+j} is the response of real GDP at period j, f_{t+j} is the response of the fiscal variable at period j, and r is the average nominal policy interest rate (the main repurchase, or repo, rate) over the sample. As before, the responses are scaled by f/y (the ratio of the fiscal variable to real GDP evaluated at the sample mean).

The multipliers in Table 3 show that, in present-value terms, tax shocks have a much greater effect on real GDP than government spending shocks. In fact, apart from over the long term under the SR approach, present-value spending multipliers never exceed 1.

Table 3: Present-value output multipliers

	Q1	Q4	Q8	Q12	Q20
Government spending multiplier					
Recursive	0.11	0.42	0.49	0.50	0.49
Blanchard–Perotti	0.11	0.42	0.49	0.50	0.49
Sign restriction	0.32	0.82	0.97	1.03	1.06
Tax multiplier					
Recursive	0.00	–0.09	–0.32	–0.55	–0.85
Blanchard–Perotti	–0.20	–0.70	–1.38	–2.05	–3.02
Sign restriction	–0.27	–0.90	–1.80	–2.78	–4.28

Source: author's calculations.

5 Alternative specifications

This section extends the baseline three-variable VAR to gauge the impact of fiscal shocks on other macroeconomic variables of interest, including private consumption and investment. Furthermore, the baseline VAR is extended to include prices and interest rates in order to control for the effects of monetary policy decisions.

5.1 Effects of fiscal shocks on private consumption and investment

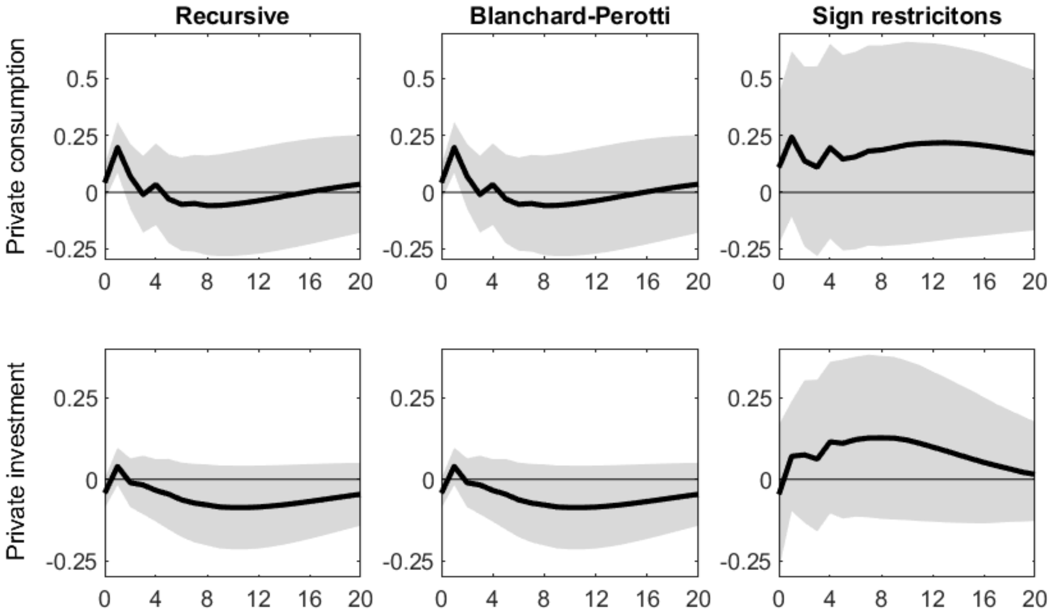
In order to gauge the impact of fiscal shocks on private consumption and investment, the baseline three-variable VAR is extended with consumption and investment in turn ordered after output in the VAR. That is, $Y_t = [g_t \quad y_t \quad x_t \quad t_t]$ where $x_t \in \{c_t, i_t\}$. Placing private consumption or private investment after output assumes that it does not react contemporaneously to taxes, but that it is contemporaneously affected by government spending and output shocks.

As before, additional restrictions are required to achieve identification. The recursive identification approach identifies structural shocks by imposing a recursive structure on matrix A_0 in Equation (9)—that is, A_0 is lower triangular, while the matrix B is assumed to be diagonal. Under the BP approach, the elasticity of tax revenue with respect to consumption and investment is estimated analogously to that of output, as detailed in Section 3.1.[15] The elasticity of consumption and investment with respect to taxes is estimated directly in the VAR framework. Under the SR approach, an additional identifying assumption is imposed in that the business cycle shock is now identified by the requirement that the impulse responses of output, taxes, and the additional output component (consumption or investment) are positive for at least four quarters after the shock.

The impulse responses for private consumption and private investment following pure spending and tax shocks are presented in Figures 3 and 4 respectively, while Table 4 provides present-value multipliers. The impulse responses are rescaled as before: the original impulse responses are first divided by the standard deviation of the fiscal shock in order to have shocks of size 1 per cent. These impulse responses are then divided by the sample mean of the ratio of the respective variable and the shocked fiscal variable.

[15] Consumption and investment elasticities, as well as details with respect to the full model specification, can be found in the Appendix.

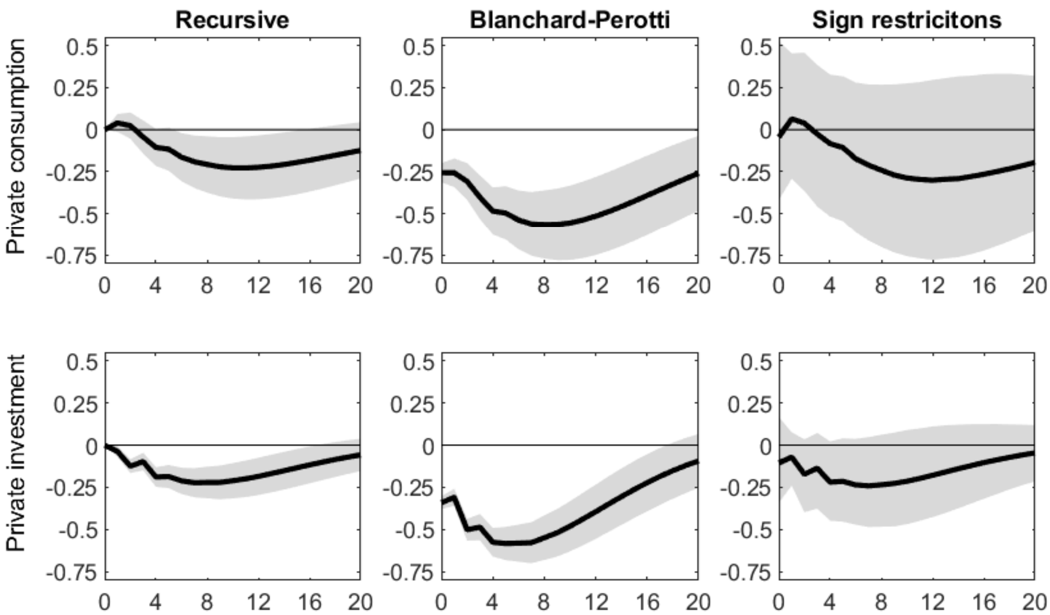
Figure 3: Response to a pure spending shock (expanded four-variable VAR)



Notes: the figures show impulse responses to a R1 increase in government spending. For the recursive and BP approach, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: author's calculations.

Figure 4: Response to a pure tax shock (expanded four-variable VAR)



Notes: the figures show impulse responses to a R1 increase in taxes. For the recursive and BP approach, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: author's calculations.

Table 4: Present-value consumption and investment multipliers

	Q1	Q4	Q8	Q12	Q20
Government spending multiplier					
Private consumption					
Recursive	0.04	0.11	0.05	0.03	0.03
Blanchard–Perotti	0.04	0.11	0.05	0.03	0.03
Sign restriction	0.11	0.22	0.25	0.28	0.31
Private investment					
Recursive	–0.04	–0.02	–0.05	–0.08	–0.10
Blanchard–Perotti	–0.04	–0.02	–0.05	–0.08	–0.10
Sign restriction	–0.05	0.07	0.11	0.13	0.13
Tax multiplier					
Private consumption					
Recursive	0.00	–0.02	–0.19	–0.34	–0.50
Blanchard–Perotti	–0.26	–0.80	–1.63	–2.58	–4.05
Sign restriction	–0.04	–0.01	–0.19	–0.38	–0.63
Private investment					
Recursive	0.00	–0.17	–0.36	–0.51	–0.62
Blanchard–Perotti	–0.34	–1.22	–2.74	–5.08	–10.99
Sign restriction	–0.10	–0.28	–0.46	–0.58	–0.66

Source: author's calculations.

