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ERSA working paper 351

May 2013

Economic Research Southern Africa (ERSA) is a research programme funded by the National Treasury of South Africa.

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Analysing the effects of fiscal policy shocks in the South African economy

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May 23, 2013

Abstract

This paper is the first one to analyse the effect of aggregate government spending and taxes on output for South Africa using three types of a calibrated DSGE model and more data driven models such as a structural vector error correction model (SVECM) and a time-varying parameter VAR (TVP-VAR) to capture possible asymmetries and time variation of fiscal impulses. The impulse responses indicate first, that increases in government expenditure have a positive impact, albeit (at times) less than unity, on GDP in the short run; second, over the long run, the impact of government expenditure on GDP is insignificant; and third, increases in taxes decreases GDP over the short run, while having negligible effects over longer horizons.

Keywords: rule-of-thumb consumers, fiscal multiplier, government spending, TVP-VAR, SVECM

JEL Classification : C54, D58, E32, E62, H31

1 Introduction

At a time when monetary policy remains constrained by the zero lower bound on policy rates, fiscal policy has received new vigour. The response of the economy to a rise in government purchases has been the subject of intensive research. Seminal contributions on the impact of fiscal policy on the economy have shown mixed effects. For instance, Blanchard and Perotti (1999), Perotti (2005), Mountford and Uhlig (2002) and Gali, Lopez-Salido, and Valles (2007) have shown supportive fiscal trends on output and consumption. Findings by

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[§]We thank the Editors, two anonymous referees for their helpful comments. We are also grateful for financial support from ERSA.

Ramey and Shapiro (1998), Hall (2009) and Barro and Redlick (2011) show that fiscal expenditure shocks have a negative impact on consumption and a subdued impact on output.

Macroeconomic models such as the neoclassical approach predicts that given economic agents are forward looking in their consumption and labour supply decisions, in short, given agents are Ricardian, tax changes holding government spending unchanged, will not affect their intertemporal budget constraint and therefore will not affect their consumption patterns. On the other hand, changes in government spending, both permanent and temporary creates negative income effect and therefore decreasing household's consumption and increasing their labour supply and therefore output. The New Keynesian approach tries to explain the rise in consumption found in the data following government spending increases by the introduction of imperfectly competitive setup such as Rotemberg and Woodford (1992) and Devereux, Head and Lapham (1996) or still Galí, Lopez-Salido, and Valles (2007) by the introduction of special features such as rule-of-thumb consumers in models with nominally sticky prices.

On empirical grounds, the size of multipliers has largely been debated. In general, studies show that the size of multipliers depends on a number of issues such as the responsiveness of interest rates to fiscal policy changes, see Christiano et al. (2011) and Monacelli et al. (2010), the degree of openness of the economy, see for instance, Ilzetzki et al. (2010) and Faia et al. (2010) and the multiplier size can largely depend on the models' properties, see for instance, Leeper et al. (2010) and Cogan et al. (2010). Knowing the size of the multiplier is of major importance to the possible implementation of fiscal rules that seek to stabilize the fiscus (the structural budget balance rule, which sets targets on discretionary spending is an example).

One interesting debate is that in the standard VAR approach (e.g., Blanchard and Perotti (1999)) the inclusion of government spending shocks is subject to a number of pitfalls as recently shown by Ramey (2011) and Leeper et al. (2010). Their ideas can be grouped under two main criticisms. Firstly, the type of government spending in these studies is of major importance if one wants to test the neoclassical model versus the Keynesian model. Government spending shocks coming from expenditures on education, public order and transportation for instance that most likely enter the production function or interact with private consumption have the disadvantages that shocks to government spending on defences might not have. This has led to a number of studies focussing on military spending such as Barro (1981), Hall (2009) and Ramey (2011). Importantly, it is difficult to disentangle endogenous shocks and exogenous government shocks. Unemployment insurance would be a good example of endogenous government shocks as the amount of claims is associated with job losses in boom-bust cycles and would vary with output.

Secondly, Shapiro and Ramey (1998) and more recently Ramey (2011) and Leeper et al. (2010) argue that many shocks identified from the standard VAR are anticipated changes in government spending, in short, the standard VAR has difficulty in trying to disentangle between true shocks and 'shocks' which might be anticipated and therefore due to faulty timing might show increases

in consumption following government spending increases which might not be present in reality. In general, the VAR methodology is backward looking and therefore it ignores the forward looking nature of decision makers. To overcome this obstacle, Ramey (2011) uses an event study approach to control for forward looking expectations. The idea is to capture the timing of news as measures of expectations by using a narrative approach or Survey of Professional Forecasters to identify shocks to government spending. This approach delivers modest multipliers and even a decline in private consumption. It is worth noting that in response, Perotti (2011) compares the traditional SVAR with Ramey's Expectations Augmented VAR (EVAR) and basically finds no difference between the two models.

The 2011 Budget Review (Budget Review, 2011) makes reference to the possibility of employing a fiscal rule in South Africa. Here it is worth noting that a fiscal rule with an exact numeric target, such as a structural budget balance, implies one of two things - that discretionary fiscal policy is ineffective in stimulating demand and that only automatic stabilisers should work, or that the uncertainty in using fiscal policy levers cannot be priced in and thus the sole reliance falls on automatic stabilisers to smooth out shocks (again avoiding the use of discretionary fiscal adjustments). Thus, it is important to ask whether fiscal policy has been and can be effective in stimulating demand and if so, whether reducing discretionary fiscal policy is a bad policy? There are many factors that influence the effectiveness of fiscal policy on demand. It is by taking most of these factors into account that we attempt to address whether policy has been effective in creating demand.

The first contribution of this work is standard and it is to shed light on the impact of fiscal policy decisions on the economy if South Africa were to implement a fiscal rule. The second contribution by using three types of methodologies, namely, DSGE, TVP-VAR and VECM allows us to answer some of the important questions raised in the field that pertains to the weaknesses of standard VARs in identifying fiscal shocks which might bias the fiscal multipliers. The extended DSGE model that incorporates rule-of-thumb consumers alongside traditional optimizing agents is able to capture the pure government spending shocks, i.e., shocks which do not interfere or interact with other economic decisions such as the production function. They are the type of shocks that research focussing on defense spending tries to capture. Though in this study, we do not use the type of datasets that might address the Ramey-Shapiro narrative approach to identify fiscal shocks due to data shortage, South Africa's spending on defence is pretty insignificant and not important in stimulating the economy and professional forecasts are non-existent. Yet by providing time variation of fiscal shocks, the TVP-VAR is able to condition on different time periods in order to provide information on the size of the fiscal multipliers. In effect, by measuring the responses of the economy to fiscal changes at different point in time might in some way provide us with valuable information as to when changes in government spending might be the most influential.

