THE EFFECTS OF FISCAL POLICY ON OUTPUT AND DEBT SUSTAINABILITY IN THE EURO AREA: A DSGE ANALYSIS*

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(preliminary version)

Abstract

This paper examines the effects of fiscal policy on output and debt sustainability in the euro area. For this purpose we develop a DSGE Fiscal Model with endogenous government bond rates to assess the impact of different fiscal policy shocks on output, its components and on government debt. The simulations suggest that fiscal policy is effective in supporting activity, especially in the short-term. In particular, the largest fiscal multipliers are found for an increase in public investment, public consumption and a cut in the tax wage. The results are robust to different parameter calibrations and are economically significant. Using this framework, the fiscal stimulus injected in the euro area economies to cushion the economic downturn in the first half of 2009 is found to boost GDP by 0.8 % in 2009 and 0.6 % in 2010. Public debt as a per cent of GDP would rise by 1.8 percentage points in 2010.

Keywords: Fiscal policy, Output, Debt sustainability, DSGE.

JEL: E62, H10.

* We are grateful to Jonathan Coppel, Peter Hoeller, Marcos Poplawski Ribeiro, David Turner, Douglas Sutherland Lukas Vogel, and the participants of the OECD Economics Seminar (Paris, April 2009) , of the IMF workshop on Fiscal Multipliers (Washington, May 2009) and of the European System of Central Banks Working Group on Public Finance (Cyprus, July 2009) for helpful comments and discussions.
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1. Introduction

The severity of the global economic downturn coupled with weakened monetary policy transmission channels has prompted the extensive use of discretionary fiscal policy to support demand in many countries. Fiscal packages have varied in their size and their composition (OECD, 2009), yet there is little evidence in the literature on the effectiveness of fiscal policy at times of crisis[1], and in the current economic environment it is even scarcer.[2] The impaired functioning of financial markets, strongly accommodative monetary policy and heightened uncertainty are likely to alter the fiscal policy impulse on economic activity. At the same time, a high level of borrowing may bear on sovereign bond interest rates and crowd out private demand. These factors are hard to quantify in the current circumstances, making it difficult to assess the effectiveness of fiscal policy as measured by the so-called fiscal multipliers.

While there have been attempts to investigate the effect of fiscal policy in situations where financial markets are impaired in a DSGE framework (e.g. Röger and in't Veld, 2009), no work to our knowledge has tried to analyse the trade-off between the effects of expansionary fiscal policy on economic activity and the increase in government bond premia, which may crowd out public investment and consumption and lead to unsustainable debt levels. The analysis undertaken in this paper seeks to fill this gap. To this end, we model government bond rates as a function of fiscal positions. Modeling explicitly government bond rates during financial crises is particularly important for two reasons. First, the difference between short-term and long-term policy rates is more marked in times of financial crises (OECD, 2009). Second, financial crises are often characterised by a large increase in the fiscal deficit and debt levels, reflecting the associated

1. See, for example, IMF (2008).
2. Some examples are OECD Interim Economic Outlook (2009) and IMF World Economic Outlook (2009).

output losses and discretionary fiscal policy responses, but also marked rises in government risk premia (Reinhart, 2009).

The model draws extensively on pre-existing DSGE models on a number of aspects (Smets and Wouters, 2003; Ratto *et al.*, 2009). In particular, it considers a large closed economy with monopolistic product markets, a heterogeneous household sector with Ricardian and liquidity-constrained households, investment adjustment costs, prices and real wage persistence.

Simulations are performed for a variety of fiscal instruments (government consumption, government investment, transfers, consumption taxes, taxes on wages and capital).

The key results of the paper are:

- Fiscal policy appears to be an effective tool to boost demand in the short-term , despite the associated rise in government bond spreads increase in response to a fiscal stimulus, that crowds out interest-sensitive demand components.
- The GDP impacts of fiscal policy vary across instruments. The largest short-term effect on GDP is found for an increase in public investment. A rise in public consumption also appears to sustain activity significantly, while a transfer to liquidity-constrained households has a more limited impact. Tax cuts would be in general less effective is supporting demand than spending measures. Among taxation measures, the strongest effects are attached to a cut in wage taxes.
- The euro area fiscal package introduced in the first half of 2009 in response to the financial crisis is found to boost GDP by 0.8 percentage point in 2009 and by 0.6 percentage point in 2010. Public debt would rise by 1.8 percentage points in 2010.

The rest of the paper is organised as follows. Section two describes the main features of the DSGE model. Section three examines the consequences of a government consumption shock.

Section four discusses fiscal policy simulations using a range of policy instruments on the spending and revenue sides. Section five presents an estimate of how the 2009 fiscal package introduced in the euro area countries affects activity, inflation and public finances. Finally, section six concludes.

2. The model

This section lays out the micro-economic foundations of the model used to perform several policy simulations. The behaviour of the different agents is examined in turn, before analysing monetary and fiscal policies. Contrary to most existing DSGE models, government bond rate developments are treated as endogenous and depend *inter alia* on the country's fiscal position.

2.1 Firms

The firm sector is composed of *n* monopolistic competitive final good producers. Each firm, indexed by *j*, produces one variety of good which is an imperfect substitute for the varieties produced by the competitors. The demand function for each firm is:

$$Y_t^j = \left(\frac{P_t}{P_t^j}\right)^{\sigma} \left(C_t + G_t^d + I_t^d + I_t\right) \tag{1}$$

where C is the consumption of private households, G_t^d is government consumption, I_t^d government investment and I private investment. σ is the elasticity of substitution between different varieties of goods, P represents the price index of the final output and P^j the price set by the individual firm *j*.

Output is produced with a Cobb-Douglas production function using private capital (*K*), public capital (K^g) and labour (*L*):

$$Y_t^j = \left(ucap_t^j \; K_t^j\right)^{\alpha} \left(L_t^j\right)^{1-\alpha} \left(K_t^g\right)^{\alpha_g} \tag{2}$$

where firms choose the degree of capital utilisation ($ucap_t$).