Consumption responds positively to a government spending shock under all three identification approaches (see Figure 3). However, the positive response is short-lived under the recursive and BP schemes, with the response turning negative (and insignificant) after around four quarters. Under both the recursive and BP approaches, the implied impact multiplier is 0.04, while the spending multiplier peaks at around 0.20 in the second quarter after the shock. In contrast, under the SR approach real private consumption persistently increases following the government spending shock, although the wider confidence bands point to significant uncertainty. That being said, the implied impact multiplier measures 0.11 and the multiplier peaks at around 0.24 in the first quarter after the shock. These results echo findings in the broader empirical literature which point to positive consumption responses to government spending shocks. However, as mentioned above, these results appear to be at odds with theoretical predictions and results from the DSGE literature which posit a negative response of consumption to government spending shocks. The final paper in this thesis attempts to shine further light on this divergence. Turning to the response of private investment, apart from a small positive response on impact, the response of private fixed investment to a shock to government spending is negative under both the recursive and BP identification approaches. While the response is positive under the SR approach, the wider confidence bands points to significant uncertainty.

Figure 4 presents the impulse responses for private consumption and private investment following a pure tax shock. The tax shock has a significant distortionary effect on both private consumption and investment, with the response particularly strong under the BP identification approach. The decline in consumption peaks at 0.57 in the eighth quarter following the shock, while the negative response for investment is similar with a peak decline of 0.58 in the fifth quarter following the shock. Under the SR approach, the decline in consumption peaks at around 0.30 12 quarters after the shock. The responses of investment under the recursive and SR identification approaches are broadly similar, with the decline peaking at just over 0.20 eight quarters after the shock.

According to Table 4, present-value consumption multipliers following a shock to government spending is positive across all horizons, but the response is relatively subdued. In contrast, private investment multipliers are small and insignificant, with only the SR approach yielding positive multipliers. Tax multipliers are negative across the board and larger in absolute terms than spending multipliers. This confirms the finding of Section 4 that tax shocks are highly distortionary and have a larger effect on real outcomes than unanticipated shocks to spending.

5.2 Effects of fiscal shocks when controlling for monetary policy

The baseline three-variable VAR is extended to include inflation and a measure of the short-term interest rate to control for the effects of monetary policy. Inflation is ordered after output but before taxes, while the short-term interest rate is ordered last—that is, $Y_t = [g_t \quad y_t \quad \pi_t \quad t_t \quad r_t]$. The ordering assumes that inflation does not respond contemporaneously to taxes and the interest rate, while it does respond contemporaneously to government spending and output. The ordering further assumes that taxes do not respond contemporaneously to the short-term interest rate, while it is assumed that the interest rate responds contemporaneously to all variables in the system. The measure of inflation is the quarter-on-quarter percentage change in the consumer price index (CPI), while the measure of the short-term interest rate is the main repurchase (or repo) rate.

Under the recursive identification scheme, the normal zero restrictions apply (i.e. A_0 is lower triangular and B is diagonal in the AB model). However, additional restrictions are required under the BP approach.

The set of equations (including the inherited identifying assumptions from the baseline VAR) can be expressed in matrix form as:

$$\begin{pmatrix} 1 & 0 & -a_{g\pi} & 0 & -a_{gr} \\ -a_{yg} & 1 & 0 & -a_{yt} & 0 \\ -a_{\pi g} & -a_{\pi y} & 1 & -a_{\pi t} & 0 \\ 0 & -1.27 & -a_{t\pi} & 1 & -a_{tr} \\ -a_{rg} & -a_{ry} & -a_{r\pi} & -a_{rt} & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^\pi \\ \eta_t^t \\ \eta_t^r \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 & 0 & 0 \\ 0 & b_{yy} & 0 & 0 & 0 \\ 0 & 0 & b_{\pi\pi} & 0 & 0 \\ b_{tg} & 0 & 0 & b_{tt} & 0 \\ 0 & 0 & 0 & 0 & b_{rr} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^\pi \\ \varepsilon_t^t \\ \varepsilon_t^r \end{bmatrix} \tag{16}$$

Four additional restrictions are required to identify the structural shocks in Equation (16). First, given that interest paid and received by the government is excluded from the fiscal variable definitions, it is assumed that $a_{gr} = a_{tr} = 0$. The elasticity of government spending with respect to inflation ($a_{g\pi}$) is calculated as the weighted average of the elasticities of the different spending components. The wage component of government spending is fixed within the quarter, implying that the elasticity with respect to inflation is -1. While prices of goods and services purchased do evolve with inflation, a portion of aggregate spending will be fixed as it is determined through the budgetary process. It is assumed that this fixed portion of total spending does not react to inflation developments (elasticity equal to -1), while the remainder will mirror developments in inflation (elasticity equal to 0). As a compromise, the elasticity of real spending on goods and services to inflation is set to -0.5. Similarly, while government investment spending might be largely fixed within a quarter, a portion might be more closely indexed to inflation. As such, the elasticity of real public sector investment spending to inflation is also set to -0.5. The weighted average of these three elasticities implies that the elasticity of real government spending with respect to inflation ($a_{g\pi}$) is set equal to -0.79.

Finally, the price elasticity of tax revenue is set equal to 0.19 ($a_{t\pi} = 0.19$). The price elasticity of PIT can be estimated by subtracting 1 from the elasticity of personal taxes to average earnings (Perotti 2005). As shown in the Appendix, this elasticity is estimated at 1.58. Subtracting 1 from this estimate implies a price elasticity of 0.58. Corporate taxes have a very uncertain relationship with prices in both directions and so a price elasticity of zero is assumed. As a large share of indirect taxes (including VAT) is *ad valorem*, a zero elasticity of real indirect tax revenue to inflation is assumed. The weighted average of these individual elasticities is then equal to 0.19.

In matrix form, the set of restrictions can be expressed as:

$$\begin{pmatrix} 1 & 0 & 0.79 & 0 & 0 \\ -a_{yg} & 1 & 0 & -a_{yt} & 0 \\ -a_{\pi g} & -a_{\pi y} & 1 & -a_{\pi t} & 0 \\ 0 & -1.27 & -0.19 & 1 & 0 \\ -a_{rg} & -a_{ry} & -a_{r\pi} & -a_{rt} & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^\pi \\ \eta_t^t \\ \eta_t^r \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 & 0 & 0 \\ 0 & b_{yy} & 0 & 0 & 0 \\ 0 & 0 & b_{\pi\pi} & 0 & 0 \\ b_{tg} & 0 & 0 & b_{tt} & 0 \\ 0 & 0 & 0 & 0 & b_{rr} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^\pi \\ \varepsilon_t^t \\ \varepsilon_t^r \end{bmatrix} \tag{17}$$

Additional identifying restrictions are also required under the SR approach. The set of identified shocks now includes a monetary policy shock. The monetary policy shock is identified by the requirement that the impulse response of the interest rate is positive for at least four quarters following the shock and that the impulse response of inflation is negative for at least four quarters after the shock (Table 5).

Table 5: Identifying sign restrictions in the extended five-variable model

	Real GDP	Government spending	Inflation	Tax revenue	Interest rate
Business cycle shock	+			+	
Monetary policy shock			−		+
Government spending shock		+			
Tax shock				+	

Source: author's compilation.

The impulse responses for pure spending and tax shocks are presented in Figures 5 and 6, respectively. The impulse responses for output and the fiscal variables are scaled as before. The responses of inflation give the percentage change in response to a 1 per cent fiscal shock. The responses of the interest rate are expressed as change in percentage points for a 1 per cent fiscal shock.

As was the case under the baseline specification, real GDP responds positively to a government spending shock under all three identification approaches (see Figure 5). However, unlike in the baseline model, the positive response is short-lived, with the output response turning negative (and insignificant) after around four quarters.

