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The Effects of Fiscal Policy on Output: A DSGE Analysis

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THE EFFECTS OF FISCAL POLICY ON OUTPUT: A DSGE ANALYSIS

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ABSTRACT/RESUMÉ

The effects of fiscal policy on output:
A DSGE analysis

This paper examines the effects of fiscal policy on output in the euro area. For this purpose we develop a DSGE Fiscal Model with endogenous government bond yields 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 wage tax. The results are robust to different parameter calibrations and are economically significant. Amongst the different structural parameters, the share of liquidity constrained households and price persistence are found to be the ones which affect the most fiscal multipliers.

JEL Classification: E62, H10

Keywords: Fiscal policy; output, debt sustainability; DSGE

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Les effets de la politique budgétaire sur la production: une analyse à partir d'un modèle DSGE

Ce papier examine les effets de la politique budgétaire sur l'activité dans la zone euro. À cette fin, nous avons développé un modèle budgétaire DSGE dans lequel les rendements des obligations d'État sont endogènes et nous examinons l'effet de différents chocs budgétaires sur le PIB et ses composantes et sur la dette publique. Les simulations indiquent que la politique budgétaire permet de soutenir l'activité, en particulier sur le court terme. Plus précisément, les multiplicateurs budgétaires les plus larges sont associés à une augmentation de l'investissement public, de la consommation publique ainsi qu'à une baisse du taux d'imposition sur les salaires. Les résultats sont robustes à différentes valeurs des paramètres structuraux du modèle et sont économiquement significatifs. Parmi les différents paramètres structurels, la part des ménages qui rencontrent des contraintes de liquidité et les inerties au niveau des prix sont les paramètres qui affectent le plus les multiplicateurs fiscaux.

Classification JEL : E62, H10

Mots clés : politique budgétaire ; activité ; soutenabilité de la dette ; DSGE

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THE EFFECTS OF FISCAL POLICY ON OUTPUT: A DSGE ANALYSIS

by

Davide Furceri and Annabelle Mourougane[1],[2]

1. Introduction

The severity of the global recession coupled with weakened monetary policy transmission channels has prompted the extensive use of discretionary fiscal policy to support demand in many countries, even though fiscal packages have varied in size and composition (OECD, 2009). Yet, there is little evidence in the literature on the effectiveness of fiscal policy at times of crisis,[3] and in the current economic environment it is even scarcer.[4] The impaired functioning of financial markets, strongly accommodative monetary policy and heightened uncertainty are likely to have increased the impact of fiscal policy impulse on economic activity. At the same time, high public borrowing may push up sovereign bond yields and crowd out private demand. These factors are hard to quantify, making it difficult to assess the effectiveness of fiscal policy as measured by the so-called fiscal multipliers.

While there have been attempts to model the effect of fiscal policy in situations of financial market stress in a DSGE framework (*e.g*. Röger and in't Veld, 2009), no work to our knowledge has analysed the trade-off between the effects of expansionary fiscal policy on economic activity and the

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1. The authors are grateful to Jonathan Coppel, Jorgen Elmeskov, Yvan Guillemette, Peter Hoeller, Paul Levine, Fabrice Murtin, Marcos Poplawski Ribeiro, David Turner, Jean-Luc Schneider, Douglas Sutherland, Lukas Vogel, and the participants in the OECD Economics Department Seminar (Paris, April 2009), the IMF workshop on Fiscal Multipliers (Washington, May 2009), the European System of Central Banks Working Group on Public Finance (Cyprus, July 2009) and the NIPFP DEA Conference (New Delhi, September 2009) for helpful comments and discussions. Special thanks to Penelope Elghadab for excellent editorial support.

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3. See, for example, IMF (2008).

4. Some examples are the OECD *Interim Economic Outlook* (2009) and the IMF *World Economic Outlook* (2009).

increase in government bond premia. This paper seeks to fill this gap and models bond premia as a function of expected fiscal positions. This is particularly important for two reasons. First, the difference between short and long-term interest 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 output losses and discretionary fiscal policy responses, but also marked rises in government risk premia (Reinhart, 2009).

The model used here shares a number of features with pre-existing DSGE models (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, price and real wage persistence. However, it also builds in a new dimension by endogenising government bond yields.

Simulations are performed for a variety of fiscal instruments (government consumption, government investment, transfers, consumption taxes, taxes on wages and capital). The key results are as follows:

- Fiscal policy appears to boost demand in the short-term, despite the associated rise in government bond spreads in response to a fiscal stimulus, that crowds out interest-sensitive demand components.

- The GDP impacts of fiscal policy vary across instruments with fiscal multipliers ranging from 0 to 0.6 after a year in the euro area. The largest short-term effect on GDP is found for an increase in public consumption and investment, while a transfer to liquidity-constrained households has a more limited impact. Tax cuts would be in general less effective than spending measures in supporting demand. Among taxation measures, the strongest effects are attached to a cut in wage taxes.

- The results appear robust to a wide range of robustness test, with the share of liquidity-constrained households and price inertia in inflation expectations being the structural parameters affecting the most the results. In particular, an increase in the share of liquidity-constrained households raises the value of fiscal multipliers in the short-run. Such a result suggests that impaired financial markets may have increase the impact of the fiscal package on activity.

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 robustness tests and investigate which structural parameters are driving the results. Finally, section six concludes.

2. The model

This section lays out the micro-economic foundations of the model. The behaviour of the different agents is examined in turn, before analysing monetary and fiscal policies. Contrary to most existing DSGE models, government bond yields 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. The function describing the capital utilisation adjustment cost is convex, penalising accelerations and decelerations in capacity utilisation:

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

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

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:

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

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

Equation (8) determines the optimal level of capital utilisation by equating the marginal product of capital services to the marginal cost of increasing capacity. Equation (11) represents the marginal cost as a function of factor prices, and equation (9) links (expected) inflation to 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:

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

which represents a more general specification of the standard new-Keynesian Phillips curve.[5] 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 intertemporal utility over an infinite planning horizon. Unconstrained households, labelled $o \in [0,\omega]$, have full access to financial markets, and can buy and sell assets and transfer income over time.[6]

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 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:

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

6. 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).

$MaxV = E_o \sum_{t=0}^{\infty} \beta^t U(C_t^i, 1 - L_t^i) - E_o \sum_{t=0}^{\infty} lamda_t \beta^t ((1 + t_C)C_t^i + I_t^i + \frac{B_t^i}{P_t} - \frac{(1+(1-t_t^i)ig_{t-1}B_{t-1}^i}{P_t}$ $-$
$E_o \sum_{t=0}^{\infty} xi_t \beta_t (K_t^i - J_t^i - (1-\delta)K_{t-1}^i$
$V =$
$E_o \sum_{t=0}^{\infty} \beta_t U(C_t^i, 1 - L_t^i) - E_o \sum_{t=0}^{\infty} \lambda_t \beta_t [(1 + t_t^c) C_t^i + I_t^i + \frac{B_t^i}{P_t} - \frac{(1+(1-t_t^k)ig_{t-1}B_{t-1}^i}{P_t} - (1 - t_t^k) i_t^K K_{t-1}^i +$
$T_t^b - (1 - t_t^w) \frac{W_t}{P_t} L_t - \sum_{j=1}^{n} PR_t^j] - E_o \sum_{t=0}^{\infty} \xi_t \beta_t (K_t^i - J_t^i - (1-\delta)K_{t-1}^i)$

$V =$
$E_o \sum_{t=0}^{\infty} \beta_t U(C_t^i, 1 - L_t^i) - E_o \sum_{t=0}^{\infty} \lambda_t \beta_t [(1 + t_t^c) C_t^i + I_t^i + \frac{B_t^i}{P_t} - \frac{(1+(1-t_t^k)ig_{t-1}B_{t-1}^i}{P_t} - (1 - t_t^k) i_t^K K_{t-1}^i +$
$T_t^b - (1 - t_t^w) \frac{W_t}{P_t} L_t - \sum_{j=1}^{n} PR_t^j] - E_o \sum_{t=0}^{\infty} \xi_t \beta_t (K_t^i - J_t^i - (1-\delta)K_{t-1}^i)$ (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:

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

With φ the elasticity of substitution between consumption and leisure, and *h* is the degree of habit persistence. Habit persistence is assumed only for Ricardian households.