The objective of each firm is to maximise the present discounted value of profits given the technological constraint described in equation (2). The profits for each firm are:

$$Pr_t^j = \frac{P_t^j}{P_t} Y_t^j - \frac{W_t}{P_t} L_t^j - i_t^k K_t^j - \frac{1}{P_t}\left(adj^P + adj^{ucap}\right) \tag{3}$$

where (i^k) represents the rental rate on capital. Price adjustment costs measure menu costs and are assumed to be a quadratic function of price changes. In addition, capital utilisation adjustment costs representing technologically and regulatory constraints evolve following a quadratic function:

$$adj^P = \frac{1}{P_{t-1}^j}\left(\frac{\gamma_P \Delta P_t^{j\,2}}{2}\right) \tag{4}$$

$$adj^{ucap} = P_t K_t \left(\gamma_{ucap,1}\left(ucap_t^j - 1\right) + \frac{\gamma_{ucap,2}}{2}\left(ucap_t^j - 1\right)^2\right) \tag{5}$$

Each firm optimises its inputs given the technology constraint and demand for their products. The first order conditions are given by:

$$\frac{\partial Pr_t^j}{\partial L_t^j} = 0 \rightarrow \frac{W_t}{P_t} = (1-\alpha)\frac{Y_t^j}{L_t^j}\mu_t^j \tag{6}$$

$$\frac{\partial Pr_t^j}{\partial K_t^j} = 0 \rightarrow i_k^t = \alpha \frac{Y_t^j}{K_t^j}\mu_t^j \tag{7}$$

$$\frac{\partial Pr_t^j}{\partial ucap_t^j} = 0 \rightarrow \gamma_{ucap,1} + \gamma_{ucap,2}\left(ucap_t^j - 1\right) = \alpha \frac{Y_t^j}{ucap_t^j K_t^j}\mu_t^j \tag{8}$$

$$\frac{\partial Pr_t^j}{\partial Y_t^j} = 0 \rightarrow \frac{1}{1-\sigma} - \gamma_P\left[\beta_t E_t\left(\pi_{t+1}^j\right) - \pi_t^j\right] = \mu_t^j \tag{9}$$

where μ_t^j is the Lagrange multiplier associated with the technological constraint. According to equation 6, the marginal product of labour (net of marginal adjustment costs) is equal to real wage costs. Equation 7 gives the optimal capital stock given the rental price of capital. Combining (6) and (7) give the employment and the marginal cost of production equations:

$$L_t^j = \frac{1-\alpha}{\alpha} \frac{i_k^t}{W_t} K_t^j \quad (10)$$

$$\mu_t^j = mc = \left(\frac{i_k^t}{\alpha}\right)^{\alpha} * \left(\frac{w_t}{1-\alpha}\right)^{1-\alpha} \quad (11)$$

Equation 8 determines the optimal level of capital utilisation by equating the marginal product of capital services to the marginal cost of increasing capacity. The function describing the capital utilisation adjustment cost is convex, penalising accelerations and decelerations in capacity utilisation.

Equation 11 represents the marginal cost as a function of factor prices, and equation (9) links (expected) inflation and the inverse of the demand elasticity. Assuming that a fraction of firms exhibit some inertia in their price adjustment behaviour and price increases are indexed to past inflation, equation (9) becomes:

$$mc = \frac{1}{1-\sigma} - \gamma_P \left[\beta_t (sfp * \pi_{t+1}^j + (1-sfp) * \pi_{t-1}^j - \pi_t^j\right] \quad (12)$$

which represents a more general specification of the standard new-Keynesian Phillips curve.[3]

Finally, symmetry is assumed so that $P_t^j = P_t$.

2.2 Households

The household sector is composed of two groups of consumers $i \in [0,1]$. A share of these households maximise its intertemporal utility over an infinite planning horizon.

3. Similar specifications can be found in Ratto *et al.* (2009).

Unconstrained households, labelled $o \in [0, \omega]$, have full access to financial markets, and can buy and sell assets and transfer income over time.[4]

The second group consists of liquidity constrained consumers, $k \in [\omega, 1]$, who have no access to financial markets for intertemporal income transfers. As a consequence, they spend their disposable income entirely on current consumption (Gali *et al.*, 2004; Mourougane and Vogel, 2008; Ratto *et al.*, 2009).

The share ω is dertermined endogenously as a function of the output gap. The idea is that in times of a economic downturn, the share of liquidity-constrained households rises in line with output gap developments:

$$\omega = \gamma \, e^{gap} \qquad (12)$$

Where *gap* represents the output gap (in logarithm), which is assumed to be equal to zero in the steady state. γ is the share of un-constrained household and is equal to 0.75 in the steady state.[5]

The two groups of consumers differ in their ability to smooth consumption through intertemporal income transfers, but they are assumed to have an identical utility function. Households can consume and/or hold two types of assets: government bonds (B) and the stock of physical capital (K). Households seek to maximise the following objective function:

4. This assumption may be optimistic in the current situation characterised by insufficient bank lending and a rising number of credit-constrained households. These issues have been analysed in detail in Röger and in't Veld (2009).

5. This level is consistent with the share of Ricardian households estimated in the literature for the euro area (Coenen *et al.*, 2007).

$$V = E_o \sum_{t=0}^{\infty} \beta_t U\left(C_t^i, 1 - L_t^i\right) - E_o \sum_{t=0}^{\infty} \lambda_t \beta_t [(1 + t_t^c)\ C_t^i + I_t^i + \frac{B_t^i}{P_t} - \frac{(1+(1-t_t^k) ig_{t-1} B_{t-1}^i}{P_t} -$$

$$(1 - t_t^k) i_t^K K_{t-1}^i + T_t^b - (1 - t_t^w) \frac{W_t}{P_t} L_t - \sum_{j=1}^{n} PR_t^j] - E_o \sum_{t=0}^{\infty} \underset{t}{\xi}\ \beta_t (K_t^i - J_t^i - (1 - \delta) K_{t-1}^i)$$

(13)

where β is the discount rate, t^c the tax rate on consumption, t^k the tax rate on asset returns, t^w is the tax rate on wage income, ig the return on government bonds, T^b is a lump-sum tax.

The utility function is separable in consumption and leisure:

$$U\left(C_t^i, 1 - L_t^i\right) = ln(C_t^i - hC_{t-1}^i) + \varphi\ ln(1 - L_t^i) \tag{14}$$

With φ the elasticity of substitution between consumption and leisure, and h is the degree of habit persistence.