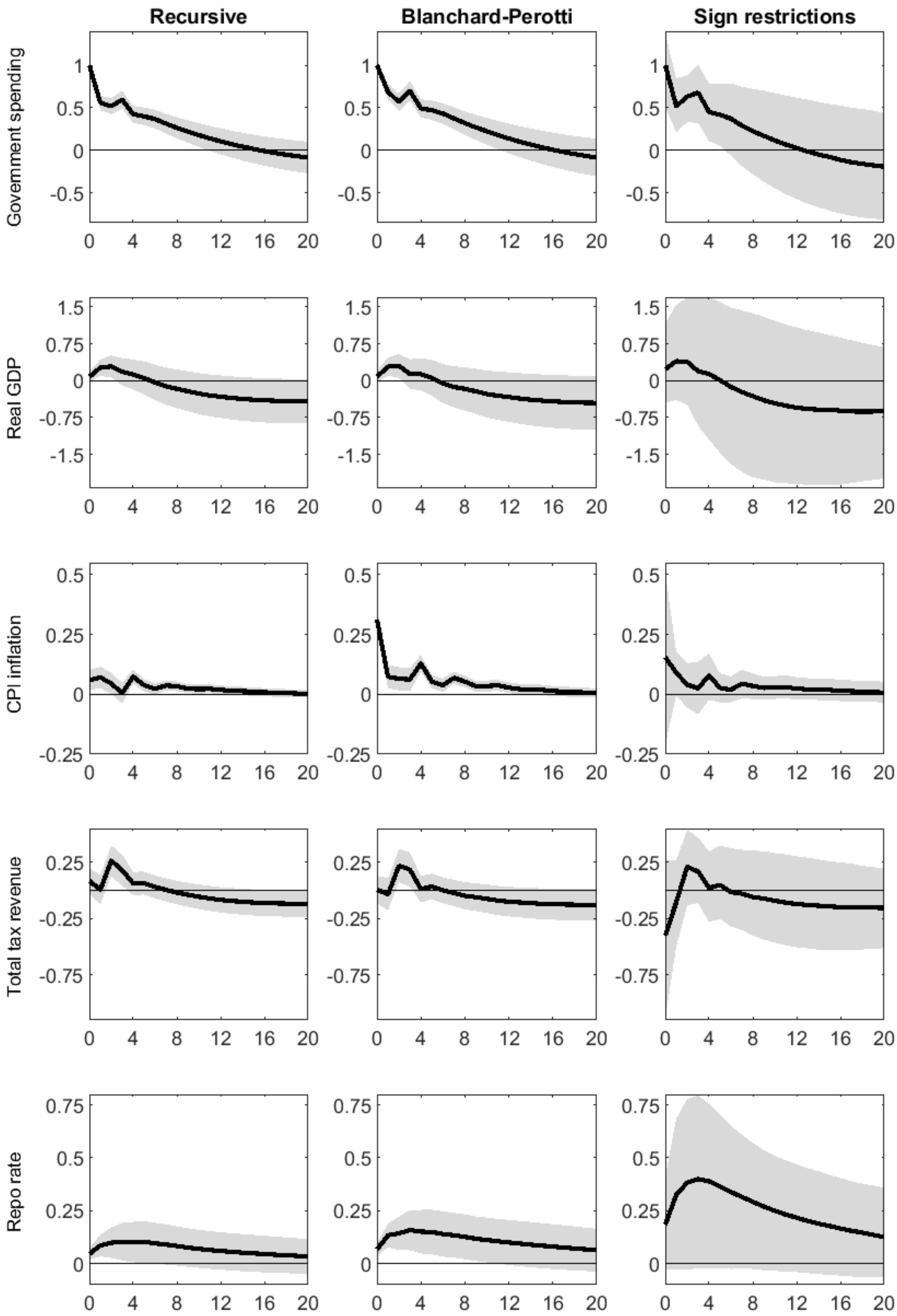
The spending shock results in a positive inflation response, which, together with the initial positive output response, results in a statistically significant interest rate response. This has the effect of lowering inflation but also dampening the output response following a positive government spending shock.

Under the recursive and BP identification schemes, the output response peaks at around 0.30 in the second quarter after the shock. Under the SR approach, the response peaks at 0.40 in the second quarter, just over half the size of the peak response under the baseline specification.

Similarly, the output response to a pure tax shock is also smaller when including monetary variables in the SVAR (see Figure 6). Under the recursive and BP approaches, the decline in real GDP peaks at 0.09 and 0.29, respectively, in the eighth quarter after the shock versus the 0.65 peak decline registered in the baseline model. The drop in output results in a marginal decline in inflation which induces a decline in the policy rate, supporting real GDP growth and limiting the negative response to a tax shock. The subdued response from government spending following the tax shock also contributes to the more muted output response. In contrast, under the SR approach, output responds much the same as in the three-variable baseline VAR.

Under the SR approach, the impact multiplier measures −0.18, with decline in real GDP peaking at 0.97 in the tenth quarter after the shock. One reason for the discrepancy might be the fact that the SR approach is relatively agnostic, imposing less restrictive identifying assumptions. This highlights the importance of the elasticity assumptions embedded in the BP approach.

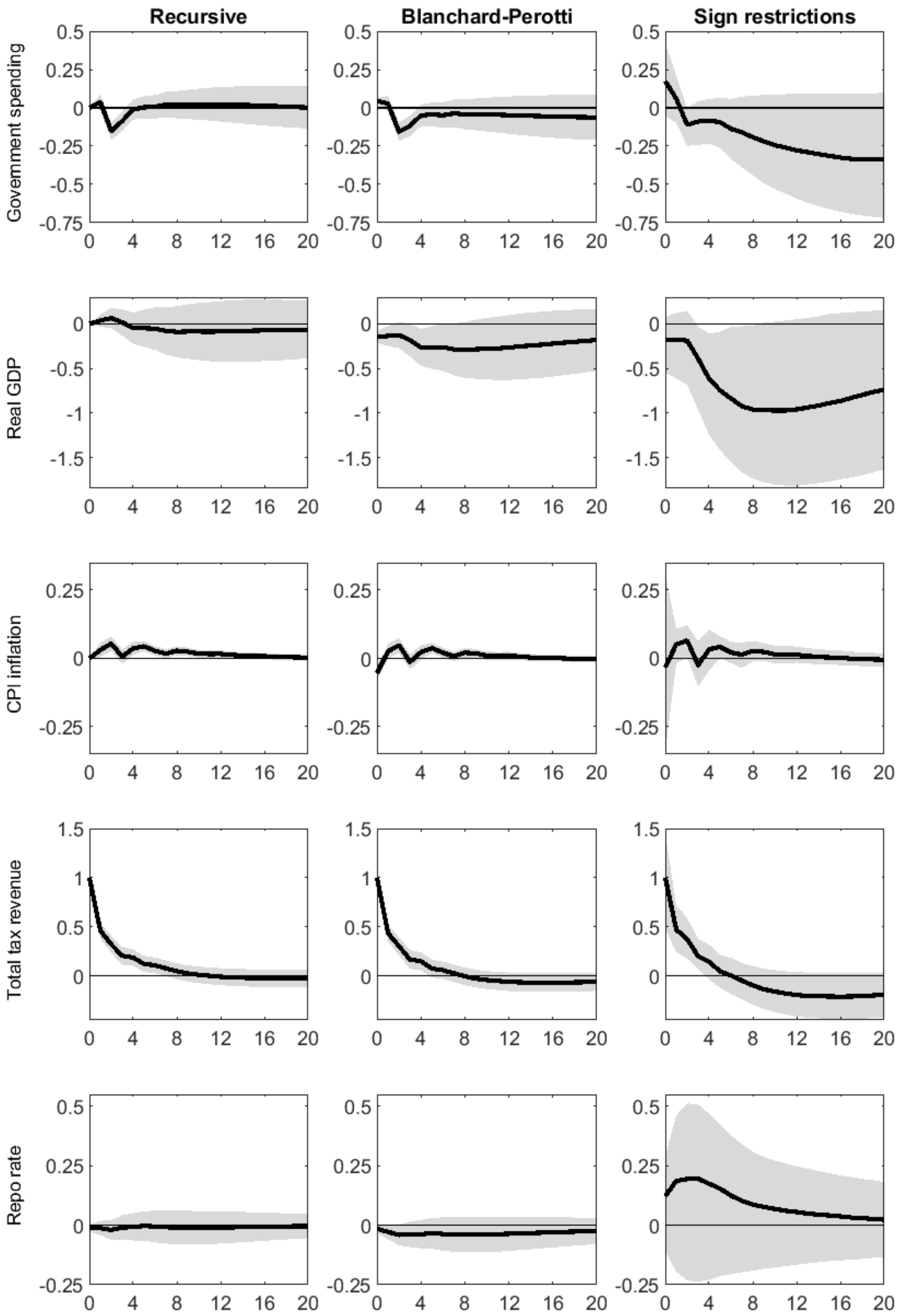
Figure 5: Response to a pure spending shock (expanded five-variable VAR)



Notes: the figures show impulse responses to a R1 increase in government spending. The responses of inflation give the percentage change in response to a 1 per cent fiscal shock. The responses of the interest rate are expressed as change in percentage points for a 1 per cent fiscal shock. For the recursive and BP approaches, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: author's calculations.

Figure 6: Response to a pure tax shock (expanded five-variable VAR)



Notes: the figures show impulse responses to a R1 increase in government spending. The responses of inflation give the percentage change in response to a 1 per cent fiscal shock. The responses of the interest rate are expressed as change in percentage points for a 1 per cent fiscal shock. For the recursive and BP approaches, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: author's calculations.