Investment adjustment costs are modelled 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:

$\frac{\partial V}{\partial C} = 0 \rightarrow \lambda_t = \frac{U_t^C}{1+t_t^c} \frac{\partial U}{\partial C} = 0 and \frac{\partial U}{\partial B} = 0 \rightarrow (\pi + 1) * \frac{1}{C_t^o} = \beta * \left(\frac{1}{C_t^o(+1)}\right) * (1 + ig(+1) - \delta)$
$\frac{\partial U}{\partial C} = 0 \rightarrow (\pi + 1) * \frac{1}{C_t^o} = \beta * \left(\frac{1}{C_t^o(+1)}\right) * (1 + ig(+1) - \delta)$ (17)

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

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

$$\frac{\partial V}{\partial K} = 0 \rightarrow Q_t = \frac{(1-\delta)*(1+\pi(+1))}{1+ig_t} * Q_{t+1} + i_t^k * (1 - t_k) + t_k\delta$$
$$\frac{\partial U}{\partial J} = 0 \rightarrow xi * (1 + t_C) = \frac{\left(1+\gamma_K * \frac{J}{K_{t(-1)}^i}\right)+\gamma_I * \Delta J)}{(\pi+1)*C_t^o + \frac{\beta * \gamma_I * \Delta J(+1)}{C_t^o(+1)*(\pi+1)}} \tag{20}$$

Equations (17) and (18) 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.

$$C_t^k = (1 - t_W) * w * L_t^i + ub * (1 - L_t^i) \tag{21}$$

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

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

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

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

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:

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

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:

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

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

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:

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

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 modelled. 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.[7]

$$ig_t - i_t = \theta E_t d_{t+1} \tag{29}$$

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. In our model, the impact of the deficit is consistent with the analysis undertaken by Laubach (2009), which suggests that an increase in the deficit-to-GDP ratio of 1 percentage point increases the spread between government bond yields and short-term rates by 0.25 percentage point. An alternative specification would have been to make the interest spread dependant on the debt level rather than the deficit. Laubach (2009) for instance found that a 1 percentage point increase in the public debt-to-GDP ratio adds about 3 basis points to the government

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

bond yield.[8] Equation (29) with this alternative would nonetheless not fundamentally alter the simulation results.

Fiscal policy

Automatic stabilisers for both expenditure and revenue are explicitly modelled. 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:

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

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):

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

where the parameters τ_1 represents the stringency of the tax rule. In particular, each time the debt level differs from the optimal debt level, a lump sum tax or credit is introduced. This tax/credit is paid/received by households.[9] By relying on a lump sum tax which does not have any impact on saving and labour supply decisions, this rule will only 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 is likely to lower the size 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:

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

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8. For other analyses on the effects of deficits and debt on government bond yields see for, example, Schuknecht *et al.* (2009), Codogno *et al.* (2003), Gale and Orzag (2003), Gomez-Puig (2006), Haugh *et al.* (2009), Manganelli and Wolswijk (2007).

9. For a more detailed discussion on rules to stabilise government debt or deficits see, for example, Campbell and Wren-Lewis (2007a, 2007b); Pappa and Vassialtos (2007); Poplawski Ribeiro *et al.* (2008).

3. Increase in government consumption

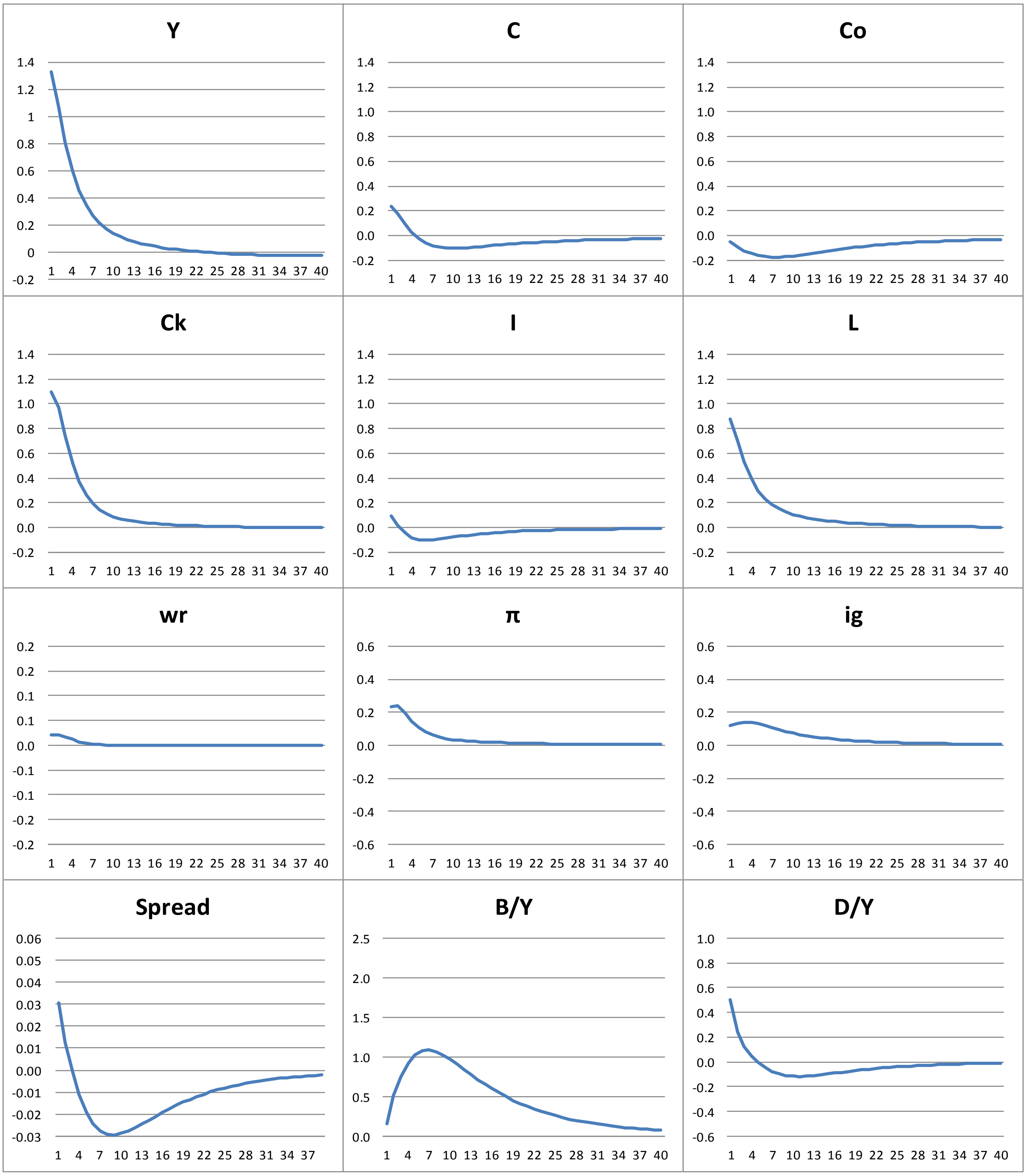
This section examines the impact of a 1% of GDP increase in government consumption in the euro area.[10] The model described above has been calibrated using available evidence from the economic literature or information from the OECD Tax and Benefit database (Annex 1). The shock is temporary implying that, in the long run, government consumption will return to its baseline value.

A 1% of GDP in government consumption is found to increase GDP by around 1.3% in the first quarter, 0.6% after one year and to reach 0.2% after two years (Figure 1). These multipliers 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-economic models (Henry *et al.*, 2008), and from other DSGE models for the euro area (Ratto *et al.*, 2008; Coenen *et al.*, 2010).

10. It corresponds to an increase in government consumption of 1.1%. In particular the increase in government consumption is assumed to die out in the long-run according to the following law of motion: $G_t^d - G_{t-1}^d = \rho^G(G_t^d - \bar{g}Y_t) + \varepsilon^G$, where $\bar{g}$ is the state steady state level of the share of government consumption over GDP (0.18) ρ^G is set to be equal to -0.05, and ε^G is the shock.

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

Per cent or percentage point, quarter



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 yield.[11] It is worth noting that the increase in the spread between the government bond yield and the short-term interest (monetary policy rate) rate implies that the crowding out effect in investment and consumption is likely to be larger than other DSGE models where the short-term interest rate coincides with the government bond yield.

In addition to the rise in the bond yield, 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.

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 yield which in turns leads to a worsening in the debt refinancing cost. As a consequence, even with a debt stabilising rule a 1% of GDP rise in government consumption would lead to an increase in the debt-to-GDP ratio by 0.9 percentage points in the first year and by 1.1 percentage points in the second.