Time variation of fiscal shocks could for example explain why the multiplier size differs during booms versus recession or during low versus high debt periods.

For instance, Giavazzi and Favero (2007) have observed that the debt level is a crucial determinant of the fiscal multipliers, proposing a possible method to account for the non-linear behaviour of the debt level variable in a VAR model. There is no reason to suggest that the size of fiscal multipliers, as an a priori, should be constant over time. It is possible that with persistent government shocks the size of the multiplier can decrease. An example of this would be when government expands during economic contractions and continues to do so even when growth becomes buoyant. It might also matter from which deficit/surplus level an expansion takes place. Increasing government spending from an already high deficit will only increase the overall debt burden which has to be financed in the future. The risks associated with ever increasing debt levels and more specifically the ability of governments to finance these deficits was well illustrated with the 2011 European sovereign woes. Rating agencies that downgrade the quality of bonds can easily lead to massive outflows of capital which in essence means that fiscal authorities have to implement severe austerity measures which limits the effectiveness of fiscal policy in stimulating demand. Understanding the time variation of fiscal shocks might elucidate why so many studies find contentious results regarding the size of the multiplier.

Although the three models, viz., DSGE, VECM and Time Varying Parameter VAR are not directly comparable, they shed light on different aspects of the fiscal multiplier. Are DSGE multipliers of the same size when estimating the multiplier from data? Comparing the two methodologies might tell us whether the data driven methods try to overestimate the fiscal multipliers if they are susceptible to the Ramey-Shapiro critique. Are multipliers constant over time and across regimes? And is it possible to infer some preliminary thoughts on how South African consumers respond to fiscal shocks? This study attempts to answer these related questions.

The paper proceeds as follows. Section 2 summarises the models used in the paper, against a general equilibrium model of a closed economy that captures the features of the South African economy with the purpose of analysing the effects of a fiscal rule-based policy, a structural vector error correction model and a nonlinear VAR. Section 3 discusses the data and reports the results and Section 4 presents some concluding remarks and offers some policy implications.

2 Methodology

We first sketch out a benchmark general equilibrium model of a closed economy. We then discuss the empirical models, versus a structural vector error correction model (SVECM) and a time varying parameter structural vector autoregression (TVP-VAR) model. The SVECM departs from the traditional VAR model in that it not only enables us to identify both short and long restrictions but also allows us to consider the cointegrating space between the variables. We then elaborate on a small TVP-VAR that allows for nonlinear effects of fiscal spending and taxes.

2.1 A dynamic stochastic general equilibrium model with differentiated consumers

The effectiveness of a fiscal expansion is often difficult to measure. To this end, we build a general equilibrium model of a closed economy that captures the features of the South African economy with the purpose of analysing the effects of a fiscal rule-based policy. Some of these inherent features include a distinction between hand-to-mouth or rule of thumb consumers and Ricardian consumers. In particular, we analyse cases where the fiscal multiplier is not zero which then makes fiscal policy effective in stimulating demand and therefore could justify the use of discretionary policy and thus cautions limits put on fiscal policy such as a single numeric structural budget balance rule target. Thus, deviating from a strict fiscal rule when required could be substantiated.

A New Keynesian DSGE model in the line of Smets and Wouters (2003) and Galí et al. (2007) is used to benchmark the empirical model. Most of the features are standard. Emphasis falls on the consumer's utility function and the monetary and fiscal policy rules. The rest of model's features are the same as in Smets and Wouters (2003) and some calibrated parameters are presented in the paper.

Households

Households are differentiated as Ricardian and rule-of-thumb households who consume their current income. The economy is populated by a continuum of households, or agents continuously distributed within the range of 0 to 1. Out of the measure 1 of households in the country, a fraction $1 - \lambda$ of the households have access to capital markets. We use the term *optimizing* or *Ricardian* to refer to that subset of households and we refer to them with an *o* superscript. The remaining fraction λ of households do not own any assets or liabilities and just consume their current labor income. We refer to them as *rule-of-thumb* households, with an *r* superscript. Ricardian households seek to maximise their expected discounted utility over consumption good C_t^o and leisure N_t^o .

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^o - hC_{t-1}^o)^{1-\eta_c}}{1-\eta_c} - \frac{(N_t^o)^{1+\eta_c}}{1+\eta_c} \right] \quad (1)$$

Where β is the subjective discount factor, η_c is the coefficient of relative risk aversion of households or the inverse of the intertemporal elasticity of substitution, η_n represents the inverse of the elasticity of work effort with respect to the real wage. The habit formation parameter h measures the importance of the reference level relative to current consumption.

In each period Ricardian households carry government bonds B_{t-1} from the previous period to the current period. Households receive the nominal profit or dividend payment D_t from the intermediate good firms. In addition, households receive their usual labour income $W_t N_t^o$ where W_t denotes the nominal wage. Households need to pay a lump sum tax T_t^o to the government. Therefore, the

Ricardian households maximise (2.1.1) subject to the following constraint:

$$C_t^o + K_t + \frac{B_t}{P_t} = \frac{W_t}{P_t}N_t^o + \frac{B_{t-1}(1+i_{t-1})}{P_t} + \frac{D_t}{P_t} - \frac{T_t^o}{P_t} + (1-\delta)K_{t-1} \quad (2)$$

After solving the standard first order conditions and log-linearizing around the steady state we have the consumption Euler equation, whereby when $h=0$, this equation reduces to the traditional forward-looking consumption equation:

$$c_t^o = \frac{h}{h+1}c_{t-1}^o + \frac{1}{h+1}E_t c_{t+1}^o - \frac{1-h}{(1+h)\eta_c}r_t \quad (3)$$

The rule-of-thumb households do not smooth their consumption over time when income fluctuates and they do not intertemporally substitute when interest rates change and therefore have a binding borrowing constraint. This might be a consequence of a direct choice not to hold bonds or equities or capital, or it might be the consequence of not being able to do so. Their period utility is given by

$$U(C_t^r, L_t^r) \quad (4)$$

subject to

$$C_t^r = \frac{W_t}{P_t}N_t^r - \frac{T_t}{P_t} \quad (5)$$

which equates consumption to labour income net of taxes.

Total consumption is aggregated as

$$C_t = \lambda C_t^r + (1-\lambda)C_t^o \quad (6)$$

where λ is the share of rule-of-thumb households in the economy. The size of λ determines whether aggregate consumption responds positively given a government spending shock. A larger λ will have consumption increase when the government expands.