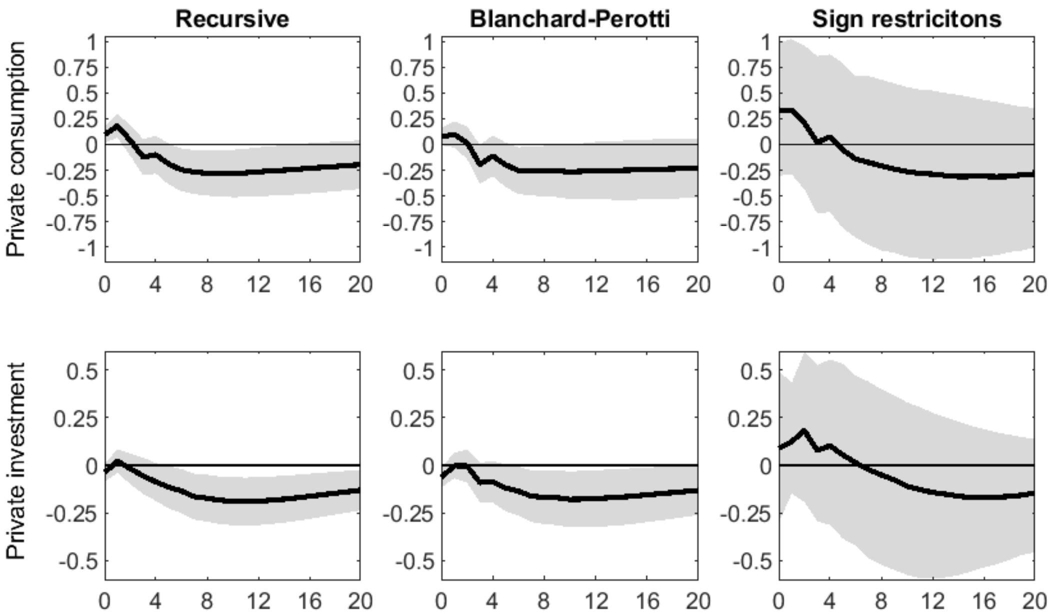
Present-value multipliers are shown in Table A4 in the Appendix. Output multipliers are based on the five-variable monetary policy VAR. Present-value output multipliers are smaller across all horizons than in the three-variable baseline model, with medium-term multipliers turning negative. For the recursive and BP approach, tax multipliers are also smaller in absolute terms, but broadly in line with baseline multipliers under the SR identification approach.

Finally, the five-variable monetary policy VAR is extended by including private consumption and private investment in turn, ordered third in the extended VAR.[16] The impulse responses for private consumption and investment are presented in Figures 7 and 8, while present-value multipliers are provided in Table A4 in the Appendix.

Similar to the results for real GDP, the inclusion of monetary policy variables in the extended VAR results in more muted responses from consumption and investment following a government spending shock. This is particularly true under the SR approach, where the consumption response turns negative after four quarters as opposed to remaining positive over the entire horizon, as was the case in the baseline model.

The present-value multipliers in Table A4 confirm the more muted (and negative in some cases) response for both consumption and investment. For the tax shock, the negative response of both consumption and investment is also more subdued under the recursive and BP identification approaches. However, as before, the impulse responses and present-value multipliers are broadly in line with the base case under the SR approach.

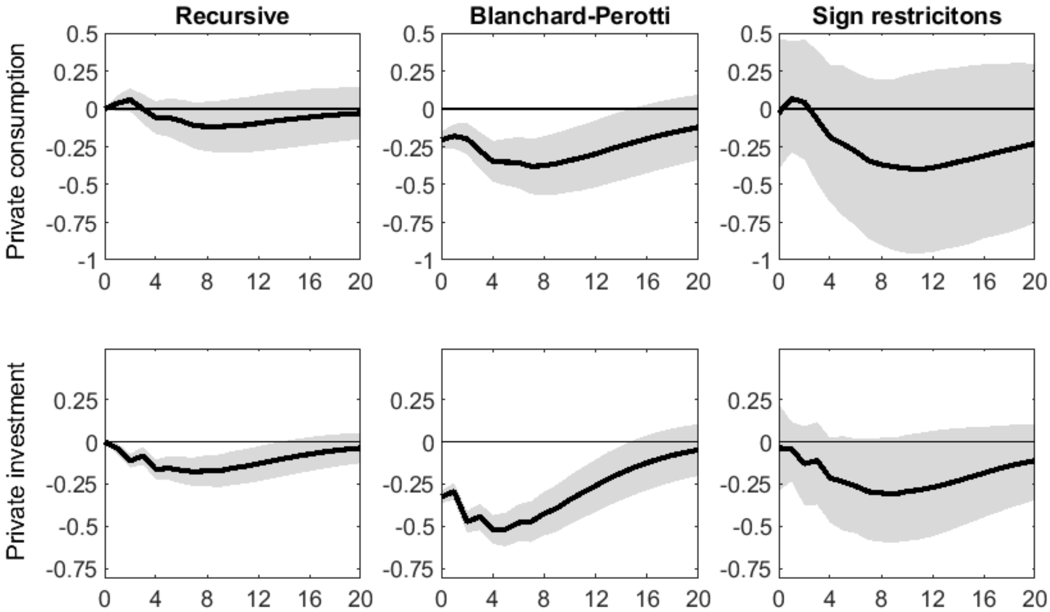
Figure 7: Response to a pure spending shock (expanded six-variable VAR)



Source: author's calculations.

[16] Consumption and investment elasticities, as well as details with respect to the full model specification, can be found in the Appendix.

Figure 8: Response to a pure tax shock (expanded six-variable VAR)



Notes: the figures show impulse responses to a R1 increase in government spending. For the recursive and BP approach, shaded areas represent 90 per cent confidence intervals. For the SR approach, the shaded area represents 90 per cent of the identified posterior distribution.

Source: author's calculations.

6 State-dependent multipliers

During the last decade, the literature on the effects of fiscal shocks on macroeconomic outcomes has explored the possibility that fiscal multipliers might differ depending on the state of the economy and/or monetary policy. As mentioned above, the GFC renewed interest in the ability of activist fiscal policy to lift the global economy out of the crisis-induced recession in an environment in which monetary policy had run out of room (i.e. policy rates hit the zero lower bound). One strand of this literature investigates the possibility that fiscal multipliers are higher during times of economic slack relative to periods of expansion (e.g. Auerbach and Gorodnichenko 2012, 2013a; Barro and Redlick 2011). Another strand considers how the stance of monetary policy affects government spending multipliers, with specific reference to the implications of hitting the zero lower bound (e.g. Christiano et al. 2011; Coenen et al. 2012; Cogan et al. 2010).

This section explores the possibility that fiscal multipliers differ across the cycle within the South African context. The approach follows that of Auerbach and Gorodnichenko (2012) as applied in Auerbach and Gorodnichenko (2013a) and Ramey and Zubairy (2018).[17]

In their original paper, Auerbach and Gorodnichenko (2012) developed a smooth transition vector autoregression (STVAR) model based on smooth transition autoregressive (STAR) models.

The basic specification was:

$$Y_t = (1 - F(z_{t-1}))\,\Pi_E(L)Y_{t-1} + F(z_{t-1})\Pi_R(L)Y_{t-1} + u_t \tag{18}$$

[17] The terms *recession* and *expansion* have varying definitions in the literature. In the context of this paper, *recession* and *downturn/downswing* are used interchangeably, as are the terms *expansion* and *upturn/upswing*.

with

$$u_t \sim N(0, \Omega) \tag{19}$$

$$\Omega_t = \Omega_E (1 - F(z_{t-1})) + \Omega_R F(z_{t-1}) \tag{20}$$

$$F(z_t) = \frac{\exp(-\gamma z_t)}{1+\exp(-\gamma z_t)}, \quad \gamma > 0 \tag{21}$$

where $Y_t = [g_t \quad t_t \quad y_t]'$ is a vector of the logarithms of real per capita government spending, taxes, and output; z is an indicator of the state of the economy; and $\Pi_i(L)$ and $\Omega_i(L)$ represent the VAR coefficients and variance–covariance matrix of disturbances in the two regimes. The weights assigned to each regime vary between 0 and 1 according to the state of the economy, z, which was calculated as the seven-period MA of real GDP growth.

Auerbach and Gorodnichenko (2013a) extended the approach to cover several OECD countries. However, instead of estimating an STVAR as in the earlier paper, the authors employ the local-projection method. The single-equation local-projection method (advocated by Jordà (2005), Stock and Watson (2007), and others) presents a flexible alternative that does not impose the implicit dynamic restrictions inherent in vector autoregressions, while at the same time being able to easily accommodate non-linearities of the type under consideration.