4. Short-term fiscal multipliers of different policy instruments

The objective of this section is to identify the effectiveness of different policy instruments. In particular, 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 assumed to go back to zero in the long-run.[12]

The effects on activity and on the debt-to-GDP ratio vary considerably with the choice of instruments (Figure 2).[13] A stronger short-term GDP impact is found for an increase in public spending, while revenue measures produce a lower rise in the debt-to-GDP ratio.

Looking at individual measures, an increase in government investment would sustain activity by a significant amount and contrary to an increase in government consumption would not have a permanent effect on output through its positive 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 0.6, while the long-run multiplier after 10 years is close to 0.2. 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. The rise in transfers to liquidity-constrained households is estimated to have the smallest impact multiplier amongst the examined spending shocks (around 0.1 after one year). However, these transfers would unsurprisingly produce the largest increase in the consumption of liquidity-constrained households.[14] Such a ranking is consistent with what is found in other macro-economic models (Coenen *et al.*, 2010).

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11. This is consistent with other empirical evidence on crowding–in versus crowding-out effects of government consumption. See Furceri and Sousa, (2009) for a literature review and recent empirical evidence.

12. The increases in the different fiscal measures are simulated as described in footnote 10.

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

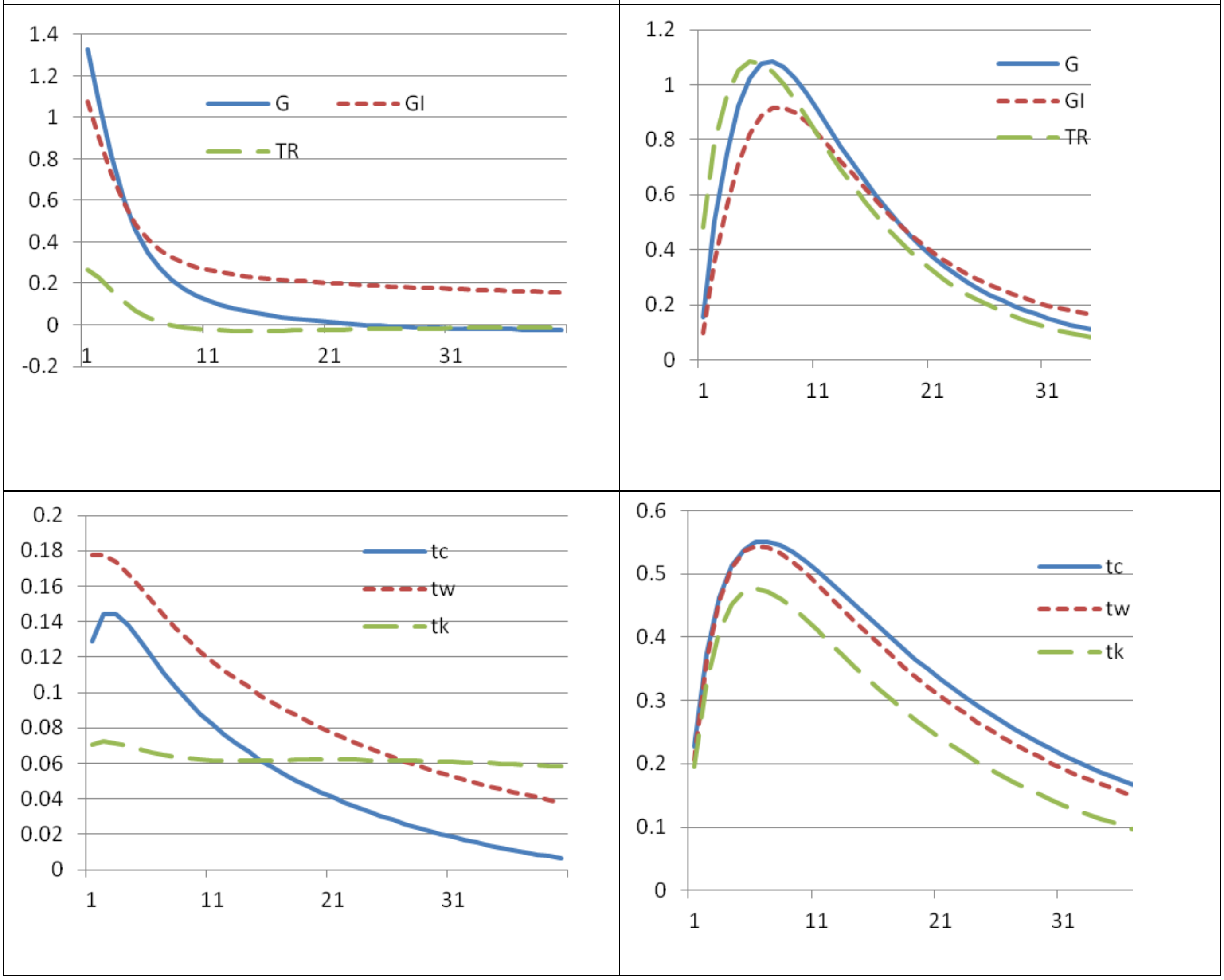
14. Multipliers would be slightly higher when transfers are targeted to liquidity-constrained households than in case of general transfers.

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 0.2% 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, even in presence of a debt stabilising rule. A cut in consumption tax also has a positive effect on GDP in the short run, leading to an increase of GDP of about 0.1 % 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 in the short-term.[15]

15. 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.

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

Output per cent, quarter	**Debt/GDP** percentage point, quarter



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 two years, which is the duration of the shock) to the maximum increase in the debt-to-GDP ratio assuming a debt-stabilising rule as described in equation (33) (Table 1).[16] 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. These results remain purely illustrative as alternative ways of computing the ratio would lead to different rankings.

16. 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.

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

		Output increase after 2 years	Debt/GDP max increase	Ratio (1)/(2)
		(%)	(%)	
Government spending increase				
	Consumption	0.22	1.08	0.20
	Investment	0.32	0.92	0.35
	Transfers	0.00	1.08	0.00
Tax cut				
	Wage	0.14	0.54	0.25
	Capital	0.06	0.48	0.13
	Consumption	0.10	0.55	0.19

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

5. Sensitivity of the results to structural parameters

Sensitivity analysis suggests that the results presented in this paper remain in general unaffected by reasonable changes in structural parameters (Annex 2). There are however some exceptions:

- The share of liquidity-constrained households appears to be the parameter that matters the most. An increase in this parameter raises the value of fiscal multipliers in the short-run. In most cases, change of the parameter to a higher but plausible assumption from 25 to 35% would increase fiscal multiplier by 0.1-0.2 percentage point at the maximum (FigureA2.1). These differences are quite limited and go in the expected direction.

- Wages rigidities, capital utilisation and investment adjustment costs are found to have very little impact on the simulation outcomes (Figure A2.3 to A2.5). A similar result is observed for the coefficient of inertia in wage setting (Figure A2.7).

- Capital adjustment costs have no impact on the spending shocks, while an increase in the cost slightly lowers the multipliers associated to revenue shocks (Figure A2.2).

- The number of firms that indexes price increases to past inflation is also found to have an influence on GDP impacts, with an increase in this parameter implying a larger multiplier in the long-run. The effect is only visible after some quarters and is particularly important for the consumption tax shock (Figure A2.6).

The sensitivity of the results to changes in the government bond yield equation, which is not standard in the DSGE literature, is also examined. In particular, we tested how changes in the coefficient associated to the deficit-to-GDP ratio (θ) modify the results. Some small changes are discernible for the revenues measures but they remain very limited. In the same vein, changing the specification of the government bond yield equation by making the spread respond to expected deficits up to 3 or 5 periods in the future (rather than the expected deficit one-period ahead as in the baseline), does not appear to modify the simulation outcomes. Marginal changes are observed in the short term for revenue and transfer shocks.

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 yields as a function 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 boost demand in the short term, but the GDP impacts vary across instruments. Short-term multiplier effects are found to be highest for an increase in government investment and consumption and for a cut in the wage tax. The results appear robust to a wide range of robustness test, with the share of liquidity-constrained households and price inertia in inflation expectations being the structural parameters affecting the most the results.