We relied on two methods to gauge the overall size of λ . The first unsuccessful approach involves surveying the literature on Ricardian equivalence for South Africa. The literature in South Africa is fairly scant. One such study by Mathfield (2006) invalidates the Ricardian Equivalence Theorem for South Africa. This unsatisfactory method leads us to test how the model reacts to different values of λ . One way to gauge the size of λ is to use the SVCEM result on the impact of government spending shock on consumption and use these results to calibrate λ in the DSGE framework. One caveat is that the idea of gauging λ from empirical data is not completely developed. The rest of the model equations (log linearised) that relates to labour supply, investment and capital accumulation decisions and firms' price setting behaviour follow Smets and Wouters (2003).

Monetary Policy

The model is closed by assuming that the monetary authority follows a Taylor-type interest rate rule. That is, the monetary authority adjusts its instrument, the short-term interest rate, in response to deviations of output and

inflation from their steady-state levels. The log-linearized Taylor rule is written as:

$$\dot{i}_t = \varkappa_i \dot{i}_{t-1} + (1 - \varkappa_i)(\varkappa_\pi \pi_t + \varkappa_y y_t) + \zeta_{i,t} \quad (7)$$

Fiscal rule

The government's budget constraint is given by

$$\frac{G_t}{P_t} + \frac{\dot{i}_t B_{t-1}}{P_t} = \frac{T_t}{P_t} + \frac{B_t - B_{t-1}}{P_t} \quad (8)$$

Government debt and expenditures are only defined as deviations from steady state. The fiscal rule is defined in the form of:

$$t_t = \varphi_b b_t + \varphi_g g_t \quad (9)$$

where both ϕ_g and ϕ_b are positive. Government purchases (in deviations from steady state) are assumed to follow a first order autoregressive process:

$$g_t = \rho g_{t-1} + \varepsilon_t \quad (10)$$

where $0 < \rho < 1$ and ε represents and i.i.d. government spending shock with a constant covariance.

2.2 A structural vector error correction model (SVECM)

The data generating process of the variables can be expressed as a VECM with cointegrating rank (r) in the form of:

$$\Delta y_t = \alpha \beta^t y_{t-1} + \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t \quad (11)$$

All the symbols have their usual meaning where y_t is a K dimensional vector of observable variables, α is a $K \times r$ matrix of loading coefficients, β is the $K \times r$ cointegrating matrix, Γ_j is a $K \times K$ short-run coefficients matrix for $j = 1, \dots, p-1$, and u_t is a white noise error vector with $u_t \sim N(0, \Sigma_u)$. We can re-write equation (2.2.1) in the Beveridge-Nelson MA representation:

$$y_t = \Xi \sum_{i=1}^t u_i + \sum_{j=0}^{\infty} \Xi_j^* u_{t-j} + y_0^* \quad (12)$$

Where Ξ_j^* is absolutely summable so that the infinite sum is well defined and y_0^* contains all the initial values. This means that Ξ_j^* converges to 0 as j tends to infinity. The long run effects of shocks are thus captured by the common trends term $\Xi \sum_{i=1}^t u_i$. To identify the structural innovations we are looking for a matrix B that satisfies $u_t = B \varepsilon_t$ with $\varepsilon_t \sim (0, I_k)$. Substituting this relationship in the common trends term gives $\Xi B \sum_{i=1}^t \varepsilon_i$. Thus the long run effects of the structural

shocks are given by ΞB . Given that B has to be non-singular, there can at most be r zero columns in the long run matrix. Thus r can have transitory shocks while $K - r$ must have permanent shocks. For the local identification of the structural shocks in B we need $K(K - 1)$ restrictions. Assuming that there are r shocks with transitory effects, and $K(K - r)$ restrictions from the cointegrating structure of the model, which leaves us with $K(K - 1)/2$ restrictions for just-identifying the structural innovations. $r(r - 1)/2$ contemporaneous restrictions are necessary to disentangle the transitory shocks and $K(K - r)((K - r)$ to identify the permanent shocks. This gives us a total of $1/2K(K - 1)$ restrictions. It is important to identify these restrictions locally and $r(r - 1)/2$ restrictions need to be imposed on B directly.

The Johansen test for cointegration suggests that there is at most three cointegrating relationships (see Table 4 for the results). The lag length criterion was not chosen to satisfy certain information criteria. Rather, a top-down approach is employed to eliminate any unnecessary parameters (Lütkepohl, 2005). Table 1 shows the estimates of a stabilisation rule and a solvency rule. Legrenzi and Milas (2012) show that when the long run relationship between taxes and government expenditure has an estimate of 1, then government is generally solvent.

The variables in the base case VECM are ordered as inflation, taxes, GDP, imputed interest rate¹ and government expenditure $[\pi_t, T_t, Y_t, i_t, G_t]$, we impose the following restrictions:

$$B = \begin{bmatrix} * & * & * & * & * \\ * & * & * & 0 & * \\ * & * & * & * & * \\ * & * & * & * & * \\ * & 0 & 0 & 0 & * \end{bmatrix}, \Xi B = \begin{bmatrix} * & 0 & * & 0 & 0 \\ * & 0 & * & 0 & 0 \\ * & 0 & * & 0 & 0 \\ * & 0 & * & 0 & 0 \\ * & 0 & * & 0 & 0 \end{bmatrix}$$

The three zero columns in the long run matrix is identified from the cointegrating analysis. This means that there is no long run effect from our policy variables (G, T, and i) on any of the variables in the system. Four more restrictions are necessary to just identify the model since $r(K - r) = 6$ linearly independent restriction in the long run matrix, $K(K - 1)/2 - r(k - r) = 4$ restrictions are still to be defined. We impose zero contemporaneous restrictions for (T, Y and i) on G and a zero contemporaneous restriction for T on i which is in line with Perotti (2005).

The open economy SVECM is the base case economy version augmented with a UIP condition. The variables are ordered as $[\pi_t, T_t, Y_t, i_t, i_{tforeing}, FX_t, G_t]$ where FX is the real effective exchange rate. The following restrictions

¹See Table 2 for variable description

are imposed:

$$B = \begin{bmatrix} * & * & * & * & * & * & * \\ * & * & * & 0 & 0 & * & * \\ * & * & * & * & 0 & * & * \\ * & * & * & * & * & * & * \\ * & * & * & * & * & 0 & * \\ * & 0 & * & * & * & * & * \\ * & 0 & 0 & 0 & 0 & 0 & * \end{bmatrix}, \Xi B = \begin{bmatrix} * & 0 & * & 0 & 0 & * & 0 \\ * & 0 & * & 0 & 0 & * & 0 \\ * & 0 & * & 0 & 0 & * & 0 \\ * & 0 & * & 0 & 0 & * & 0 \\ * & 0 & * & 0 & 0 & * & 0 \\ * & 0 & * & 0 & 0 & * & 0 \\ * & 0 & * & 0 & 0 & * & 0 \end{bmatrix}$$

The restrictions again imply that the policy shocks do not have a long run impact on any of the variables. Again zero contemporaneous restrictions are imposed for government shocks as in the closed economy version. Both domestic and foreign interest rates do not affect taxes contemporaneously and the exchange rate has no contemporaneous impact on foreign interest rates.