Investment adjustment costs are modeled by differentiating between real investment expenditure (I) and physical investment (J), which are related to each other by the following convex adjustment cost function:

$$I_t^i = J_t^i \left(1 + \frac{\gamma_K}{2} \left(\frac{J_t^i}{K_t^i}\right) + \frac{\gamma_I}{2} (\Delta J_t^i)^2\right) \tag{15}$$

where $J_t^i = K_t^i - (1 - \delta) K_{t-1}^i$ (16)

For the unconstrained households, the first-order conditions with respect to consumption and financial wealth (physical capital and government bonds) lead to the following equations:

$$\frac{\partial V}{\partial C} = 0\ \rightarrow \lambda_t = \frac{U_t^C}{1+t_t^c} \tag{17}$$

$$\frac{\partial V}{\partial B} = 0 \rightarrow \lambda_t = \beta_t E_t \left\{\lambda_{t+1} (1 + ig_t (1 - t_t^K)) \frac{P_t}{P_{t+1}}\right\} \tag{18}$$

$$\frac{\partial V}{\partial J} = 0 \ \rightarrow Q_t - 1 = \gamma_K \frac{J_t^i}{K_t^i} + \gamma_I \Delta J_t^i - \gamma_I \beta \Delta J_{t+1}^i \tag{19}$$

$$\frac{\partial V}{\partial K} = 0 \ \rightarrow Q_t = \frac{1-\delta}{1+ig_t} * Q_{t+1} + i_t^k \tag{20}$$

Equations (14) and (15) combined give the Euler equation, which determines the optimal consumption levels for Ricardian households, with U_t^C the marginal utility of consumption. Equation (19) expresses investment as a function of the real present discounted value of the rental rate (Q_t), which evolves according to equation (20).

Liquidity-constrained households simply consume their disposable income at each period. Their real consumption C_t^k is determined by either net wage income or unemployment benefits when the household does not work, and transfers.

$$(1 + t_t^c)\, C_t^k = (1 - t_t^w)\, w_t L_t^i + ub_t\left(1 - L_t^i\right) + TR_t \tag{21}$$

where *ub* represents the unemployment benefit and *TR* (social) transfers received by households, which are assumed to not being taxed.

Aggregate consumption is then defined as the weighted sum of consumption by the two types of households.

$$C_t = \omega C_t^o + (1 - \omega) C_t^k \tag{22}$$

2.3 Labour markets

Households within each group are identical and aggregate employment is given by $L = L_k = L_o$. Unions maximise a joint utility function, defined as a weighted average of the two different types of households. Following Ratto *et al.* (2009) real rigidities are introduced in the wage equation in the form of adjustment costs to change wages with γ_W the persistence parameter.

$$\frac{W_t}{P_t} = (1-\gamma_w)\frac{W_{t-1}}{P_{t-1}} + \frac{1}{\eta^w}\gamma_w \frac{1+t_t^c}{1-t_t^w}\frac{(\omega U_{L,t}^0 + (1-\omega)U_{L,t}^k)}{(\omega U_{c,t}^0 + (1-\omega)U_{c,t}^k)} \quad (23)$$

The real wage is thus defined as a mark up over the reservation wage. η^w is a mark-up factor which is determined by:

$$\eta^w = \left(1-\frac{1}{\theta}\right) - \frac{\gamma_w}{\theta}[\beta_t(\pi_{t+1}^w - (1-sfw)\pi_t) - (\pi_t^w - (1-sfw)\pi_{t-1})] \quad (24)$$

It fluctuates around the inverse of the elasticity of substitution between different varieties of labour services. Fluctuations arise because of wage adjustment costs and the fact that a fraction of workers index their wage demands to price inflation in the previous period.

2.4 Economic policies

Fiscal and monetary policies are partly rule-based and respond to the output gap.

Output gap

Following Ratto *et al.* (2009), the output gap is constructed by reference to the steady-state inputs levels. This measure closely approximates standard output gap calculations such as production function-based measures used for fiscal surveillance and monetary policy decisions (see Denis *et al.*, 2002). In particular, the output gap is defined as follows:

$$GAP_t = \left(\frac{ucap_t}{ucap_t^{ss}}\right)^{\alpha}\left(\frac{L_t}{L_t^{ss}}\right)^{1-\alpha} \quad (25)$$

where the steady state levels of labour and capital utilisation (respectively L^{SS} and $ucap^{SS}$) are determined by the average of past steady-state levels and the actual levels:

$$ucap_t^{ss} = (1-\rho^{ucap})ucap_{t-1}^{ss} + \rho^{ucap}\, ucap_t^j \quad (26)$$

$$L_t^{ss} = (1-\rho^L)L_{t-1}^{ss} + \rho^L L_t^j \quad (27)$$

Monetary Policy

The central bank sets policy interest rates in response to inflation and output gap developments following a standard Taylor rule, with interest rate persistence:

$$i_t = \rho_i i_{t-1} + (1-\rho_i)[r + \vartheta_1(\pi_t - \pi^*) + \vartheta_2 log(GAP_t)] \quad (28)$$

Where ρ_i is the interest rate persistence, r denotes the equilibrium (or neutral) policy rate, and π^* the inflation target.

Government Bonds

One of the key features of the model is that the interest rate on government debt is explicitly modeled. The spread between the interest rate on government debt and the policy rate is assumed to be a function of future expected deficits. This term can be interpreted as a risk premia on government bonds reflecting market expectations on long-term public debt sustainability.[6]

$$ig_t - i_t = \theta E_t d_{t+1} \quad (29)$$

Equation 29 is essential to capture the trade-off existing between the GDP impact of fiscal impulses in the short-term and long-term debt sustainability. It also plays an important role in the analysis of the effectiveness of various fiscal policy instruments. Evidence from the empirical literature on the extent of the effect of fiscal balance on government bonds is mixed, but generally points to a significant effect, particularly when expected rather than current fiscal variables are considered (Haugh *et al.*, 2009). In our model, the impact of the deficit is consistent with the analysis undertaken by Laubach (2009)[7], which suggests that an increase in the deficit-to-GDP

6. As the focus of the analysis is on the effectiveness of fiscal policy, liquidity risks are set to zero.

7. For other analyses on the effects of deficit and debt level on government bond rates see for, example, Schuknecht et al. (2009), Codogno et al. (2003), Gale and Orzag (2003), Gomez-Puig (2006), Manganelli and Wolswijk (2007).

ratio of 1 percentage point increases the spread between government bond rates and short-term rates by 0.25 percentage point.

Fiscal Policy

Automatic stabilisers for both expenditure and revenue are explicitly modeled. On the spending side, unemployment benefits (*ub*) depend on the cyclical position of the economy as measured by the output gap:

$$ub_t = \varepsilon \, log(GAP_t) \tag{30}$$

where ε proxies the generosity of the social security system. When the economy is in a downturn, unemployment is likely to increase as does the total amount of unemployment benefits distributed by the government.