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 behaviour and considering government spending as endogenous.[18]

17. This could also help to capture the effect of an 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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ANNEX 1: CALIBRATION OF THE MODEL

The structural parameters have been calibrated using available evidence on the euro area from the economic literature or information from the OECD Tax and Benefit database (Table A1.1). 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 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 yields (equation 28) is calibrated to be consistent with a five-year maturity for government bonds, following Kuttner (2001).[19] In addition, the impact on government bond yields 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 yields see for, example, Schuknecht *et al*. (2009), Codogno *et al.* (2003), Gomez-Puig (2006), Manganelli and Wolswijk (2007).

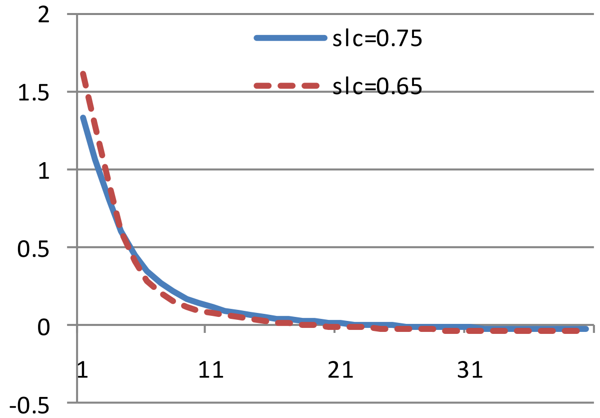
Table A1.1 **Calibration of the parameters**

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	φ	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)
	$\rho^{ucap} = \rho^L = \rho$	0.85	Ratto *et al.* (2009)
	δ	0.023	
	γ_i	1.2	Ratto *et al.* (2009)
Debt influence on stabilisation rule	τ_1	0.4	
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 yield	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)

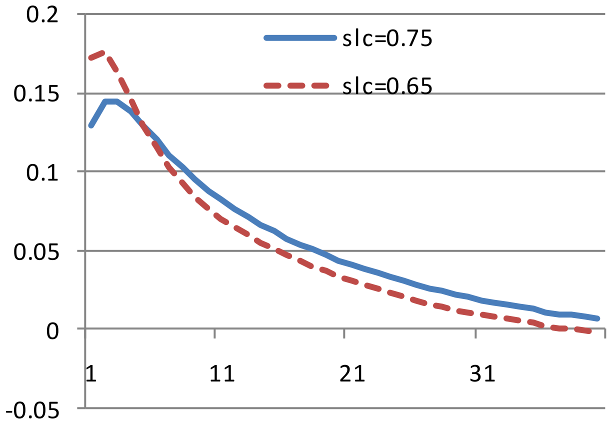
ANNEX 2: ROBUSTNESS TESTS

Figure A2.1 **Effect of change of the liquidity-constrained share on the GDP impact of fiscal measures**
Percentage, quarter

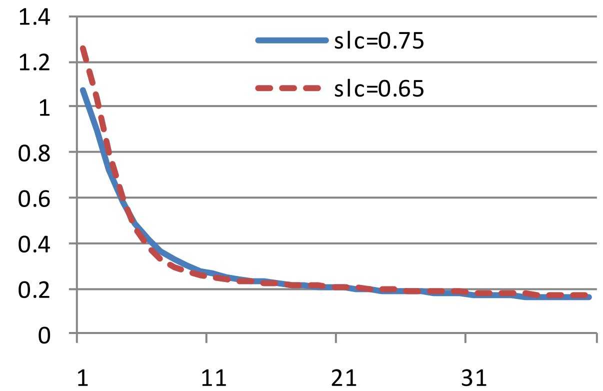
Government consumption



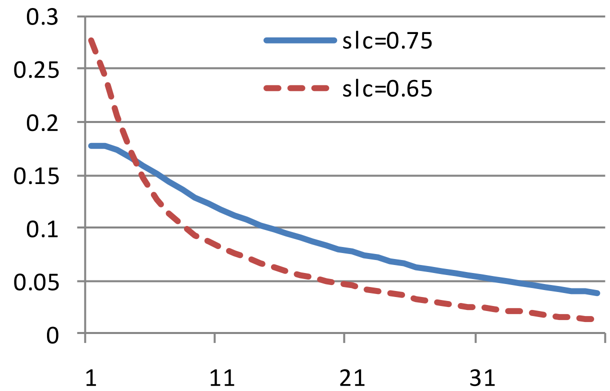
Consumption tax



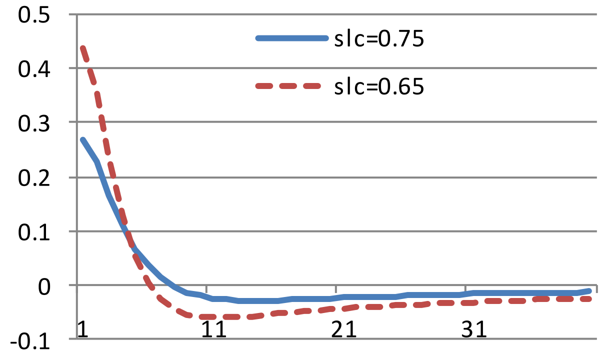
Government investment



Wage tax



Transfers



Capital tax

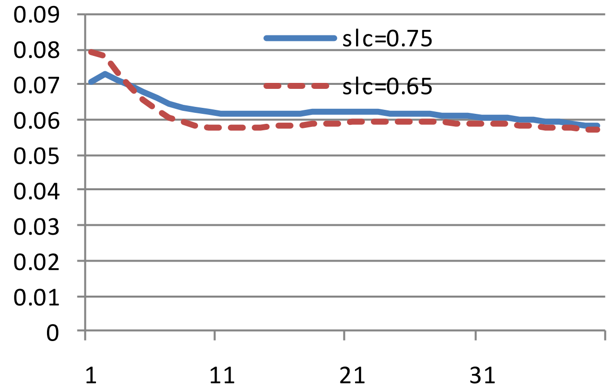
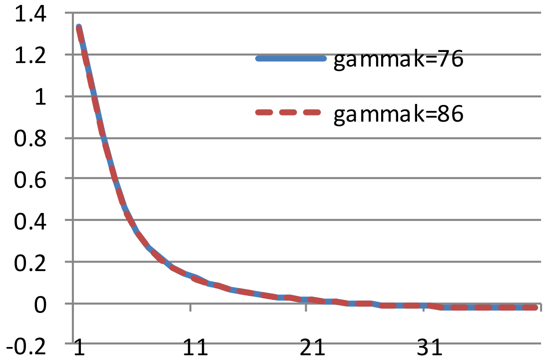


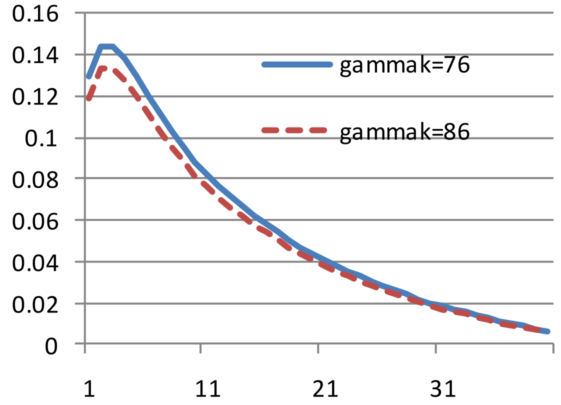
Figure A2.2 **Effect of change of capital adjustment rigidities on the GDP impact of fiscal measures**