The different schools of thought (in particular Keynesian and New Classical) are pretty much in agreement in terms of the sign of the impact of a government shock on output (Fatas et al. (2001)). However, the stark differences between the different schools arise in the analysis of consumption. The SVECM is augmented with consumption to analyse the overall effects of a government shock on consumption. As in Fatas et al. (2001) we also use different types of government expenditures to trace the effects on output. The vector of variables are $[\pi_t, T_t, Y_t, i_t, Ct, GX_t]$, where GX is either total government consumption, government non-wage consumption and government investment.

2.3 A time varying parameter (nonlinear) vector autoregression (TVP-VAR)

Given the time varying nature of fiscal policy, it is natural to ask how the evolution of fiscal policy has affected output. Time varying impulses allows us to study the evolution of fiscal shocks to the economy which could possibly assist us in understanding the circumstances under which fiscal policy seems to be most effective. The estimation of time varying impulses also allows us to analyse whether fiscal policy makers are improving in making fiscal decisions and whether households expect an expanding government today will increase future taxes. For this purpose, the paper estimates a time varying structural VAR, where time variation comes from both the parameters and the variance covariance matrix of the model's innovations. This reflects simultaneous relations among variables of the model and heteroscedasticity of the innovations (Primiceri, 2005). To accomplish this, a Monte Carlo Markov Chain algorithm is used to estimate the coefficients and the multivariate stochastic volatility.

Estimating time variation is a pretty well developed field (see Sims (1993), Stock and Watson (1996) and Cogley and Sargent (2001)). However, these studies impose restrictions on the variance covariance matrix that is supposed to evolve over time. Most of these models are limited to reduced form models that are usable only for data description and forecasting (Primiceri, 2005).

With drifting coefficients one essentially also captures the learning process. The drifting coefficients are meant to capture possible nonlinearities or time variation in the lag structure of the model. The multivariate stochastic volatility is meant to capture possible heteroscedasticity of the shocks and nonlinearities in the simultaneous relations among the variables of the model.

The basic modelling structure follows Primiceri (2005). Start with the following model:

$$y_t = c_t + B_{1,t}y_{t-1} + \dots + B_{k,t}y_{t-k} + u_t \quad (13)$$

where y is an $nx1$ vector of observed endogenous variables, c is an $nx1$ vector of time varying coefficients that multiply constant terms, B is an nxn matrix of time varying coefficients and u are heteroskedastic unobservable shocks with variance covariance matrix Ω . The triangular reduction of Ω is defined by:

$$A_t \Omega_t A_t' = \sum_t \sum_t' \quad (14)$$

where A is the lower triangular matrix

$$A_t = \begin{bmatrix} 1 & 0 & \dots & 0 \\ \alpha_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ \alpha_{n1,t} & \dots & \alpha_{nn1,t} & 1 \end{bmatrix}$$

And Σ_t is the diagonal matrix

$$\sum_t = \begin{bmatrix} \sigma_{1,t} & 0 & \dots & 0 \\ 0 & \alpha_{2,t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_{n,t} \end{bmatrix}$$

It follows that

$$y_t = c_t + B_{1,t}y_{t-1} + \dots + B_{k,t}y_{t-k} + A_t^{-1} \sum_t \varepsilon_t \quad (15)$$

Stacking in a vector B all the right hand side coefficients can be rewritten as:

$$\begin{aligned} y_t &= X_t' B_t + A_t^{-1} \sum_t \varepsilon_t \\ X_t' &= I_n \otimes [1, y_{t-1}', \dots, y_{t-k}'] \end{aligned} \quad (16)$$

The dynamics of the model's time varying properties are specified as random walks:

$$\begin{aligned} B_t &= B_{t-1} + v_t, \\ \alpha_t &= \alpha_{t-1} + \zeta_t, \\ \log(\sigma_t) &= \log(\sigma_{t-1}) + \eta_t \end{aligned} \quad (17)$$

The innovations are assumed to be jointly normally distributed while assuming the following for the variance-covariance matrix:

$$V = Var \left(\begin{bmatrix} u_t \\ v_t \\ \zeta_t \\ \eta_t \end{bmatrix} \right) = \begin{bmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix}$$

Here I_n is an identity matrix while Q, S and W are positive definitive matrices and S being block-diagonal, with blocks corresponding to parameters belonging to separate equations. Furthermore it is assumed that Q, W and S take on an Inverse-Wishart prior distribution which is the conjugate prior for the covariance-variance matrix of a multivariate normal distribution. To reduce the number of parameters in the model, we restrict the model to include only three variables – output, interest rates and government expenditure. This is in line with the model of Du Plessis et al. (2007). The choice of the zeros in the off diagonal matrix in V is to reduce the numbers of parameters required to be estimated while also avoiding having to pick priors for them to ensure that those parameters are not ill-determined. The standard deviations σ_t are assumed to evolve as random walks. This presents an advantage of focussing on permanent shifts and reducing the number of estimated parameters in the estimation procedure (Primiceri, 2005). The first seven years are used to calibrate the prior distributions. The mean and the variance of B and A are OLS point estimates and four times its variance. The normal prior on B is taken from the literature (Primiceri, 2005). In the same vein we follow Primiceri (2005) (and references within) in assuming a log-normal prior for σ_t . Degrees of freedom and scale matrices are needed for Q, S and W. For Q the degrees of freedom are set to 28 which is the size of the initial subsample while W and S1 and S2 are set to 4, 2 and 3 respectively. The scale matrices are set as a constant fraction of the variances of the OLS estimates in the initial subsample. The result of the paper are obtained by assuming the following values; $k_Q = 0.01$, $k_S = 0.1$, $k_W = 0.01$. These priors are uninformative and tells us about the amount of time variation. Large values for K would imply more time variation. These are summarised as follows:

$$\begin{aligned} B_0 &\sim B(\hat{B}_{OLS}, 4 * V(\hat{B}_{OLS})) \\ A_0 &\sim N(\hat{A}_{OLS}, 4 * V(\hat{A}_{OLS})) \\ \log \sigma_0 &\sim N(\log \hat{\sigma}_{OLS}, I_n) \\ Q &\sim IW(k_Q^2 * 27 * V(\hat{B}_{OLS}), 27) \\ W &\sim IW(k_W^2 * 4 * I_n, 4) \\ S_1 &\sim IW(k_S^2 * 2 * V(\hat{A}_{OLS}), 2) \\ S_2 &\sim IW(k_S^2 * 3 * V(\hat{A}_{OLS}), 3) \end{aligned}$$

3 Results

In this section, we first discuss the theoretical results of the DSGE model and we compare its findings with the empirical specifications discussed in the previous

section. More specifically, we estimate the effects of government spending and tax shocks in the structural vector error correction model (SVECM). Then we introduce some time variation in the impulse responses by estimating the small nonlinear VAR which enables us to distinguish between the impact of shocks in different regimes and periods.