Total government spending (*G*) is given by

$$G_t = ub_t + G_t^d + I_t^g + TR_t \tag{31}$$

with G^d, discretionary government consumption spending considered on top of automatic stabilisers.

On the revenue side, revenues R_t^a is the sum of tax returns on consumption, wages and financial and physical capital:

$$R_t^a = t_t^w W_t L_t + t_t^c P_t C_t + t_t^k i_t^k P_t K_{t-1} + t_t^k ig_t B_{t-1} \tag{32}$$

In addition, a stabilisation (tax) rule is included to avoid explosive debt levels (T^b):

$$T_t^b = \tau_1 \left(\frac{B_t}{Y_t} - b^* \right) + \tau_2 d_t \tag{33}$$

where the parameters τ_1 and τ_2 represent the stringency of the tax rule. In particular, each time the debt level differs from the optimal debt level, or the deficit (*d*) changes, a lump sum tax or credit is introduced. This tax/credit is paid/received by households.[8] By relying on a lump sum tax which does not have any impact on saving and labour supply decisions, this rule will affect marginally the magnitude of fiscal multipliers. By contrast, the use of other types of taxes (such as personal income tax or labour tax) to limit the public deficit which would be more detrimental to growth are likely to lower the extent of fiscal multipliers.

Summarising, the budget deficit is given by:

$$d_t = G_t - R_t^a - T_t^b \tag{34}$$

and government debt (B) dynamics follows:

$$B_t = (1 + ig_t)B_{t-1} + d_t \tag{35}$$

3. Increase in government consumption

This section examines the impact of a temporary 1% of GDP increase in government consumption[9]. The model described above has been calibrated using available evidence from the economic literature or information from the OECD Tax and Benefit database (Annex 1). The shock is temporary implying that in the long run government consumption will return to its baseline value.

A temporary increase of 1% of GDP in government consumption is found to increase GDP by around 1 % in the first quarter, 0.6% after one year and to 0.5% after two years (Figure 1). The multipliers relative to the first and second year are within the range of estimates existing in previous empirical studies. In particular, they are consistent with estimates from structural vector autoregressive (SVAR) models *à la* Blanchard-Perotti (2002), from large multinational macro-

8. For a more detailed discussion on stabilisation rules to stabilise government debt or deficits see, for example, Campbel and Wren-Lewis (2007a, 2007b), Ljungman (2008); Pappa and Vassialtos, (2007); Poplawski Ribeiro *et al.* (2008).
9. It corresponds to an increase in government consumption of 1.1 per cent.

economic models (Henry *et al.*, 2008), and from other DSGE models for the euro area (Ratto *et al.*, 2008).

Looking at the breakdown in final demand, the increase in government consumption crowds out both private investment and consumption through increases in the government bond rate[10]. It is worth noting that the increase in the spread between the government bond rate and the short-term interest (monetary policy rate) rate implies that the crowding out effect in investment and consumption is larger than other DSGE models where the short-term interest rate coincides with the government bond rate.

In addition to the rise in the bond rate, total consumption is affected by the prospect of a higher tax burden which influences the consumption choice of Ricardian households. However, while the consumption of Ricardian households decreases, the consumption of liquidity-constrained households surges due to the rise in their disposable income. At the same time, the fiscal impulse triggers an increase in employment and inflation as well as a decline in real wages.[11]

The increase in government consumption has also public finance implications as it raises debt refinancing costs. An increase in government consumption, and therefore in the level of the deficit, translates into an increase in the government bond rate which in turns leads to a worsening in the debt refinancing cost. As a consequence, a 1% of GDP rise in government consumption would lead to an increase in the debt-to-GDP ratio by 2 percentage points in the first year and by 3 percentage points in the second.

10. This is consistent with other empirical evidence on crowding–in versus crowding-out effects of government consumption (Furceri and Sousa, 2009).

11. All these results are in line with previous studies using DSGE models (Ratto *et al.*, 2009; Coenen and Straub, 2005).

Sensitivity analysis suggests that results presented in this paper remain unaffected by reasonable changes in structural parameters (Annex 2, Figure A2.1). There are some exceptions, such as the share of liquidity-constrained households and the number of firms that indexes price increases to past inflation. In particular, an increase in the share of liquidity constrained household increases the value of fiscal multipliers in the short-run, while an increase in the number of firms that indexes price increases to past inflation implies a larger multiplier in the long-run. However, both these differences are quite limited and go in the direction expected.

Finally, the sensitivity of the results to changes in the government bond rate equation, which is not standard in the DSGE literature is examined. In particular, we tested the sensitivity of the results to changes in the coefficient associated to the deficit-to-GDP ratio in the government bond spread equation (θ), and to changes in future deficits time horizon. Tests suggest that an increase in the responsiveness of government spreads to the deficit and an increase in the time horizon of the deficit both decrease the impact of a government consumption shock on output (Annex 2, Figure A2.2). At the same time, both changes would lead to a stronger effect on debt. However, the differences with respect to the baseline simulation are small, suggesting that the results are robust to different specifications in the government bond equations.

4. Short-term fiscal multipliers of different policy instruments

The objective of this section is to identify the policy measures whose short-term positive effects on economic activity are the largest and that do not compromise long-term fiscal sustainability. Five alternative policy measures are examined in turn: i) an increase in government investment; ii) an increase in transfers to households; iii) a wage tax rate cut; iv) a capital tax rate cut and v) a consumption tax rate cut.

The size of the shock is comparable among measures and amounts to 1% of baseline GDP and in all cases the shock is temporary.

While the differences on the effects of the various spending measures on debt sustainability are relatively limited, associated fiscal multipliers vary largely with the choice of instruments (Figure 3).[12] A stronger short-term GDP impact is found for an increase in government investment, as the latter also has a positive permanent supply side effect. The impact multiplier after 1 year of a rise of 1% in the government investment to GDP ratio is found to be close to around 1.1, while the long-run multiplier after 10 years is close to 0.3. A higher output elasticity of public investment would lead to a higher fiscal multiplier in the long-run but the difference is likely to be limited in the short-term. An increase in government consumption would sustain activity by a significant, but lower amount than an increase in public investment. Another major difference between the two policy measures is that an increase in government consumption would not have a permanent effect on output.