Percentage, quarter

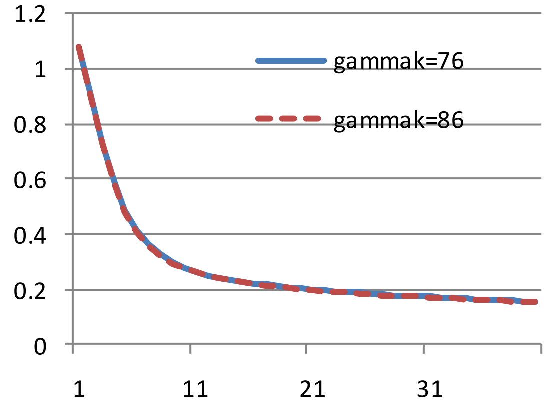
Government consumption



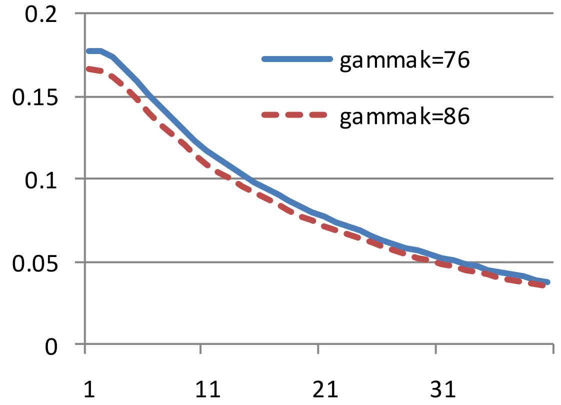
Consumption tax



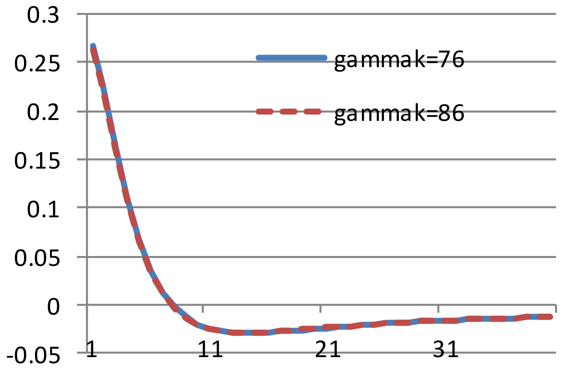
Government investment



Wage tax



Transfers



Capital tax

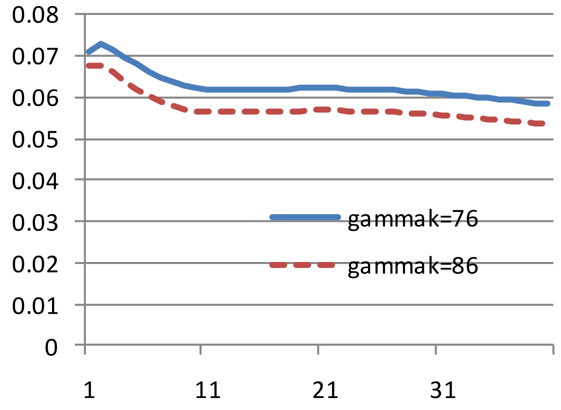


Figure A2.3 **Effect of change of wage rigidities on the GDP impact of fiscal measures**
Percentage, quarter

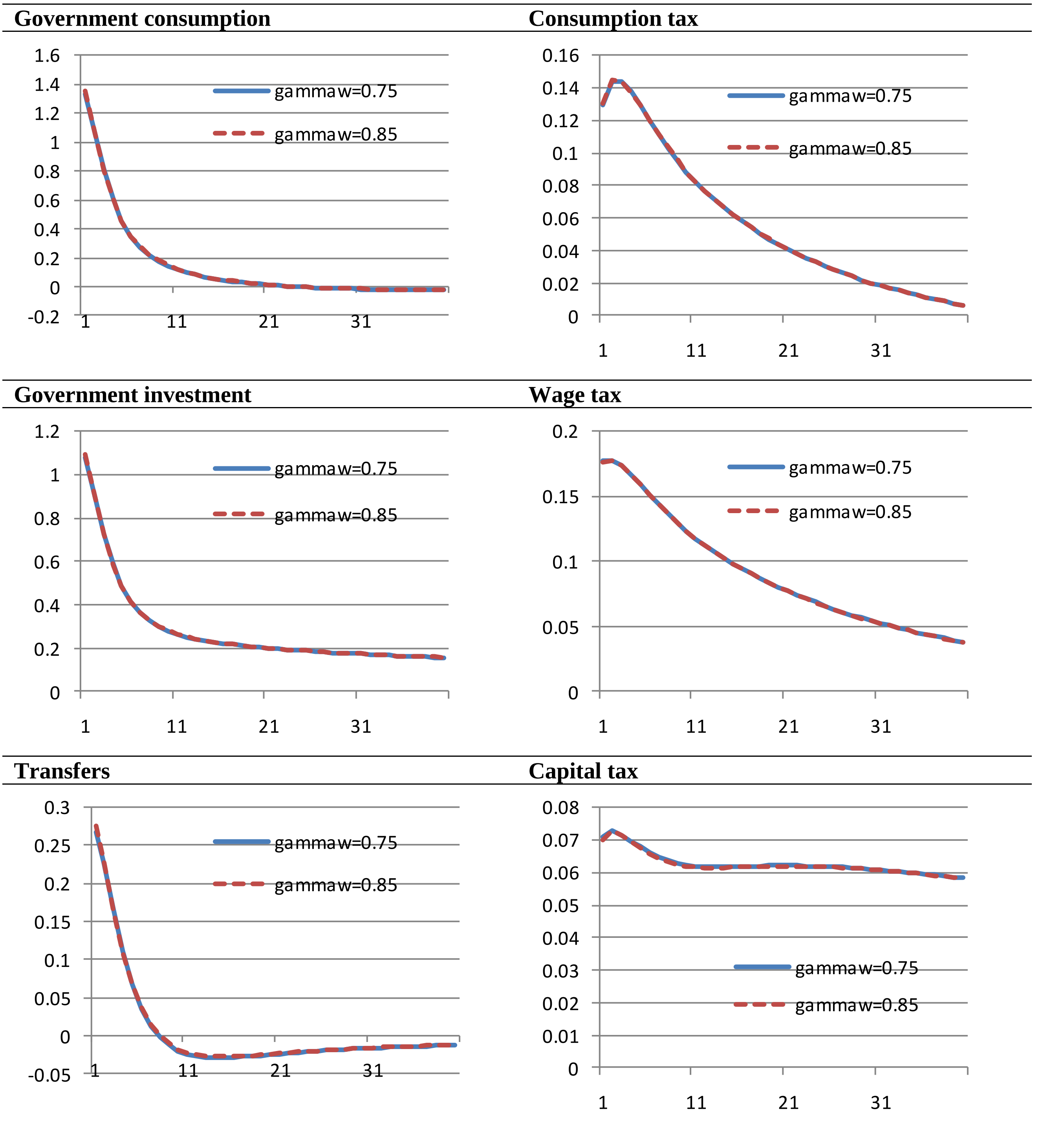
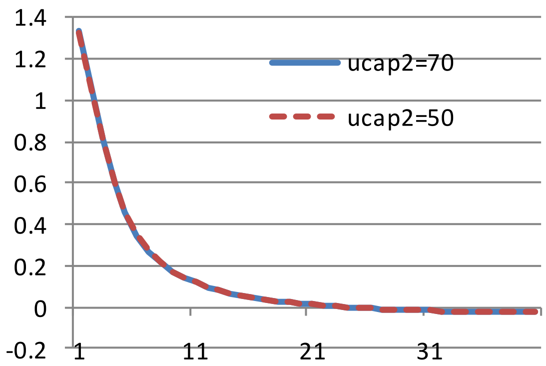
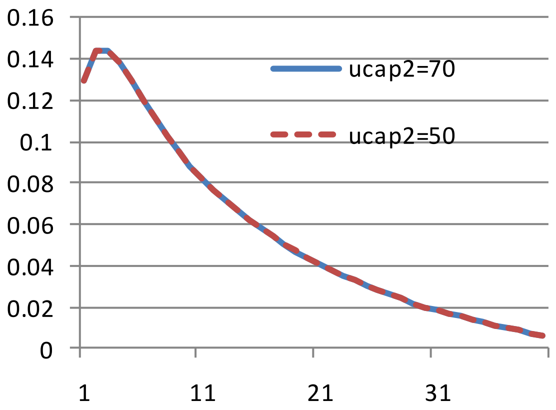


Figure A2.3 **Effect of change in capacity utilisation adjustment cost on the GDP impact of fiscal measures**
Percentage, quarter