For the empirical models of Sections 2.2 and 2.3, we use South African seasonally adjusted data for the period 1970:Q1-2010Q4. The data used are general government expenditure and taxes per capita, GDP per capita, an imputed measure of interest rates on debt, inflation measured as the annual change in the consumer price index and household consumption. All the data are in quarterly format and logs are used except for inflation and interest rates (a full description of sources and data transformations are shown in Table 2). Augmented Dickey-Fuller tests are provided in Table 3 and the results show that all the variables are $I(1)$.

3.1 Dynamic Stochastic General Equilibrium model

The DSGE model is calibrated to South African data² Since there is no direct measure for the share of Ricardian versus rule of thumb households for South Africans, the share is changed to observe how both output and consumption changes. The SVECM impulse response is then used to gauge the share of Ricardian households This is done by attempting to replicate the impulse responses of the VECM in the DSGE model by changing the size of lambda. Figures 3 shows the impact responses of consumption, interest rates and output to a one per cent unit change in the innovation of government spending in equation (2.1.10) given three assumptions regarding the share of rule of thumb households (shares equal 0.8, 0.5 and 0.1, respectively). In the presence of a small share of Ricardian households, aggregate consumption increases due to the large response in rule-of-thumb households The consequence of the strong increase in consumption and government spending causes interest rate increases that are also more persistent. Output's response is close to unity which implies that fiscal policy has the potential to effectively stimulate demand. However, if the share of rule-of-thumb consumers decreased then aggregate consumption declines. Furthermore, inflation and interest rates are also less responsive with the low share scenario. Output responses decline as the shares decline.

The results clearly show the importance of liquidity constrained consumers in analysing fiscal shocks. With South Africa being a developing country with a large share of the population in poverty, it is important to keep the economy afloat in the midst of adverse economic shocks. The empirical results seem to indicate that South Africa has indeed a large share of liquidity constrained consumers that are unable/unwilling to save given extra income. Since it is difficult to measure the share of Ricardian consumers, the empirical approaches

²Most of the parameters' values are borrowed from Liu and Gupta (2007), in which the author estimates a similar medium-size New Keynesian model of Smet and Wouters (2003) on South African data. This includes the value of lambda. See Table 5 for parameter values.

that follow from Sections 2.2 and 2.3, uses aggregate consumption to ascertain the impact of fiscal responses.

3.2 Structural vector error correction model (SVECM)

The first set of results report the baseline SVECM. Figure 4 shows the baseline scenario that an increase in government expenditure increases GDP per capita by more than one per cent.³ The maximum impact is reached after three quarters. Over the long run, the effect of an increase in expenditure on GDP per capita is virtually zero.

Conversely, Figure 5 shows that an increase in taxes clearly distorts GDP per capita. The impact on GDP reaches a minimum over four quarter. These results also need to be interpreted with some caution; the effects of say an increase in progressive personal income tax on GDP might not have large social costs as the lower ends of the income distribution is unaffected, but will still impact GDP negatively. The impact of an increase in company taxes might see investment opportunities shift to different countries.

The second set of results in Figures 6 and 7 is drawn from the extended SVECM that includes total household consumption. An important result is the impact of government expenditure on interest rates. Often, when monetary policy does not accompany a fiscal expansion, a fiscal expansion raises interest rates which could crowd out investment. Studies such as Gupta and Uwilingiye (2009) show this effect albeit on high frequency data. An increase in government expenditure increases interest rates by a maximum 0.35 percentage points. This result is consistent with the DSGE model.

The effect on output is still similar to the base line case as well as the DSGE model. Aggregate consumption increases by a maximum 0.7 when government spending increases but is reduced by 0.9 given a total tax shock. These results seem to suggest that households in South Africa are generally not Ricardian.

Just to address other issues, we use the empirical model multipliers changes in the case where the model includes open economy dynamics such as an uncovered interest parity condition. An opening up of the economy effectively reduces the size of the fiscal multiplier. A quick and dirty calculation of the fiscal multiplier that include tax rates, the marginal propensity to consume and the marginal propensity to import can be calculated as: $\Delta Y = \Delta G * \frac{1}{1 - MPC * (1 - \tau) + MPI}$. This identity shows that the marginal propensity to import reduces the effect

³To obtain the fiscal responses as in Figure 3-7 we rescale the impulses on growth by dividing it by the mean of the standard deviation of the shocked variable's own impulse and multiplied it by the inverse of the ratio of the observed variable that you wanted to shock and the variable affected:

$$\frac{\partial \varepsilon_{t,y,j}}{\frac{\sum_{i=0}^n (\partial \varepsilon_{t,j,j}) - E(\partial \varepsilon_{t,j,j})^2}{n-1}} \frac{1}{G_t}$$

The major advantage of this transformation is that the responses of output to the fiscal shocks can be interpreted as (non-accumulated) multipliers. We use bootstrap methods to obtain the standard errors or confidence bands. We extract the confidence bands using 20 and 80 percent quintiles.

government has on stimulating the domestic economy (which could explain the smaller multiplier when compared to the baseline case). This simple identity shows that the fiscal multiplier is close to 0.77 when we assume a MPC of 0.97, a MPI of 0.99 and a tax rate of 0.3. The maximum impact is now only reached five quarters from impact and is as big as 0.6 per cent (see Figure 7). The response of per capita GDP to a tax shock remains similar to the previous output.

When an increase in government expenditure is associated with an increase in the demand for foreign goods then the real exchange rate will depreciate which is in line with the Mundell-Flemming framework. However, it should be noted that proper counter-cyclical fiscal policy should have close to no direct effect on the exchange rate (Clarida and Prendergast, 1999). When there is an output gap and inflation is low, government expansion should have little impact on exchange rates and rather perceptions on sustainable fiscal policy could see an inflow of bonds which could depreciate the currency.

Finally, for robustness reasons, total government expenditure is replaced by government consumption, government consumption on non-wages and government investments. Figure 8 show that government investment has the largest impact on output and consumption. This should not be surprising as it is assumed that government investment can complement private investment in the form of private public partnerships.