The rise in transfers to liquidity-constrained households is estimated to have the smallest impact multiplier amongst the examined spending shocks (around 0.15 after one year). However,

12. A full set of results is available upon request.

these transfers would unsurprisingly produce the largest increase in the consumption of liquidity-constrained households.[13]

Among the revenue measures, the strongest fiscal multipliers are found for a tax cut on wage income. Indeed, the latter would lead to a more pronounced fall in the real wage and more employment creation than other tax cuts. In particular, a temporary cut in wage income tax rates leads to i) an increase in activity of around 0.4% after a year, which tends to vanish in the long-run; and ii) an increase of approximately 0.8% of the debt-to-GDP ratio after 10 years. A cut in consumption tax also has a sizeable effect on GDP in the short run, leading to an increase of GDP of about 0.25 % after one year, but is the most detrimental for debt sustainability in the long-run. Finally, a capital tax cut seems to have little impact on GDP.[14]

A simple way to capture the trade-off between the short-term impact on activity and long-term fiscal sustainability is to compute the ratio of the fiscal multipliers (after a year) to the increase in the debt-to-GDP ratio after 10 years (Table 1).[15] DSGE-based simulations point to a higher ratio for a wage tax cut among the revenue measures, and to a higher ratio for government investment among the spending measures.

5. An application to the fiscal package introduced in the euro area countries in response to the economic downturn

Over the last year, the euro area countries have implemented discretionary fiscal packages to counter the economic downturn (Table 2). For the euro area as a whole, the fiscal impulse is

13. Multipliers would be slightly higher when transfers are targeted to liquidity-constrained households than in case of general transfers.

14. These results rely on the value of the labour supply response. The latter has been calibrated to get a plausible value for the steady state value of employment, which has been chosen to be consistent with standard results from the literature.

15. The long-term is achieved after 10 years in all simulations. As a consequence, considering a longer-time horizon would significantly not change these results.

expected to have an effect mostly in 2009 and 2010 (OECD, 2009). Although, the composition of the fiscal packages vary across countries, at the aggregate euro area level, it is mostly composed of spending measures in 2009, in particular increases in public investment and transfers to households and businesses. Cuts in direct taxes for households and firms are less prevalent though still significant. In 2010, the extent of spending measures, particularly public investment diminishes, while tax cuts remain broadly stable.

The Fiscal DSGE described above has been used to evaluate the impact of this discretionary fiscal package on activity, inflation and public finances. In this simulation, monetary policy is assumed to be accommodative (i.e. interest rates stay at their initial low levels). In the short run, the fiscal package is found to boost activity by 0.8 % in 2009 and 0.6 % in 2010 (Figure 3).[16] The effect on inflation would be small in the short-term (Table 3). The public balance is estimated to deteriorate: the interest rate on government bonds would rise by 0.05 percentage points in 2009 and by 0.08 percentage points in 2010. Overall, public debt as a per cent of GDP would increase by 0.8 percentage point in 2009 and by 1.8 percentage points in 2010. This limited impact reflects mostly the small size of the package, relative to the fiscal impulse introduced in other countries. In addition fiscal multipliers in the Fiscal model may be lower than in standard macro-economics neo-Keynesian models, though they are found to be in the range of estimates found with DSGE models.

6. Conclusions

This paper examines the effects of fiscal policy on output and debt sustainability by developing a DSGE Fiscal Model, which explicitly models government bond rates as a function

16. This simulation does not incorporate the effects of transfers to business or cut in corporate taxes other than capital tax.

of fiscal positions. The model is then simulated to assess the impact of different fiscal policy shocks on output, its components and government debt as a share of GDP. Fiscal policy is found to be an effective tool to boost demand in the short-term, but the GDP impacts vary across instruments. Short-term multiplier effects are found to be the highest for an increase in government investment and consumption and for a cut in the wage tax. These are also the three tools that generate the lowest rise in public debt over the long term.

Using this framework, the fiscal stimulus injected in the euro area countries is found to support activity by 0.8 % in 2009 and 0.6 % in 2010, while augmenting public debt by 1.8 percentage points in 2010.

Although the results are qualitatively robust and can provide insights on the relative effectiveness of each fiscal instrument, point estimates of short-term multipliers should be interpreted with caution given the stylised features of the model. In particular, the very large disruptions that have impaired the functioning of financial markets are not well-captured. This is likely to lower the effectiveness of fiscal policy. In addition, the exercise is subject to the usual caveats related to DSGE modelling (De Grauwe, 2008).

Interesting extensions of the current model would consist in: i) developing a multi-national model, with international financial and trade linkages, to examine the international leakages associated with an expansionary fiscal policy and to assess the potential gains from a coordinated approach[17]; ii) modelling government behavior and considering government spending as endogenous.[18]

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17. This could also help to capture the effect of a external borrowing constraint which can significantly bear on the effectiveness of fiscal policy, for instance in emerging market economies.
18. See, for example, Kumhof and Ykadina (2007), Rieth (2008), Poplawski Ribiero *et al.* (2008).

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Figure 1. Response to a 1% of GDP increase in government consumption