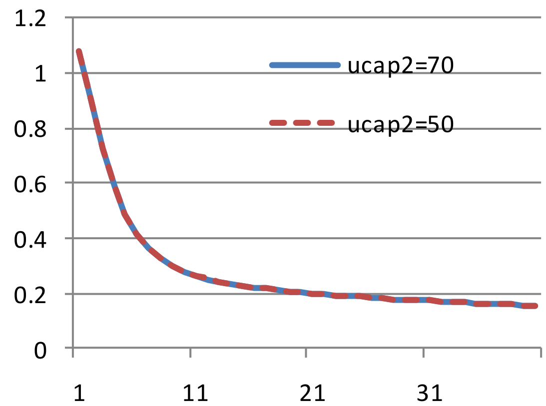
Government consumption



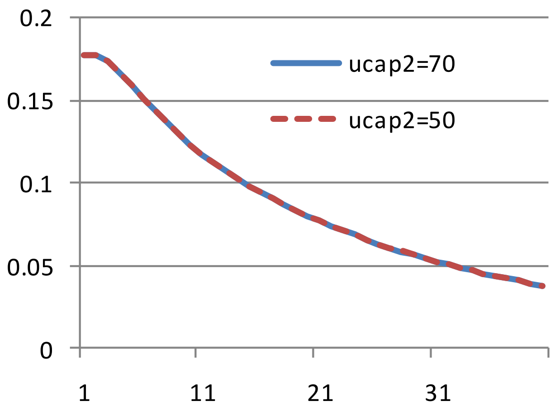
Consumption tax



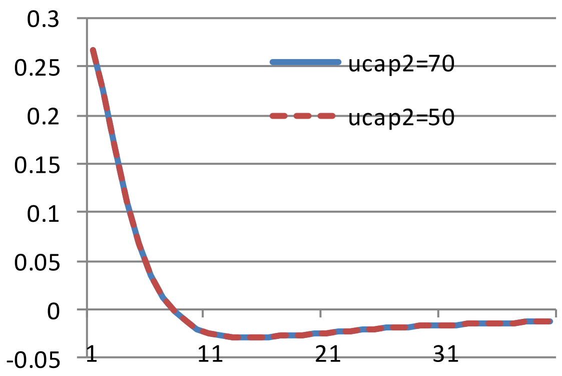
Government investment



Wage tax



Transfers



Capital tax

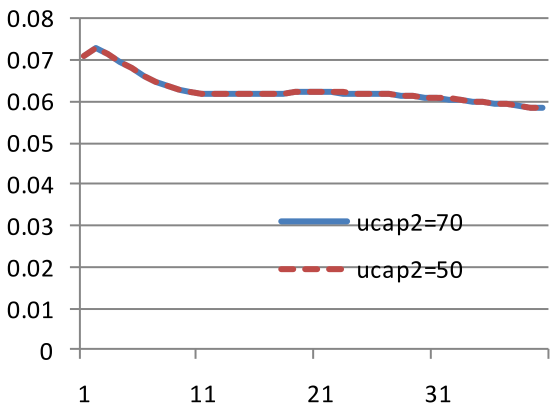


Figure A2.4 **Effect of change in investment costs on the GDP impact of fiscal measures**
Percentage, quarter

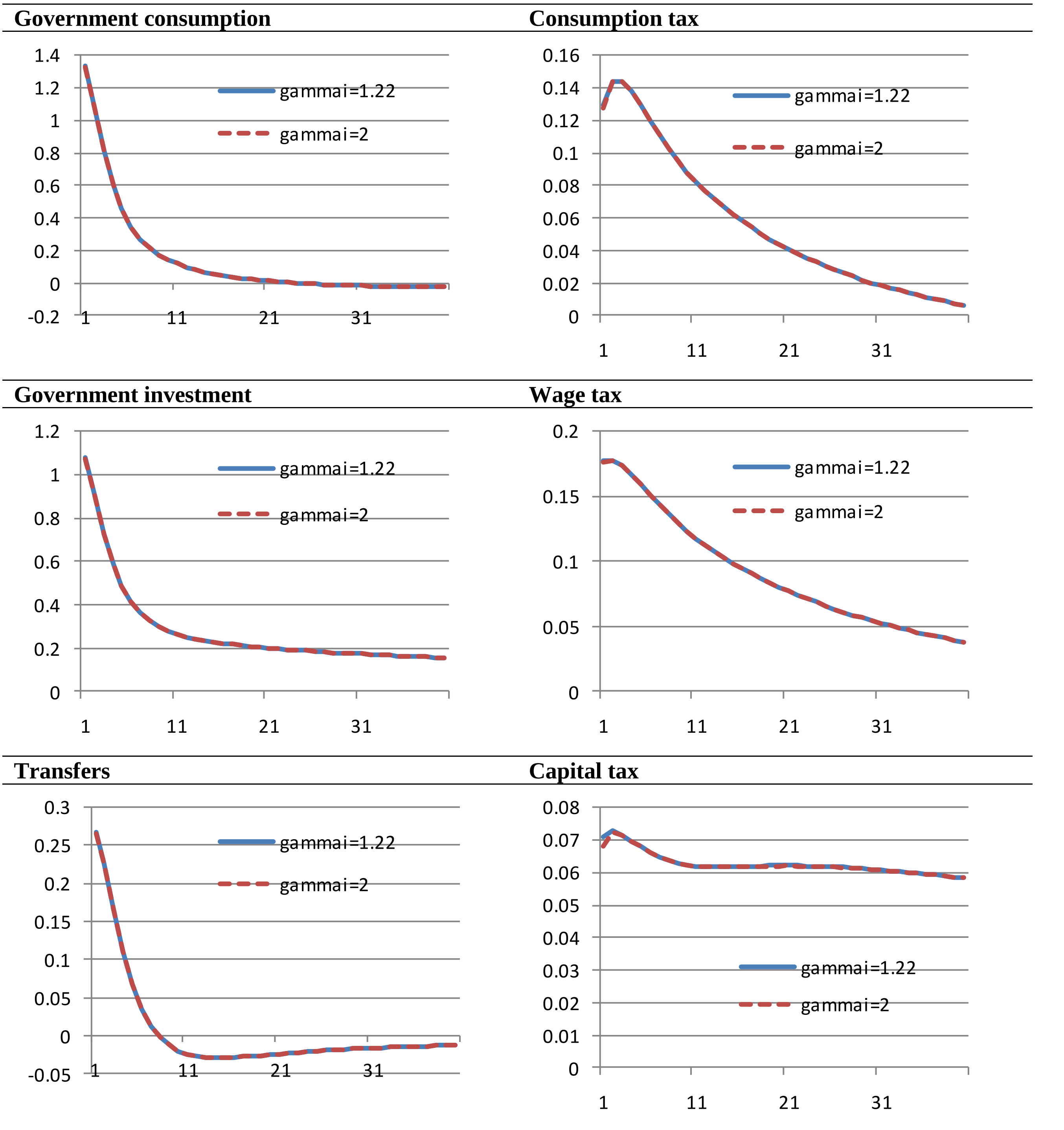
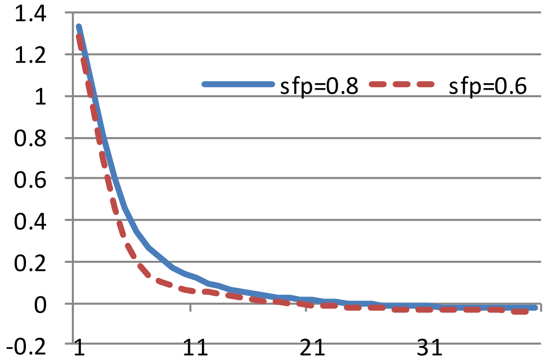
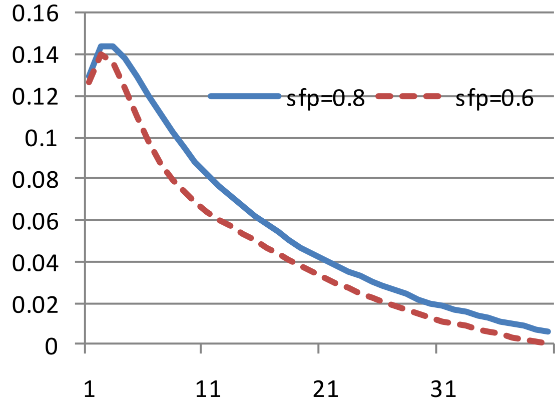


Figure A2.5 **Effect of change in price inertia on the GDP impact of fiscal measures**
Percentage, quarter