The method simply requires estimation of a series of regressions for each horizon h for each variable. In the simple linear case, this takes the following form (following Ramey and Zubairy 2018):

$$y_{t+h} = \alpha_h + \Pi_h(L)x_{t-1} + \beta_h \text{shock}_t + \varepsilon_{t+h} \tag{22}$$

where y_t is the variable of interest, x_t is a vector of control variables, $\Pi_h(L)$ is the coefficients related to the lagged control variables, and shock_t is a measure of the fiscal policy shock.[18] The coefficient β_h gives the response of y at time $t+h$ to the shock at time t. Thus, impulse responses can be constructed as a sequence of the estimated β_h. This is different to the standard method of constructing impulse response functions, whereby the parameters of the VAR are estimated for horizon 0 and then used to iterate forward to construct impulse responses (Ramey and Zubairy 2018).

This method is easily adapted to estimating a state-dependent model (using a similar notation to Equation (18)):

$$\begin{aligned} y_{t+h} = (1 - F(z_{t-1}))\left[\alpha_{E,h} + \Pi_{E,h}(L)x_{t-1} + \beta_{E,h}\text{shock}_t\right] \\ + F(z_{t-1})\left[\alpha_{R,h} + \Pi_{R,h}(L)x_{t-1} + \beta_{R,h}\text{shock}_t\right] + \varepsilon_{t+h} \end{aligned} \tag{23}$$

Therefore, the forecast of y_{t+h} is allowed to differ according to the state of the economy when the shock hit. As in Ramey and Zubairy (2018), the Newey–West correction is used to account for the serial correlation in the error terms induced by the successive leading of the dependent variable.

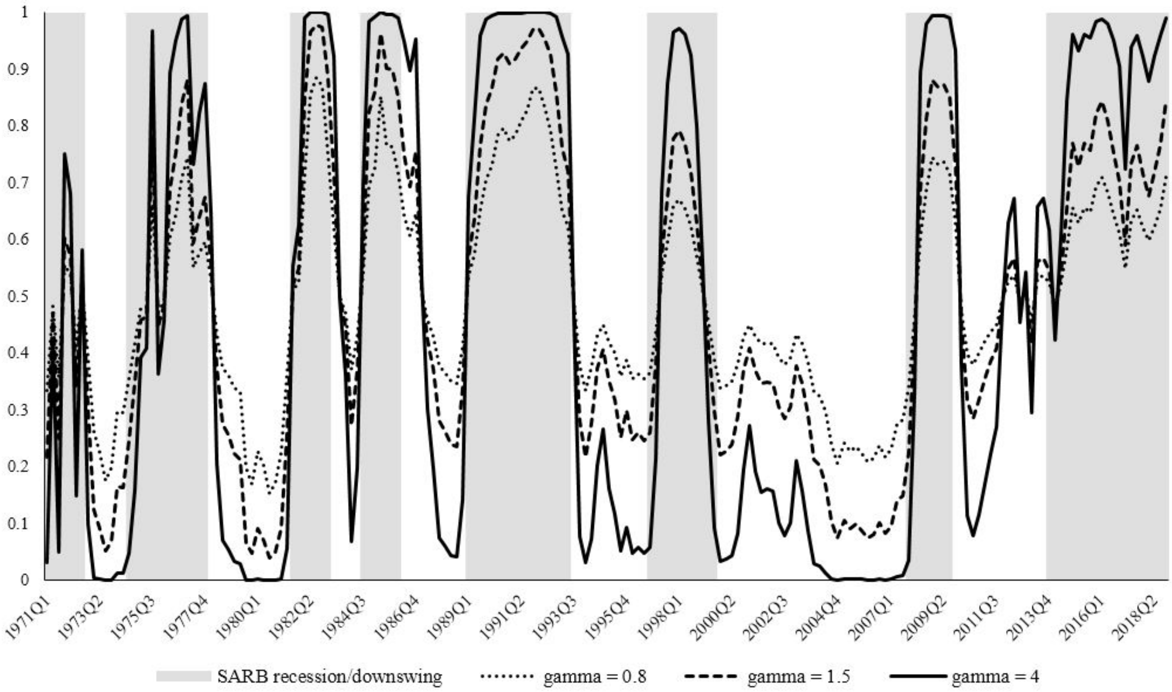
According to Auerbach and Gorodnichenko (2013a), the local-projection method has several advantages over the STVAR approach when it comes to estimating state-dependent multipliers. First, it involves only linear estimation in the case where γ in Equation (21) is fixed (as it is in Auerbach and Gorodnichenko 2012 and in this application). Second, it reduces the dimensionality of the problem, given the fact that one need not estimate equations for variables other than the variable of interest (GDP in this case). Finally, because the set of regressors does not vary with horizon h, the impulse response incorporates the average transitions of the economy between states. That is, there is no need to separately model how z changes over time (Auerbach and Gorodnichenko 2013a). If fiscal shocks systematically affect

[18] In Ramey and Zubairy (2018) the shock vector is either the estimated military spending news series or a measure of the Blanchard–Perotti shock.

the state of the economy, this effect will be absorbed into the estimated β. In contrast, the system in Equation (18) requires the explicit modelling of the dynamics of z.

Following Auerbach and Gorodnichenko (2012) and Ramey and Zubairy (2018), z is set equal to the seven-quarter MA of output growth. The parameter γ in Equation (21) governs the smoothness of the transition between states. Figure 9 plots the values of $F(z)$ for different values of γ along with the SARB dated downswings. In the current application, γ is set equal to 4 so that the economy spends approximately 45 per cent of the time in the recessionary regime, where the economy is assumed to be in recession when $F(z_t) > 0.6$. This calibration is consistent with the duration of recessions in South Africa over the sample according to SARB business cycle dates (49 per cent of the time since 1970).

Figure 9: SARB dates and weight on recession regime $F(z)$



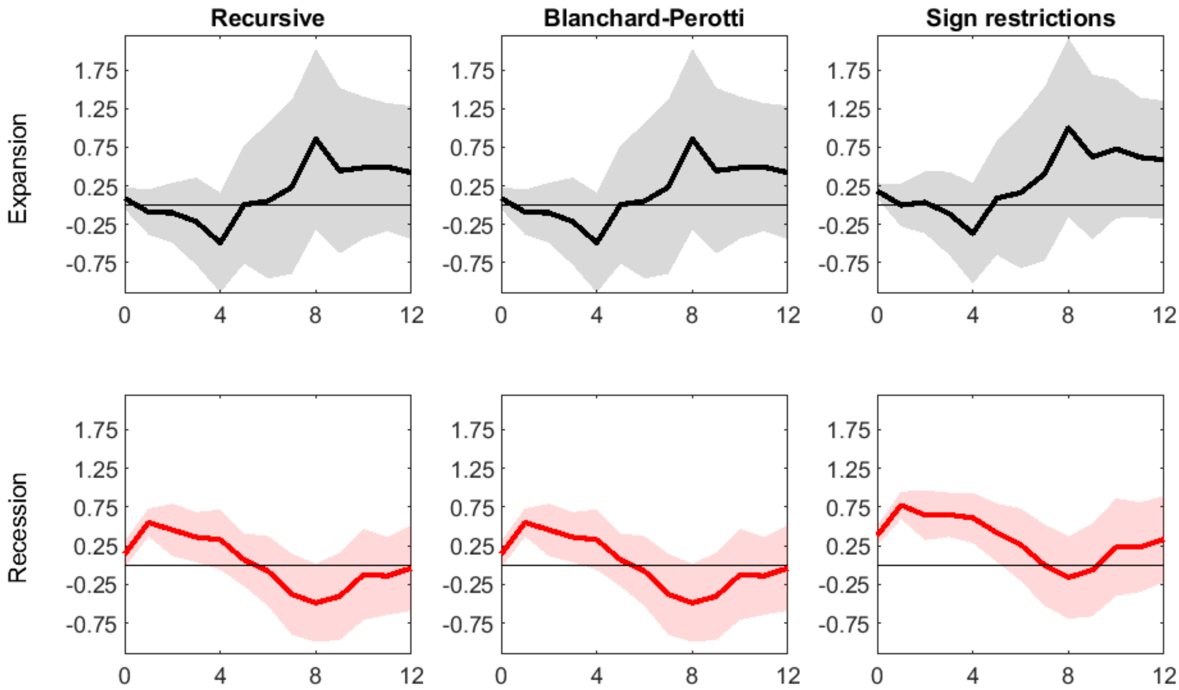
Source: author's calculations based on SARB Quarterly Bulletins.