3.3 Time varying parameter (nonlinear) vector autoregression (TVP-VAR)

The results from the time varying VAR tell an interesting story. Figure 9 shows the impact of fiscal shocks for various periods (1994, 1999, 2007, 2008 and 2009). Prior to 2000 South Africa mainly had a procyclical fiscal stance (Du Plessis et al., 2007). The pre 2000 period had multipliers slightly less than one and took five quarters to have a maximum impact on the economy. The periods in which the multipliers were the strongest was in the build up to the crisis, 2007 and 2008. During these years South Africa run budget surpluses not seen since 1990. An expansionary fiscal shock during this period also had longer and far reaching effects (the area under the curve is higher). However, any additional increase in fiscal expenditure onwards would have contributed less to stimulating demand and its impact on the economy would have been significantly shorter than other periods. Some plausible explanations for this could be that households become more aware of a growing fiscal deficit and hence higher debt and debt service costs that they start to save more. In essence, it could very well be that non-Ricardian households become slightly more Ricardian as fiscal shocks continue. Or, households' habits don't change where questions about whether the additional income is structurally higher or that households are not accustomed to changing consumption behaviour and hence save more. Another explanation is that the degree of crowding out is nonlinear and time varying. When continued fiscal shocks hit the economy and replace firms' investment decisions then crowding out effects grow over time which limits the extent to which firms can reinvest in the economy.

4 Conclusion

The size of fiscal multipliers is sensitive to many factors; the methodology, the identifying restrictions, structural changes in fiscal policy and the effectiveness of fiscal policy implementation. This study is the first one to analyse fiscal policy in a macroeconomic environment for the South African economy. Using different methodologies, this study shows that fiscal policy has been effective in stimulating both output and consumption. A closed economy typically yields larger multipliers which are in line with empirical findings, whereas an open economy reduces the multiplier. For South Africa, the multiplier is larger than one in countercyclical policy periods, indicating effective expenditure outcomes. However, the multiplier becomes less effective in periods where fiscal policy is procyclical. It clearly matters how liquid households are; the more they are able to save additional income, the lower the impact of a government shock to the economy. The time varying impulse responses show that government shocks have been effective in stimulating demand, however, persistent increases seem to reduce the effectiveness of spending.

The paper has a number of policy implications. Fiscal policy has contributed significantly in stimulating demand during the recent 2008/09 fiscal crisis. Hence the implementation of a fiscal rule as suggested in the 2011 South African Budget Review would have limited the extent to which fiscal levers could have been used during this period. Given that a large portion of South Africans are generally poor, good fiscal guidance can shield both individuals and companies from negative economic shocks. However, fiscal policy should continue to be conducted in a prudent countercyclical fashion, primarily saving in good times and spending in bad times. The results of the 2009 impact also suggest that fiscal policy can only be used for a short period of time to stimulate aggregate demand and that fiscal policy makers should be mindful of not overextending the duration of deficits or continuously increasing it. A suggestion for future research would be to study the impact of fiscal shocks when deviating from a fiscal rule.

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Table 1
Fiscal rules

Stabilisation	Solvency
$Y_t=0.973G_t$	$T_t=1.147G_t$

Table 2
Data description

Variables	Source:	Transformation
GDP	South Africa Reserve Bank	
Population estimates	Quantec	Linear interpolation
Interest rate	South Africa Reserve Bank	Debt service costs/debt*100
Inflation	Statistics South Africa	Y-O-Y growth of CPI
General government expenditure	South Africa Reserve Bank	
General government taxes	South Africa Reserve Bank	
Household consumption	South Africa Reserve Bank	

Table 3
Stationarity tests

Variables	ADF-levels (P-values)	ADF-difference(P-values)
GDP	0.91	0.000
Population estimates	0.68	0.484
Repo rate	0.17	0.000
Inflation	0.16	0.000
General government expenditure	0.79	0.000
General government taxes	0.69	0.000

Table 4
Johansen's cointegrating analysis

Rank	LR	P-values
0	243.3	0.000
1	111.0	0.000
2	51.51	0.005
3	15.9	0.507
4	4.9	0.612

Table 5
Calibrated parameters

Habit formation (H)	0.7
Fraction of R-O-T households	0.2 , 0.5, 0.8
Steady state ratio of G expenditure to output	0.26
Steady state ratio of G expenditure to G debt	4.33
Steady state ratio of taxes to G expenditure	3.33
Φ_b	0.4
Φ_g	0.1
P_g	0.9