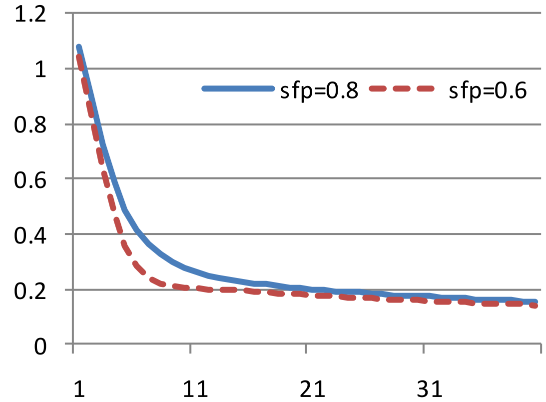
Government consumption



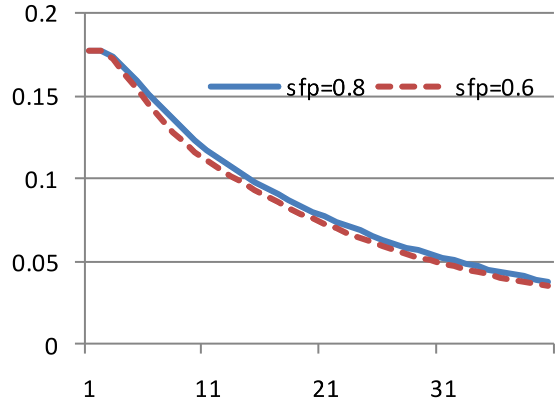
Consumption tax



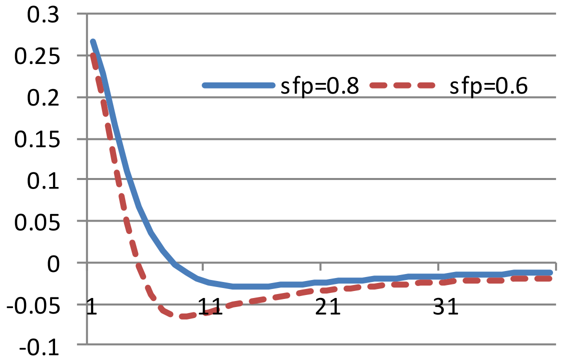
Government investment



Wage tax



Transfers



Capital tax

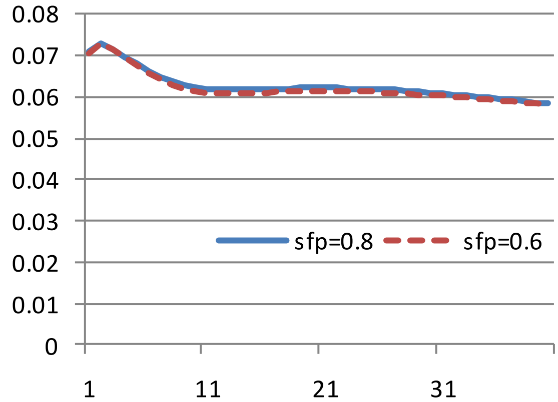
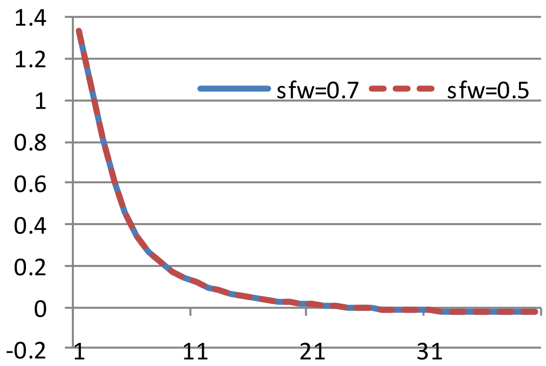
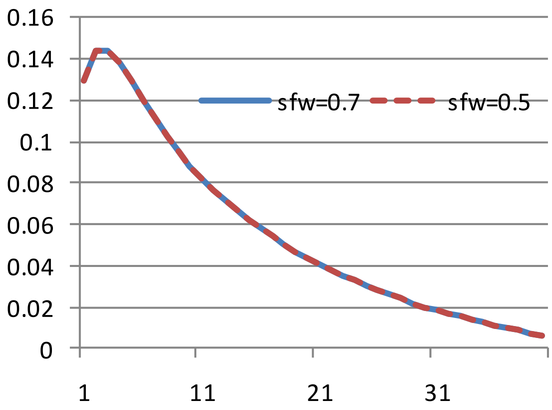


Figure A2.6 **Effect of change in wage inertia on the GDP impact of fiscal measures**
Percentage, quarters

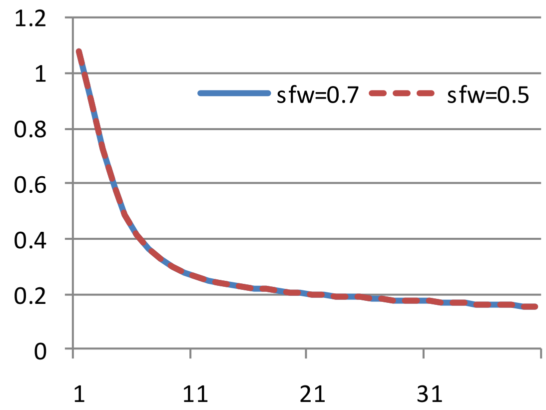
Government consumption



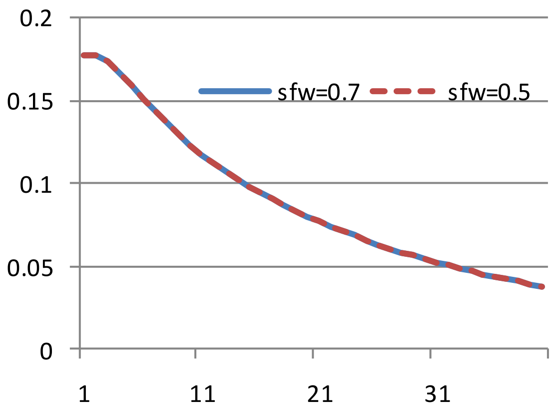
Consumption tax



Government investment



Wage tax



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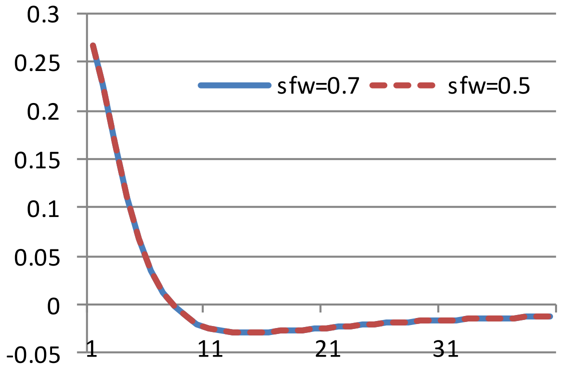


Capital tax

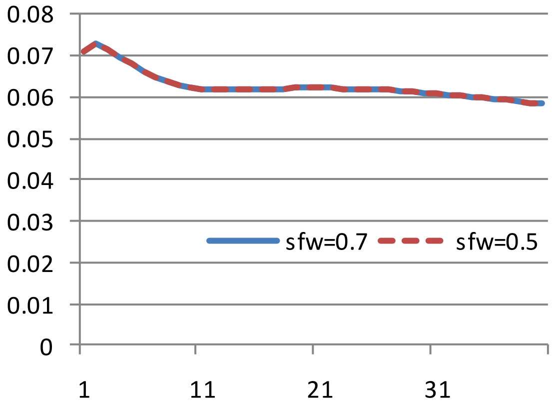
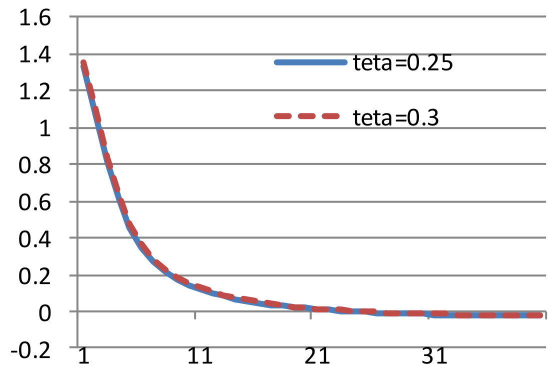


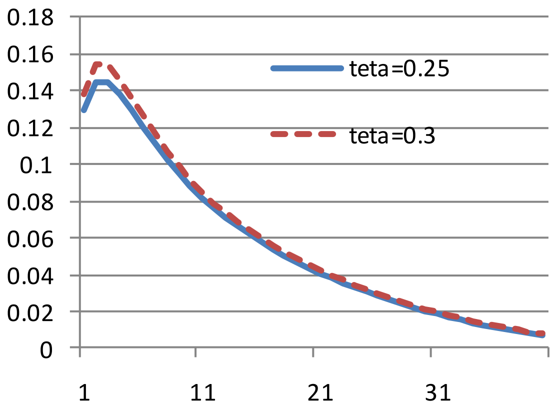
Figure A2.7 **Effect of change in deficit sensitivity in the government bond equation on the GDP impact of fiscal measures**