In estimating the set of regressions in Equation (23) with output as the dependent variable, the vector of control variables, x, contains four lags of the log of real per capita GDP, government spending, and total tax revenue. In addition, x contains lags of the shock variable to control for any serial correlation. The structural shocks identified in Section 4 are used as the shock variable. The estimation horizon is set equal to 12 quarters—that is, $h = 12$ in Equation (23), the average duration of recession states over the sample.

Figures 10 and 11 show the output response under the different regimes following shocks to government spending and taxes respectively, with columns referencing the identification scheme employed to estimate the structural shocks used as input in estimating Equation (23). Impulse responses are scaled as before. Table 6 presents present-value multipliers under the different states and identification schemes.

From the impulse responses it is evident that there is a clear difference between the responses of output to a government spending shock in the different regimes, with a larger output response recorded under the recession regime than under the expansion regime. This is particularly true over the one-year horizon.

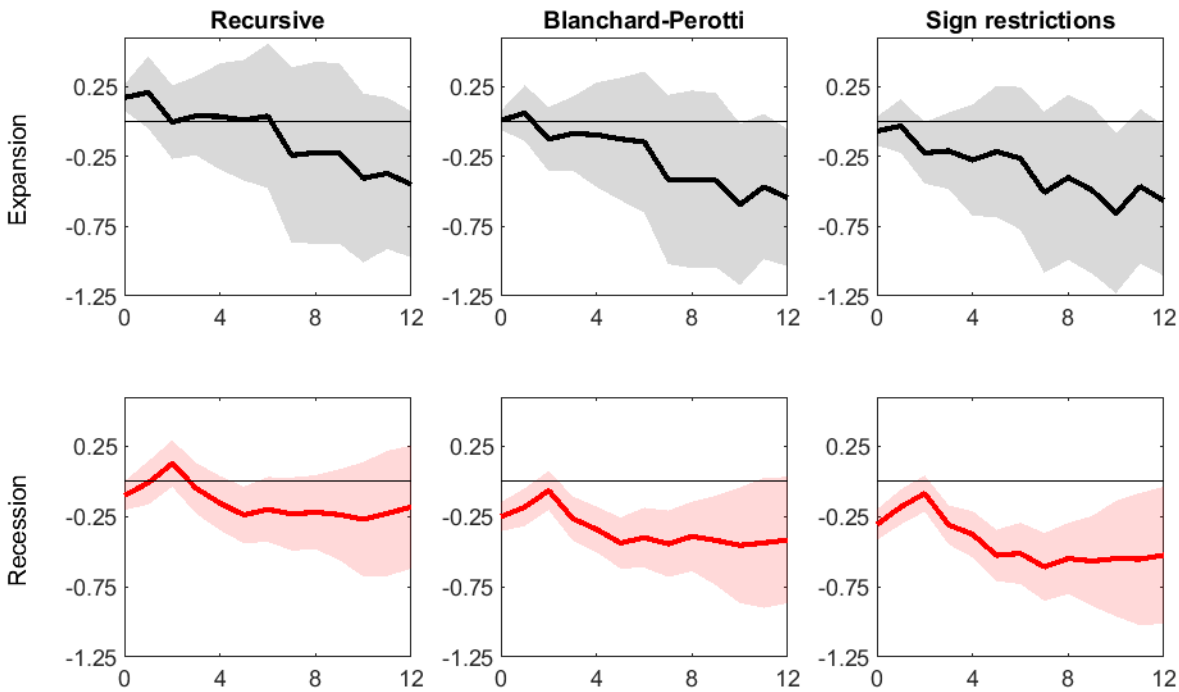
Figure 10: State-dependent output response to a government spending shock



Notes: columns refer to the shock processes embedded in Equation (23). The figures show impulse responses to a R1 increase in the fiscal variable. Shaded areas represent 90 per cent intervals.

Source: author's calculations.

Figure 11: State-dependent output response to a tax shock



Notes: columns refer to the shock processes embedded in Equation (23). The figures show impulse responses to a R1 increase in the fiscal variable. Shaded areas represent 90 per cent intervals.

Source: author's calculations.

This observation is borne out by the implied present-value multipliers in Table 6, where output multipliers are significantly larger under the recession regime no matter the identification approach employed. Additionally, while the confidence bands suggest that the output response is not statistically significant under the expansion regime, the output response under the recession regime is statistically different from zero, at least over the first four quarters following the shock to government spending.

Table 6: Present-value output multipliers under different regimes

	Q1	Q4	Q8	Q12
Government spending multiplier				
Recursive				
Linear	0.11	0.39	0.41	0.43
Expansion	0.09	–0.18	0.00	0.15
Recession	0.14	0.58	0.33	0.24
Blanchard–Perotti				
Linear	0.11	0.39	0.41	0.43
Expansion	0.09	–0.18	0.00	0.15
Recession	0.14	0.58	0.33	0.24
Sign restrictions				
Linear	0.33	0.79	0.87	0.95
Expansion	0.19	–0.04	0.18	0.36
Recession	0.38	0.89	0.74	0.74
Tax multiplier				
Recursive				
Linear	0.00	–0.06	–0.24	–0.46
Expansion	0.17	0.19	0.08	–0.11
Recession	–0.10	–0.07	–0.28	–0.43
Blanchard–Perotti				
Linear	–0.20	–0.69	–1.16	–1.76
Expansion	0.01	–0.08	–0.28	–0.59
Recession	–0.25	–0.48	–0.88	–1.24
Sign restrictions				
Linear	–0.29	–0.93	–1.63	–2.47
Expansion	–0.07	–0.30	–0.54	–0.88
Recession	–0.31	–0.56	–1.14	–1.65

Notes: the linear model refers to results obtained from estimating the set of regressions in Equation (22)—that is, using the full sample.

Source: author's calculations.

The difference in output responses following a tax shock are less clear. However, the present-value multipliers in Table 6 suggest that the negative output response following a tax shock is significantly larger under the recession regime than under the expansion regime. The calculation of the present-value multipliers in Table 6 takes into account the difference in the cumulative response of taxes under the different regimes following the shock (see Equation (15)). Tax revenues decline faster under the recessionary regime following the tax shock, resulting in the clear divergence in present-value output multipliers relative to the expansionary regime. As with the government spending shock, the output response to a tax shock is never significantly different from zero under the expansion regime. In contrast, the response is statistically significant under the recession regime across most of the impulse horizon, particularly under the BP and SR identification approaches.

7 Conclusion

This paper has used a variety of identification approaches and model specifications to investigate the response of macroeconomic aggregates to fiscal policy innovations. Similar to results found in the literature, the estimated impulse responses and implied fiscal multipliers are sensitive to the identification approach employed.

It needs to be noted that the wide range of multipliers documented in the literature narrows significantly once methods for calculating multipliers are standardized. This requires calculating multipliers as the ratio of the cumulative macro variable response to the cumulative fiscal response (which more accurately represents theoretical multipliers), as opposed to the size of the effect on impact or the constant, non-cumulative rand value. It must be pointed out, however, that the cumulated multipliers are discounted at the mean interest rate for the sample, and that they are scaled by the ratio of the fiscal variable to the macro variable evaluated at the sample mean. These transformations introduce sample selection biases that need to be considered when drawing policy conclusions.

Keeping this caveat in mind, results show that government spending multipliers are generally positive, albeit smaller than 1. An important exception is when the models are extended to control for the effects of monetary policy. While present-value spending multipliers remain positive over short horizons, the long-term spending multiplier turns negative in models that account for the effects of monetary policy. Long-term (i.e. 20-quarter) present-value government spending multipliers range from -0.24 to 1.06. Tax multipliers are found to be statistically significant and larger (in absolute terms) than spending multipliers, pointing to the significant effects of tax shocks on macroeconomic outcomes. Long-term present-value tax multipliers range from -0.15 to -4.28.

The private consumption and investment responses broadly mirror that of output, in that tax shocks are significantly more distortionary than shocks to government spending. Importantly, while consumption reacts positively to government spending shocks over the short run, the response is short-lived. Present-value consumption multipliers range from -0.33 to 0.31 for government spending, and between -0.19 and -4.05 for taxes. Present-value investment multipliers range from -0.26 to 0.13 for government spending, and between -0.47 and -10.99 for taxes.

Finally, the possibility of state-dependent multipliers was investigated using local-projection methods. It is found that both government spending and tax multipliers are larger during periods of slack, with long-term present-value multipliers doubling in size during recessionary states.