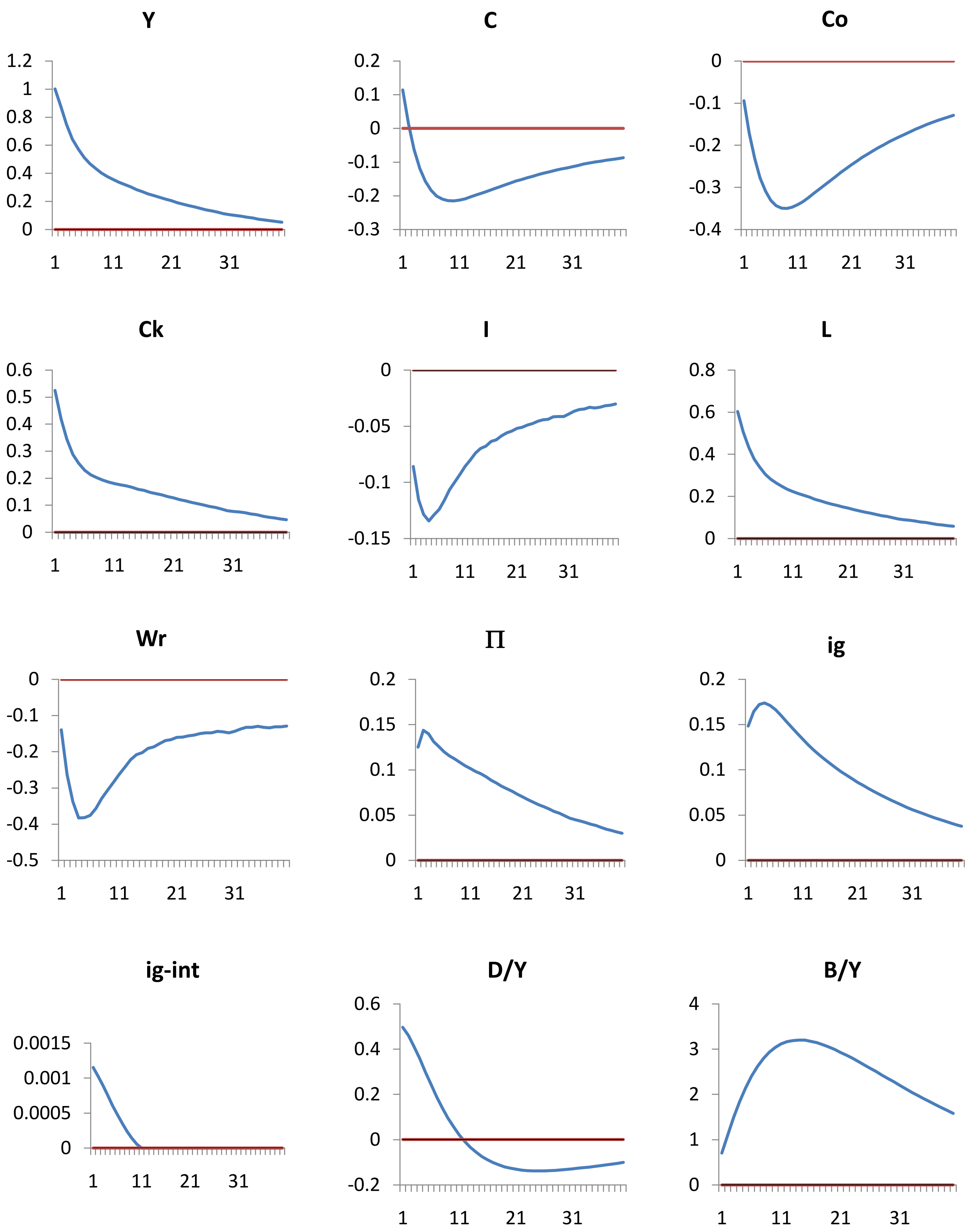


Figure 2. Impact of selected fiscal policy shocks on activity and public debt

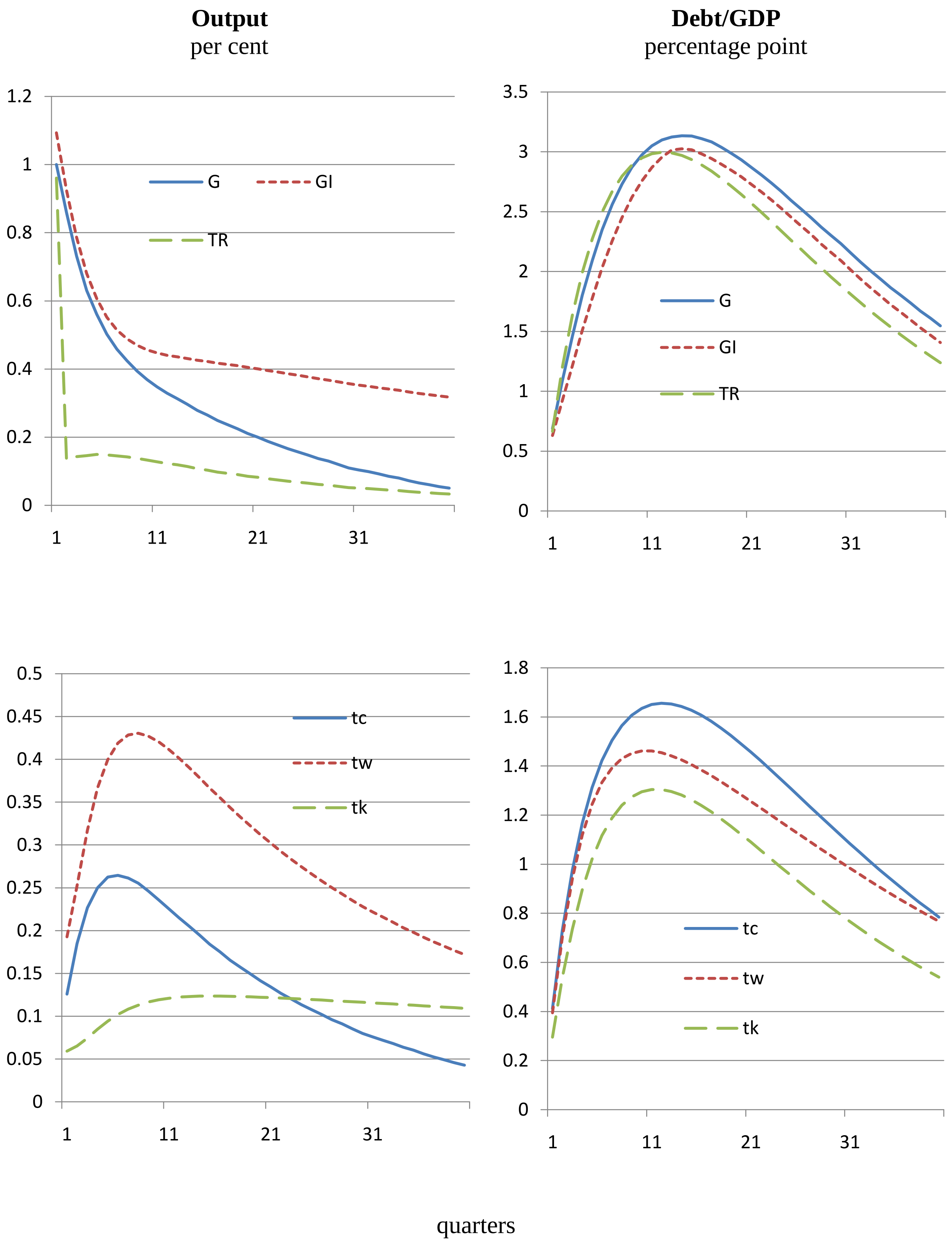
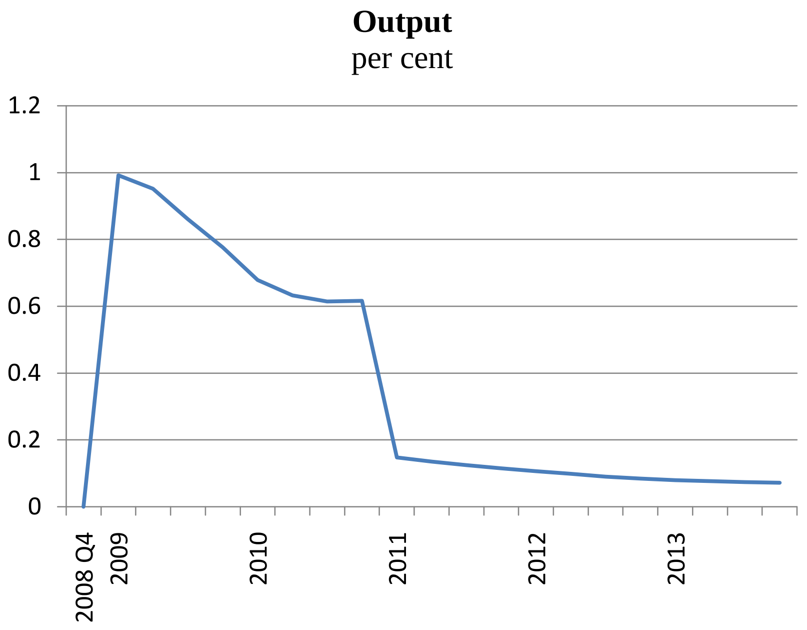