Percentage, quarters

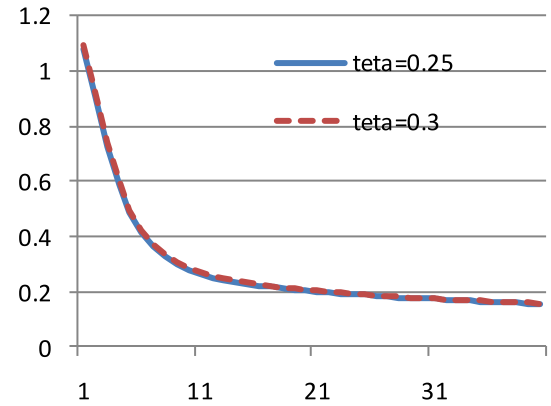
Government consumption



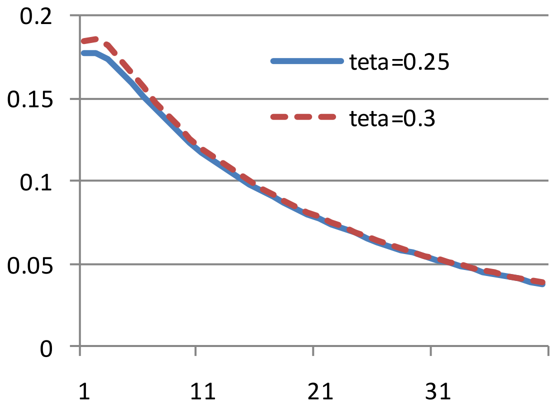
Consumption tax



Government investment



Wage tax



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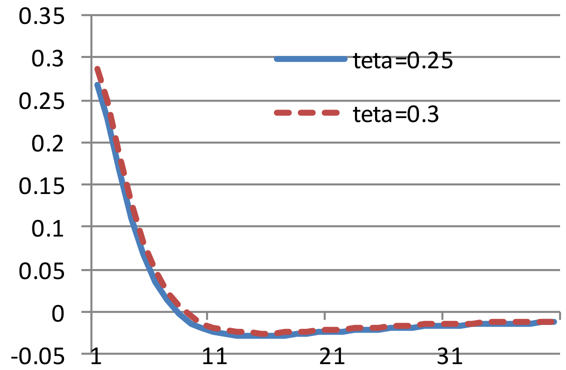


Capital tax

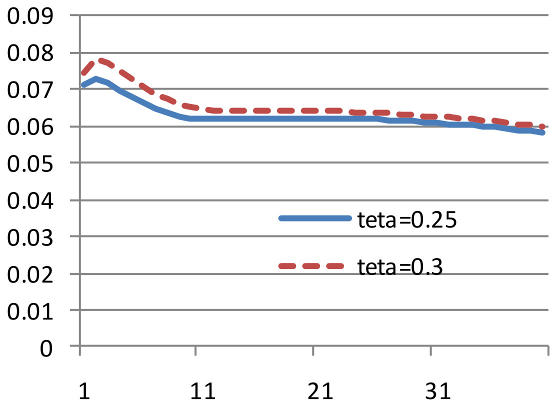
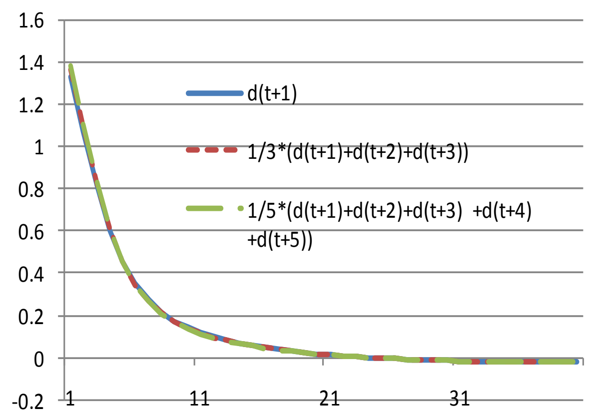


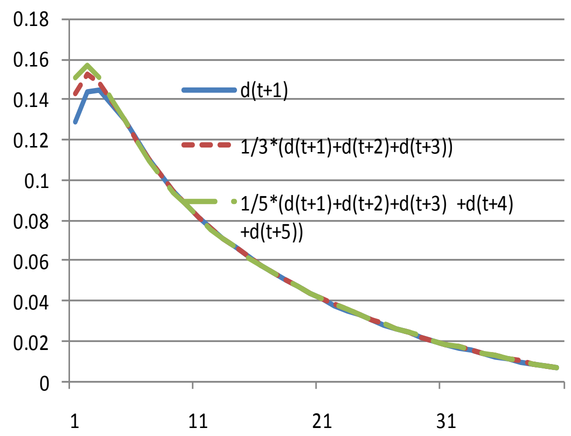
Figure A2.8 **Effect of change in the specification of government bonds equation on the GDP impact of fiscal measures**

Percentage, quarters

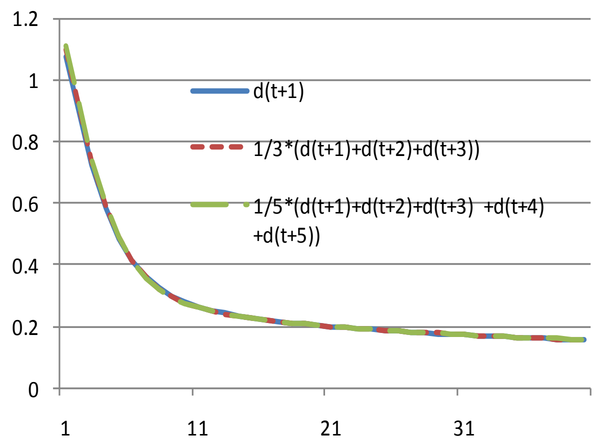
Government consumption



Consumption tax



Government investment



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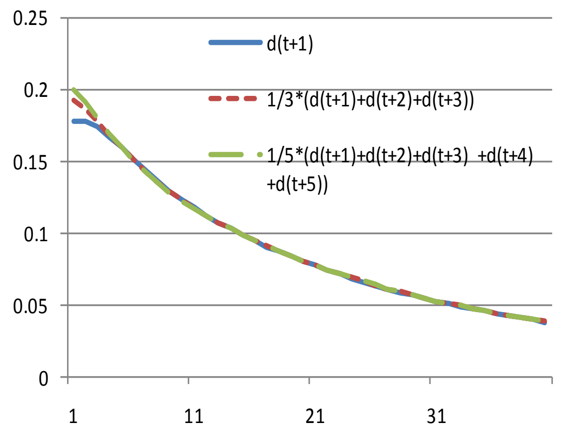

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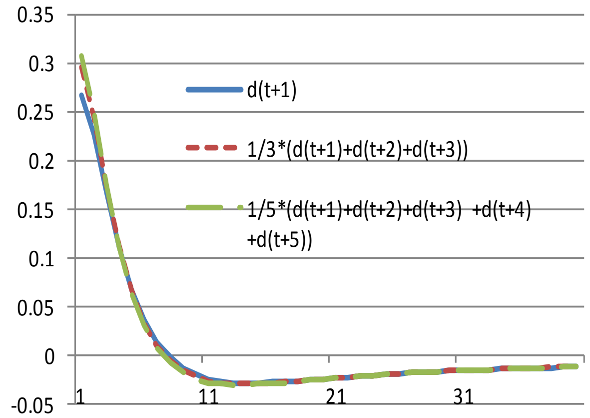

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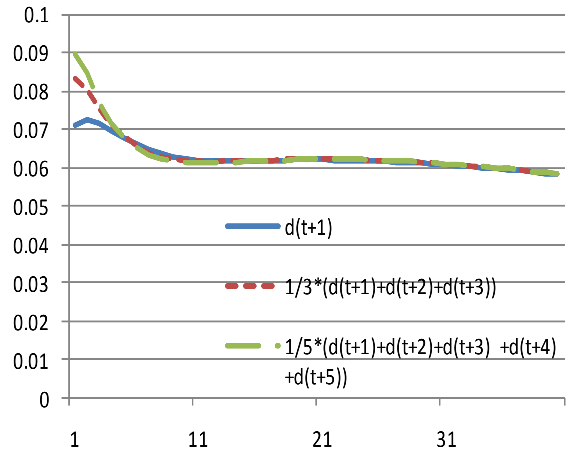

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