A general observation is that the multipliers estimated in this paper are somewhat smaller than those found in the literature, at least with respect to the developed world. As mentioned above, multipliers tend to be smaller in open, less developed economies. This could be due to a range of factors. On the spending side, possible factors include import leakages, corruption, and spending inefficiencies (i.e. inefficiencies in implementation of spending plans). Counteracting monetary policy is another factor that might result in lower spending multipliers, as reflected in the results discussed in Section 5.2. Similarly, the relatively large (negative) tax multipliers might be related to both behavioural and institutional factors. Behavioural factors relate to individual behavioural responses to changing tax rates (see Kemp (2019, 2020) for a discussion on results for South Africa), while institutional factors could be reflective of problems in enforcement and/or collection and tax structure. The latter could include the availability of exemptions and deductions, and the opportunity for tax avoidance/evasion in the face of rising tax rates.

It should also be noted that all of the identification procedures employed in this paper, and in the literature in general, impose relatively strong priors on the results. The recursive and BP approaches imposes explicit restrictions on the contemporaneous relationships between variables, while the SR approach is subjective in that only those draws are kept that conform to the researcher's expectations. Even the popular event-study approach assumes that the correct instruments have been identified and that these are, in fact, orthogonal to output. These caveats should be considered when making policy recommendations based on estimated multipliers.

Having said that, the estimates in this paper, combined with insights from Kemp (2019, 2020) regarding the individual behavioural response to changing tax rates, suggest that should South African authorities need to embark on a fiscal consolidation drive, policies should be designed in favour of cutting government consumption expenditure as opposed to raising taxes. Unfortunately, this is the exact opposite approach to that followed by the South African government over recent years, with significant personal tax increases bearing the brunt of the responsibility for fiscal consolidation.

That being said, this paper does not distinguish between the different effects of current government expenditure and public investment expenditure, and/or the effects of different tax measures (i.e. PIT versus CIT). While future research could investigate the differentiated impacts of the different spending and tax measures within the current reduced form framework, another option is to cast the problem in a structural model (i.e. a DSGE model) and investigate the differentiated impact of alternative policy instruments within a fully fleshed out dynamic structural model.

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Appendix

A1 Variable definitions and sources

Table A1: Variable definitions and sources

Variable	Description	Source
Real government spending	Sum of government consumption expenditure and public sector investment	
Total tax revenue	Sum of PIT, CIT, tax on goods and services, and other direct and indirect taxes	
Private consumption expenditure	Real private consumer spending	South African Reserve Bank
Private fixed investment	Real private fixed investment outlays	
Repo rate	Main repurchase rate	
GDP deflator		
CPI	Headline CPI for all urban areas	Statistics South Africa

Source: author's compilation.

A2 Elasticity of tax revenue with respect to output

The elasticity of tax revenue to output, a_{ty}, is constructed through a weighted sum of the elasticities of the different tax instruments with respect to output.

The elasticity of each tax instrument with respect to output can be calculated either directly or indirectly (see Du Plessis et al. 2007). Direct estimation involves calculating the sensitivity of the ith tax component to output. The elasticity is estimated from an unrestricted VAR with the ith tax component and output as the endogenous variables, using a lag order of four quarters. The following equation in the VAR, with the ith tax component as the dependent variable, is used to calculate the elasticity:

$$T_t^i = \mu + \sum_{k=1}^{4} \beta_k Y_{t-k} + \sum_{k=1}^{4} \gamma_k T_{t-k}^i + \varepsilon_t$$

where the elasticity is then calculated as:

$$a_{t_i y} = \frac{\sum_{k=1}^{4} \beta_k}{1 - \sum_{k=1}^{4} \gamma_k}$$

However, where possible, it is more prudent to calculate the elasticity of the ith tax category with respect to output indirectly—that is, as the product of two elasticities: the elasticity of the ith tax category with respect to the relevant tax base ($\eta_i^{t,tb}$) and the elasticity of that tax base with respect to output ($\eta_i^{tb,y}$):

$$a_{t_i y} = \eta_i^{t,tb} \eta_i^{tb,y}$$

where $\eta_i^{t,tb}$ and $\eta_i^{tb,y}$ are each estimated from unrestricted VARs.

Data on PIT, CIT, VAT, and other indirect taxes are sourced from the SARB Quarterly Bulletin, and are used together with real output to calculate the relevant elasticities. Fiscal series are seasonally adjusted and deflated using the GDP deflator.

The indirect method is followed for estimating the elasticity of PIT, CIT, and VAT with respect to output, with total compensation of employees, gross operating surplus, and consumer spending serving as the respective tax bases. For indirect taxes excluding VAT, the direct method is used. Table A2 provides details of the estimated elasticities. The aggregate elasticity of tax revenue with respect to output is calculated as the weighted sum of the individual elasticities. As such, $a_{ty} = 1.27$.

Table A2: Exogenous elasticities with respect to real GDP

	Elasticity of tax item to tax base ($\eta_i^{t,tb}$)	Elasticity of tax base to output ($\eta_i^{tb,y}$)	Elasticity of tax item to output ($a_{t_i y}$)	Share in total taxes (T_i/T)
PIT	1.58	0.87	1.37	0.32
CIT	1.17	0.96	1.12	0.23
VAT	1.31	1.20	1.58	0.20
Other indirect	–	–	1.05	0.25
Direct taxes			1.26	0.55
Indirect taxes			1.28	0.45
Total tax			1.27	

Source: author's calculations.

A3 Elasticity of tax revenue with respect to private consumption and investment

Estimates for the elasticity of total taxes with respect to private consumption and investment are calculated in a similar fashion to the output elasticity described above, and are provided in Table A3.

Table A3: Exogenous elasticities with respect to private consumption and investment

	Elasticity of tax base to private consumption ($\eta_i^{tb,C}$)	Elasticity of tax base to private investment ($\eta_I^{tb,I}$)	Elasticity of tax item to private consumption ($a_{t_i C}$)	Elasticity of tax item to private investment ($a_{t_i I}$)
PIT	0.68	0.59	1.07	0.94
CIT	0.76	0.26	0.88	0.31
VAT	1.31	0.64	1.31	0.84
Other indirect	–	–	0.82	0.70
Direct taxes			0.99	0.68
Indirect taxes			1.03	0.76
Total tax			1.01	0.71

Source: author's calculations.

A4 Alternative SVAR specifications

A4.1 Extended baseline VAR

The first set of alternative SVAR models extend the baseline VAR with an output component, either private consumption or investment, placed third in the system. Under the BP identification approach, the system can be written as:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ -a_{yg} & 1 & 0 & -a_{yt} \\ -a_{y^i g} & -a_{y^i y} & 1 & -a_{y^i t} \\ 0 & -1.27 & -a_{ty^i} & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^{y^i} \\ \eta_t^t \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 & 0 \\ 0 & b_{yy} & 0 & 0 \\ 0 & 0 & b_{y^i y^i} & 0 \\ b_{tg} & 0 & 0 & b_{tt} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^{y^i} \\ \varepsilon_t^t \end{bmatrix} \tag{A1}$$

where y^i is the output component under consideration, either private consumption or private investment. The elasticity estimates in Table A3 are used to calibrate a_{ty^i} in Equation A1. For example, in the case of consumption, the system becomes:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ -a_{yg} & 1 & 0 & -a_{yt} \\ -a_{y^i g} & -a_{y^i y} & 1 & -a_{y^i t} \\ 0 & -1.27 & -1.01 & 1 \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^{y^i} \\ \eta_t^t \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 & 0 \\ 0 & b_{yy} & 0 & 0 \\ 0 & 0 & b_{y^i y^i} & 0 \\ b_{tg} & 0 & 0 & b_{tt} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^{y^i} \\ \varepsilon_t^t \end{bmatrix} \tag{A2}$$