Figure 3. The effects of the fiscal package in the euro area on output and the debt/GDP ratio.



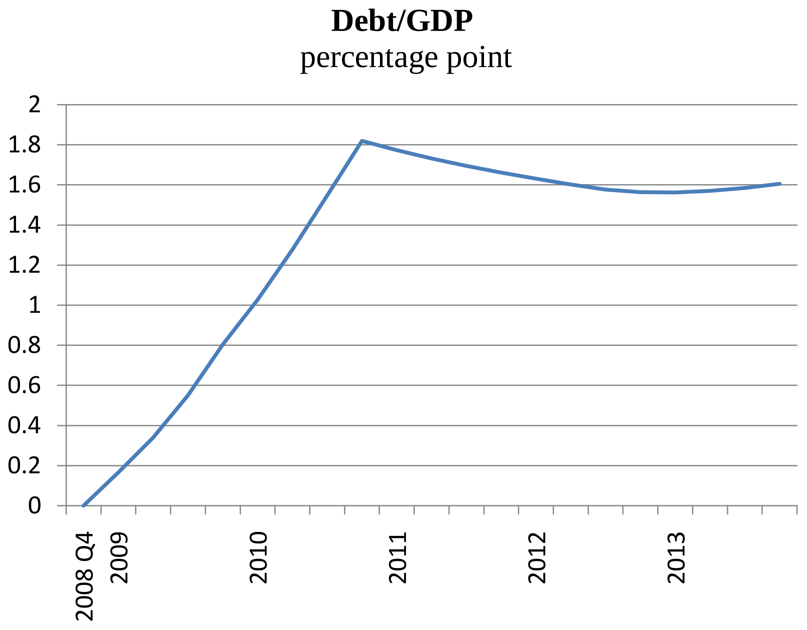


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Table 1: Short-term impact on activity *vs.* long-term implications on debt

		(1) Output increase after 1 year (%)	(2) Debt/GDP increase after 10 years (%)	Ratio (1)/(2)
Government spending Increase				
	Consumption	0.64	1.54	0.42
	Investment	0.68	1.40	0.49
	Transfers	0.15	1.24	0.12
Tax cut				
	Wage	0.36	0.77	0.46
	Capital	0.08	0.54	0.15
	Consumption	0.25	0.78	0.32

Note: in all cases the shock amounts to 1% of baseline GDP.

Table 2. Discretionary fiscal measures in response to the crisis in the euro area*

	2009	2010
Net effect on fiscal balances	-0.9	-0.7
Tax measures	-0.3	-0.4
For individuals	-0.2	-0.2
For businesses	-0.1	-0.1
On consumption	0.0	0.0
Contributions for public pensions, unemployment, healthcare, invalidity…	-0.1	-0.1
Others	0.0	0.0
Spending measures	0.6	0.3
Increase in government final demand	0.3	0.1
of which public investment:	0.2	0.2
Transfers to households	0.2	0.1
Transfers to businesses	0.1	0.1
Transfers to sub-national governments	0.0	0.0
Other spending	0.0	0.0

* Weighted average of euro area countries, in percentage of GDP. The aggregate excludes Portugal and Greece.
Source: OECD Economic Outlook database.

Table 3. Effect of the discretionary fiscal package in the euro area*

	2009	2010
GDP (per cent from baseline)	0.8	0.6
Inflation (percentage point)	0.14	0.7
Government bond rates (percentage point)	0.05	0.08
Debt/GDP (percentage point)	0.8	1.8

* Weighted average of euro area countries. The aggregate excludes Portugal and Greece

ANNEX 1: CALIBRATION OF THE MODEL

The structural parameters have been calibrated using available evidence from the economic literature or information from the OECD Tax and Benefit database (Table 1). Many of these parameters are standard in the DSGE literature, in particular the share of liquidity-constrained households, and have been calibrated using results from the literature. Some parameters, such as the elasticity of substitution between consumption and leisure have been derived to be get a plausible steady state value of employment. Other parameters are less common and are thus subsequently detailed here.

The first one is the sensitivity of the unemployment benefit to the output gap which has been calibrated using Darby and Melitz (2008). This coefficient captures the response of labour market spending to the cycle. Estimated on 21 countries over the period 1983-2003, this coefficient is statistically significant and estimated to range between 0.03 to 0.09, with a middle range point estimate of 0.06.

The second set of important parameters are those driving the dynamics of adjustment costs (γ_{ucap}, γ_L, γ_I, γ_P, γ_W *and* γ_K*)*. These are taken from Ratto *et al.* (2009) and have been estimated using a Bayesian approach.

Finally, the effect of the policy interest rate on the government bond rate (equation 28) is calibrated to be consistent with a 5 year maturity for government bonds, following Kuttner (2001)[19]. In addition, the impact on government bond rates of the deficit is consistent with the analysis undertaken by Laubach (2009) for the United States[20].