Fig. 1. Simple multiplier calculation

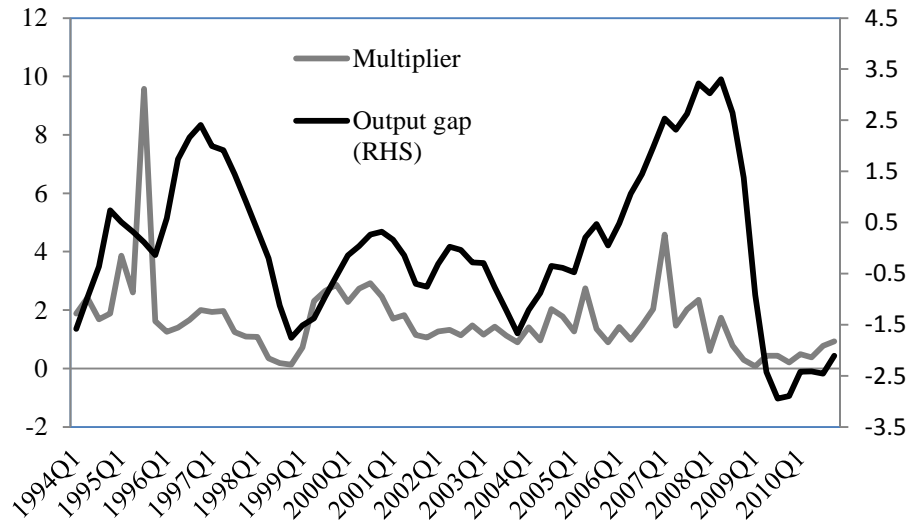


Fig. 2. Government expenditure

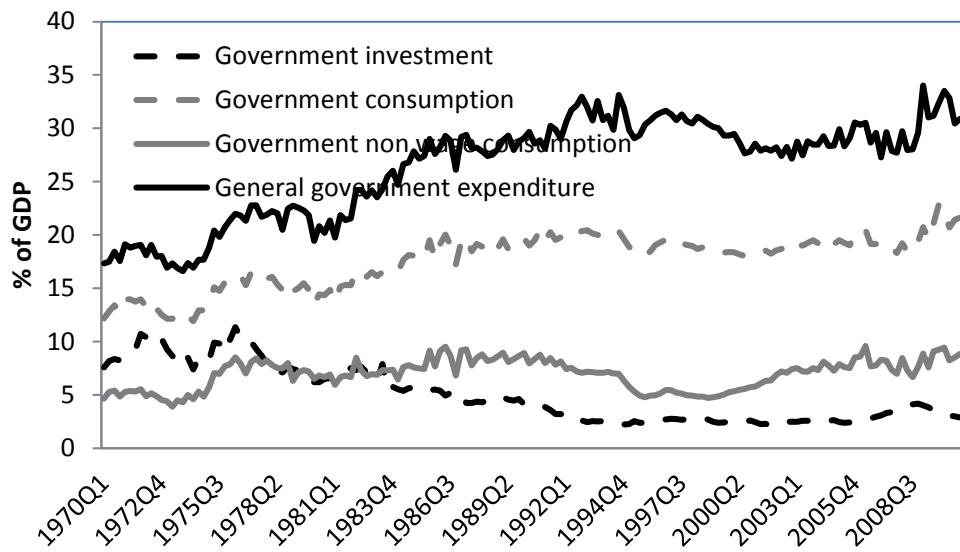


Fig. 3. Different rule of thumb consumers

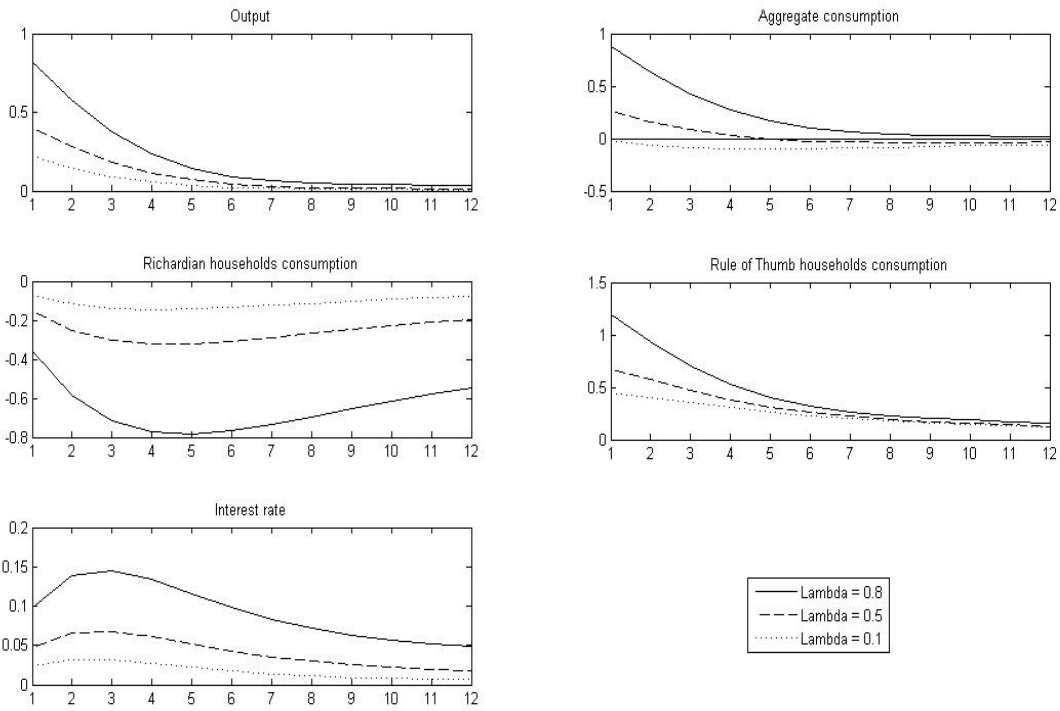


Fig. 4. Baseline SVECM: Government expenditure and tax shocks shock

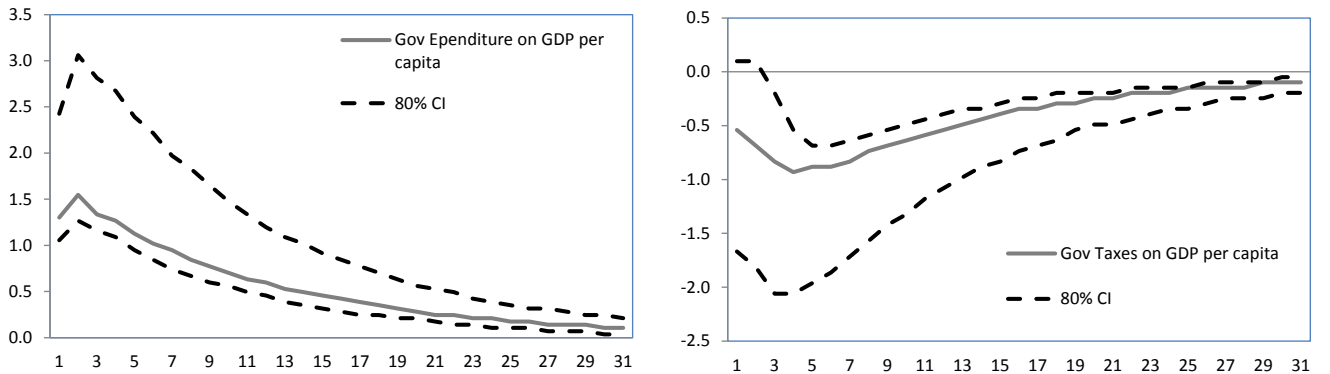


Fig. 5. Baseline SVECM: Total general tax shock