A4.2 Extended monetary policy VAR

The second set of alternative SVAR models extends the five-variable monetary policy VAR with an output component, either private consumption or investment, again placed third in the system. Under the BP identification approach, the system can be written as:

$$\begin{pmatrix} 1 & 0 & 0 & 0.79 & 0 & 0 & \\ -a_{yg} & 0 & 1 & 0 & -a_{yt} & 0 & \\ -a_{y^ig} & -a_{y^iy} & 1 & 0 & -a_{y^it} & 0 & \\ -a_{\pi g} & -a_{\pi y} & -a_{\pi y^i} & 1 & -a_{\pi t} & 0 & 0 \\ 0 & -1.27 & -a_{ty^i} & -0.19 & 1 & 0 & \\ -a_{rg} & -a_{ry} & -a_{ry^i} & -a_{r\pi} & -a_{rt} & 1 & \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^{y^i} \\ \eta_t^\pi \\ \eta_t^t \\ \eta_t^r \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{yy} & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{y^iy^i} & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{\pi\pi} & 0 & 0 \\ b_{tg} & 0 & 0 & 0 & b_{tt} & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{rr} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^{y^i} \\ \varepsilon_t^\pi \\ \varepsilon_t^t \\ \varepsilon_t^r \end{bmatrix} \tag{A3}$$

where y^i is the output component under consideration, either private consumption or private investment. The elasticity estimates in Table A3 are used to calibrate a_{ty^i} in Equation A3. For example, in the case of consumption, the system becomes:

$$\begin{pmatrix} 1 & 0 & 0 & 0.79 & 0 & 0 & \\ -a_{yg} & 0 & 1 & 0 & -a_{yt} & 0 & \\ -a_{y^ig} & -a_{y^iy} & 1 & 0 & -a_{y^it} & 0 & \\ -a_{\pi g} & -a_{\pi y} & -a_{\pi y^i} & 1 & -a_{\pi t} & 0 & 0 \\ 0 & -1.27 & -1.01 & -0.19 & 1 & 0 & \\ -a_{rg} & -a_{ry} & -a_{ry^i} & -a_{r\pi} & -a_{rt} & 1 & \end{pmatrix} \begin{bmatrix} \eta_t^g \\ \eta_t^y \\ \eta_t^{y^i} \\ \eta_t^\pi \\ \eta_t^t \\ \eta_t^r \end{bmatrix} = \begin{pmatrix} b_{gg} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{yy} & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{y^iy^i} & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{\pi\pi} & 0 & 0 \\ b_{tg} & 0 & 0 & 0 & b_{tt} & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{rr} \end{pmatrix} \begin{bmatrix} \varepsilon_t^g \\ \varepsilon_t^y \\ \varepsilon_t^{y^i} \\ \varepsilon_t^\pi \\ \varepsilon_t^t \\ \varepsilon_t^r \end{bmatrix} \tag{A4}$$

A4.3 Present-value multipliers for the extended monetary policy VAR

Table A4 presents present-value multipliers based on the extended five- and six-variable monetary policy VARs.

Table A4: Present-value multipliers based on monetary policy VAR

	Q1	Q4	Q8	Q12	Q20
Government spending multiplier					
Output					
Recursive	0.08	0.29	0.19	0.07	–0.10
Blanchard–Perotti	0.08	0.26	0.17	0.06	–0.11
Sign restriction	0.23	0.41	0.23	0.04	–0.24
Private consumption					
Recursive	0.09	0.05	–0.11	–0.22	–0.33
Blanchard–Perotti	0.08	–0.01	–0.14	–0.22	–0.32
Sign restriction	0.33	0.30	0.16	0.05	–0.08
Private investment					
Recursive	–0.04	–0.05	–0.13	–0.19	–0.26
Blanchard–Perotti	–0.06	–0.07	–0.13	–0.18	–0.24
Sign restriction	0.09	0.16	0.13	0.08	0.02
Tax multiplier					
Output					
Recursive	0.00	0.03	–0.03	–0.09	–0.15
Blanchard–Perotti	–0.15	–0.37	–0.65	–0.88	–1.14
Sign restriction	–0.18	–0.61	–1.56	–2.60	–4.25
Private consumption					
Recursive	0.00	0.02	–0.07	–0.14	–0.19
Blanchard–Perotti	–0.21	–0.56	–1.04	–1.46	–1.92
Sign restriction	–0.03	–0.05	–0.33	–0.61	–0.92
Private investment					
Recursive	0.00	–0.16	–0.31	–0.41	–0.47
Blanchard–Perotti	–0.33	–1.13	–2.21	–3.24	–4.39
Sign restriction	–0.04	–0.19	–0.41	–0.60	–0.78

Notes: output multipliers based on five-variable monetary policy VAR. Consumption and investment multipliers based on a six-variable VAR with consumption/investment ordered third.

Source: author’s calculations.

A5 Selected multiplier studies

Table A5: Government spending multipliers from selected studies

Study	Region	Identification	Implied multiplier
Developed economies			
Barro (1981), Hall (1986), Hall (2009), Barro and Redlick (2011)	US	Military spending as instrument for government spending	0.6–1
Rotemberg and Woodford (1992)	US	Residuals from regression of military spending on own lags	1.25
Ramey and Shapiro (1998), Edelberg et al. (1999), Burnside et al. (2004)	US	Ramey–Shapiro military build-up dates	0.6–1.2
Blanchard and Perotti (2002)	US	SVAR with Cholesky decomposition	0.9–1.3
Perotti (2005)	US Germany UK	SVAR with contemporaneous restrictions	0.3–1.4 0.3 –0.6 to 0.5
Giordano et al. (2007)	Italy	SVAR with contemporaneous restrictions	1.2–1.7
Burriel et al. (2010)	Euro area	SVAR with contemporaneous restrictions	0.9
Mountford and Uhlig (2009)	US	Sign-restricted SVAR	0.65
Cogan et al. (2010)	US	Estimated Smets–Wouter model	0.64
Fisher and Peters (2010)	US	VAR using excess stock returns of military contractors	1.5
Tenhofen et al. (2010)	Germany	Disaggregated SVAR with contemporaneous restrictions	0.6–1.3
Ramey (2011a,b)	US	VAR using shocks to expected present value of government spending caused by military events	0.6–1.2
Auerbach and Gorodnichenko (2012)	US	SVAR that controls for forecast, Ramey-type news (regime switching)	Expansion: –0.3 to 0.8 Recession: 1–3.6
de Castro and Fernández (2013)	Spain	SVAR with contemporaneous restrictions	0.5– 0.9
Owyang et al. (2013)	US Canada	Defence spending news	0.8 0.4–1.6
Parkyn and Vehbi (2014)	New Zealand	SVAR with contemporaneous restrictions and debt feedback	–0.1 to 0.4
Caldara and Kamps (2017)	US	SVAR with contemporaneous restrictions, sign restrictions, proxy-VAR	0.9–1.7
Developing economies			
Mirdala (2009)	European transition economies	SVAR with contemporaneous restrictions, long-run restrictions	Positive
Lozano and Rodríguez (2011)	Colombia	SVAR with contemporaneous restrictions	1.2
Ravnik and Zilic (2011)	Croatia	SVAR with contemporaneous restrictions	Negative
Guy and Belgrave (2012)	Several Caribbean countries	SVAR with contemporaneous restrictions	0.1–0.2
Jooste et al. (2013)	South Africa	VECM, time-varying parameter VAR, calibrated DSGE	>1
Gnip (2014)	Croatia	SVAR with contemporaneous restrictions	0.33 (peak)
		Regime switching model	Expansion: 0.6 Recession: 2.2
IMF (2018)	19 Latin American countries	Local projection method with forecast errors	0.2
Alichi et al. (2019)	Several small states (IMF and World Bank definitions)	Local projection method with forecast errors	0.3–0.4

Source: author's compilation.

Table A6: Tax multipliers from selected studies

Study	Region	Identification	Implied multiplier
Developed economies			
Blanchard and Perotti (2002)	US	Assumed output elasticity in SVAR	–0.5 to –1.7
Perotti (2005)	US Germany UK	SVAR with contemporaneous restrictions	–1.4 –0.05 to 0.3 –0.2 to 0.7
Mountford and Uhlig (2009)	US	Sign-restricted SVAR	–5
Burriel et al. (2010)	Euro area	SVAR with contemporaneous restrictions	–0.5
Romer and Romer (2010)	US	Narrative approach	–3
Barro and Redlick (2011)	US	Average marginal tax rates	–1.1
Favero and Giavazzi (2012)	US	Romer and Romer narrative series embedded in SVAR	–0.5
Mertens and Ravn (2014)	US	Proxy-SVAR using Romer and Romer series	–3
Caldara and Kamps (2017)	US	SVAR using outside elasticities	–0.65
Developing economies			
Mirdala (2009)	European transition economies	SVAR with contemporaneous restrictions, long-run restrictions	No effect, positive in some cases
Lozano and Rodríguez (2011)	Colombia	SVAR with contemporaneous restrictions	Positive
Ravnik and Zilic (2011)	Croatia	SVAR with contemporaneous restrictions	Positive
Guy and Belgrave (2012)	Several Caribbean countries	SVAR with contemporaneous restrictions	Positive
Jooste et al. (2013)	South Africa	VECM, time-varying parameter VAR, calibrated DSGE	Large and negative
Gnip (2014)	Croatia	SVAR with contemporaneous restrictions	–0.03 (impact)
		Regime switching model	Expansion: –0.02 Recession: 0.4
IMF (2018)	19 Latin American countries	Local projection method with forecast errors	–0.5 (average)
Alichi et al. (2019)	Several small states (IMF and World Bank definitions)	DSGE model	–0.4

Source: author's compilation.