19. Although debt levels have been found to be related to government bond maturity, (see for example, Missale and Blanchard, 1994; De Haab et al.1995) our results are robust to changes in the maturity.

20. For other analyses on the effects of deficit and debt level on government bond rates see for, example, Schuknecht et al. (2009), Codogno et al. (2003), Gomez-Puig (2006), Manganelli and Wolswijk (2007).

Table 1: Calibration of the parameters

Name	Symbol	Value	Source
Elasticity of private capital to output	α	0.42	Standard
Elasticity of public capital to output	α_g	0.1	Ratto et al. (2009)
Discount factor	β	0.996	Standard
Elasticity of substitution between types of goods	σ	10	Standard
Labour supply elasticity	ψ	1.1	Derived to be consistent with a steady state level of employment of 0.3
Consumption tax rate	τ^c	0.18	OECD (2007)
Labour income tax rate	τ^w	0.20	OECD (2007)
Capital tax rate	τ^K	0.10	OECD (2007)
Unemployment benefits elasticity	ε	0.06	Darby and Melitz (2008)
Share of liquidity-constrained households	ω	0.25	Coenen *et al.* (2007)
Degree of habit persistence	h	0.8	Grenouilleau et al. (2007)
Adjustment cost in capital utilisation	$\gamma_{ucap,1}$		Derived to get ucap =1 in the steady state
Adjustment cost in capital utilisation	$\gamma_{ucap,2}$	70	Ratto *et al.* (2009)
Adjustment cost in price	γ_P	61.4	Ratto *et al.* (2009)
Adjustment cost in capital	γ_k	76	Ratto *et al.* (2009)
Real wage persistence	γ_w	0.73	Ratto *et al.* (2009)
Inertia in price setting	sfp	0.87	Ratto *et al.* (2009)
Inertia in wage setting	sfw	0.77	Ratto *et al.* (2009)
Effect of deficit on government bond rate	θ	0.25	Laubach (2009)
Policy interest rate persistence	ρ_i	0.9	Smets and Wouters (2003)
Policy response to inflation	ϑ_1	1.5	Gali *et al.* (2007)
Policy response to output gap	ϑ_2	0.5	Gali *et al.* (2007)

ANNEX 2

Figure A2.1 Effect on GDP of a 1% of GDP increase in government consumption under different structural parameter calibrations (%)

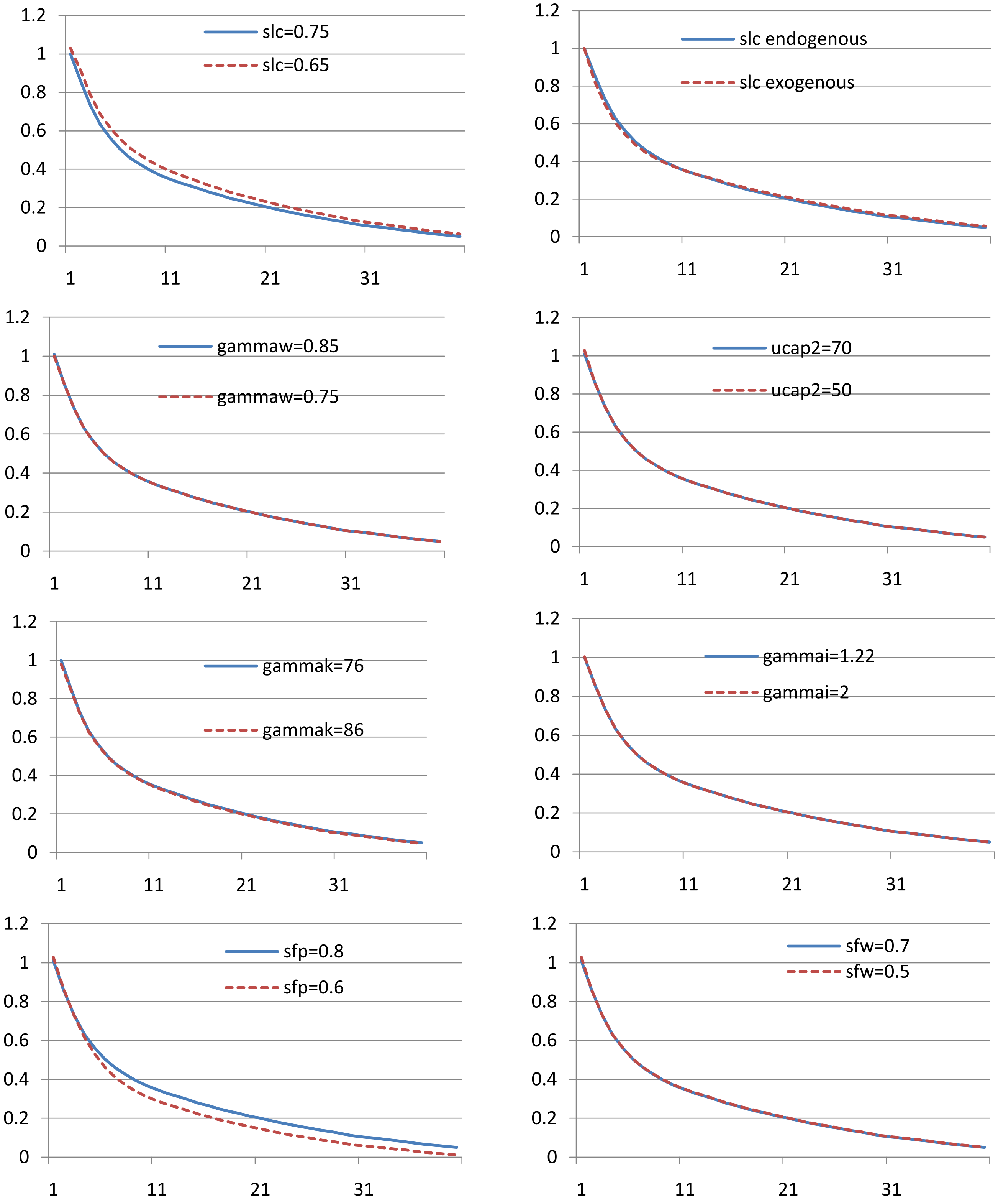

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Figure A2.2 Response to a 1% of GDP increase in government consumption under different calibrations of the government bond equation