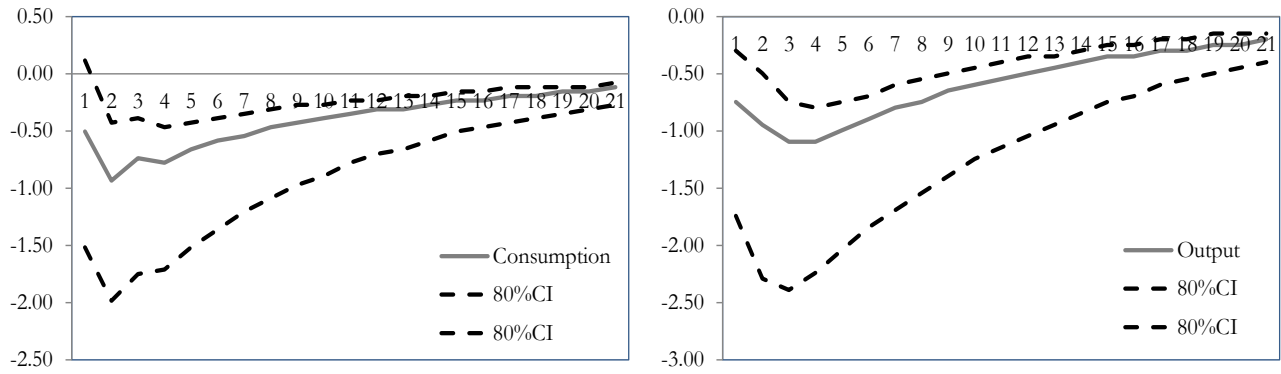


Fig. 6. Consumption in the SVECM: Government expenditure shock

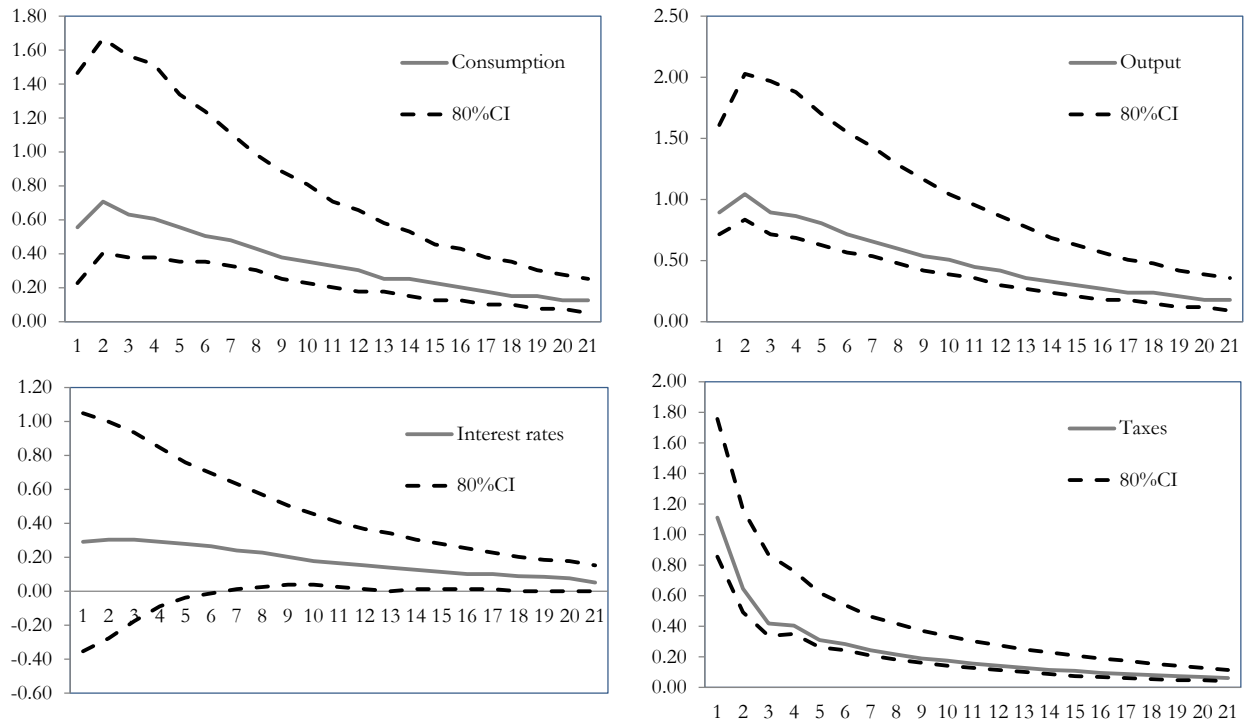


Fig. 7. Output responses in an open economy

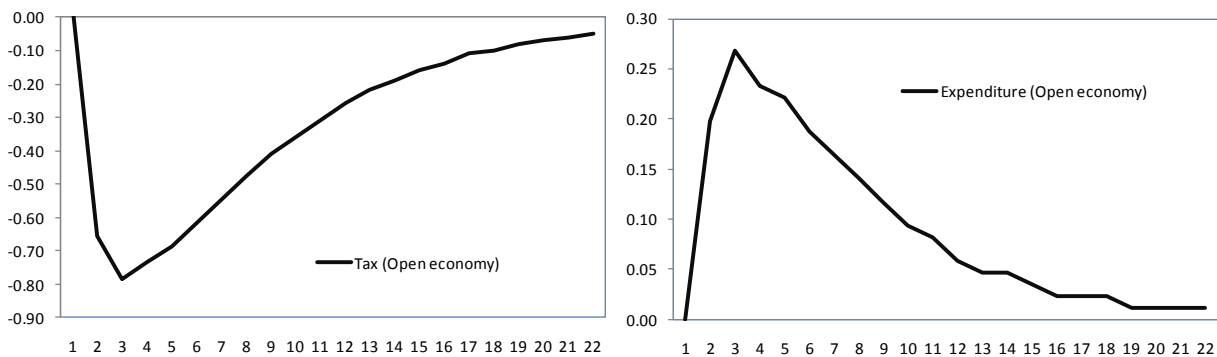


Fig. 8. Alternative government shocks

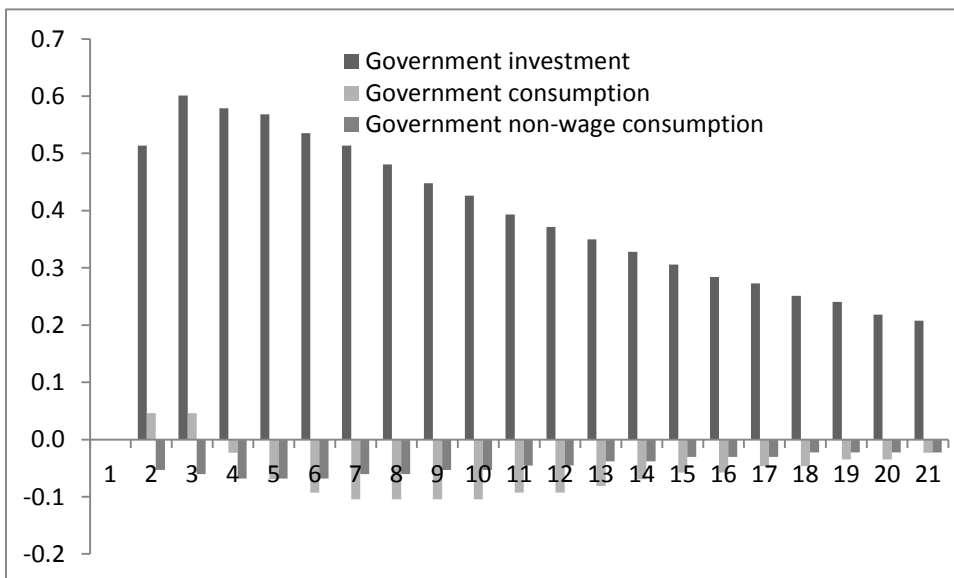


Fig. 9. Nonlinear Time Varying impulse responses

