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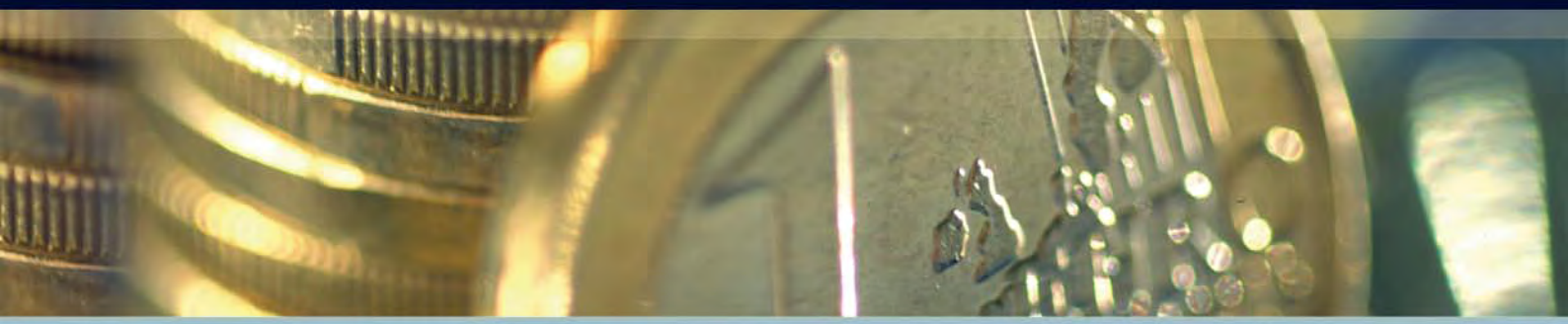

Fiscal stimulus and exit strategies in the EU: a model-based analysis

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Fiscal stimulus and exit strategies in the EU: a model-based analysis *

by

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Abstract

This paper uses a multi-region dynamic general equilibrium model with collateral constrained households and residential investment to examine the effectiveness of fiscal policy. The presence of credit constrained households makes fiscal policy a more powerful tool for short run stabilisation and reinforces the effects from monetary accommodation at the zero lower bound. There exists an asymmetry between fiscal multipliers of temporary stimulus and multipliers of permanent fiscal consolidation, with the latter being smaller. Fiscal consolidations are likely to have short term negative output effects, but GDP will be higher in the medium and long run. Designing consolidations in such a way as to maximise the long term growth benefits from tax reforms could help to minimise the short term costs.

JEL Classification: E21; E62; F42; H31; H63
Keywords: Fiscal Policy, Monetary Policy, Fiscal Multiplier, Collateral Constraint, DSGE modelling

* The views expressed in this paper are those of the authors and should not be attributed to the European Commission.

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1. Introduction

In response to the collapse in output following the financial crisis, the European Commission called for an EU-wide framework of fiscal and structural measures to support growth (European Economic Recovery Plan). Despite widespread scepticism about the effectiveness of fiscal policy as a stabilisation tool, it was argued that the specific circumstances surrounding the crisis warranted fiscal stimulus measures, in particular the increase in households facing credit constraints and the fact that the zero lower bound on nominal interest rates had become binding and monetary policy could accommodate a fiscal stimulus. Both these factors increase the effectiveness of temporary fiscal stimulus measures and could justify significant fiscal stimulus measures.

However, when the crisis unfolded the underlying deterioration in fiscal positions became more and more apparent and led to widespread concerns about the long-run sustainability of public finances. This manifested itself in sharp increases in risk premia on sovereign bonds of the countries most perceived at risk. But even in countries with lower government debt ratios a general consensus view has taken hold that large consolidations are now required to bring fiscal positions back on a sustainable path. Although the fiscal stimulus packages were not the main driving factor behind the deterioration in fiscal positions – and had probably only a relatively minor impact on fiscal positions - calls for a fiscal exit have become stronger.

This paper discusses the effectiveness of fiscal policy at the current juncture, and focuses in particular first on the effects of fiscal stimulus measures and their withdrawal, and, second, on the effects of permanent fiscal consolidations that can help to reduce government debt. We base our analysis on the QUEST III model, a dynamic stochastic general equilibrium (DSGE) model which allows for a disaggregation of households into credit-constrained and non-constrained groups, where the importance of tighter credit constraints on the effectiveness of discretionary fiscal policy can be analysed. The presence of credit-constrained households raises the marginal propensity to consume out of current net income and makes fiscal policy shocks that directly impact on households' purchasing power a more powerful tool for short run stabilisation. It also reinforces the effects from monetary accommodation as credit-constrained consumers react even more strongly to a fall in real interest rates which occurs when the zero lower bound on nominal interest rates is binding. Just as the positive effects of a fiscal stimulus are larger than under normal conditions in the presence of credit-constrained households and monetary policy at the zero lower bound, the cost of a withdrawal will also be larger if these conditions still hold.

There is however an important asymmetry between the fiscal multiplier of a temporary stimulus and that of a permanent fiscal consolidation. The impact of a temporary fiscal shock is larger than that of a permanent change, and hence, the loss in output from permanent fiscal consolidations is lower than that of temporary changes in the fiscal stance. Fiscal retrenchment is likely to lower output on impact, but if the permanent nature of the fiscal consolidation is fully credible economic agents could anticipate a lower tax burden in the future. As the stock of outstanding debt gradually declines, the costs of servicing this debt also falls and creates space for reductions in distortionary taxes. In the medium and long run, this can boost employment and output.

This paper is structured as follows. The next section briefly describes fiscal policy developments in the European Union and the deterioration in fiscal positions. This is followed by a description of the model. We then discuss first how the presence of credit constraints in the model and monetary accommodation raises the multiplier for temporary fiscal shocks. This is followed by a discussion of the effects of permanent fiscal expansions and higher debt. In section 7 we then discuss possible consolidation scenarios that reduce government deficits

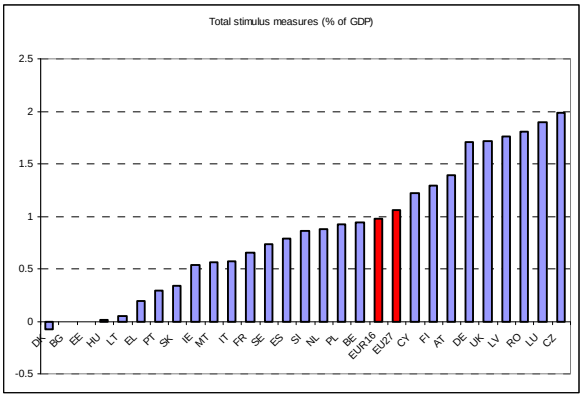
permanently and compare the effects of alternative fiscal instruments. The last section concludes.

2. Recent fiscal policy developments in the European Union

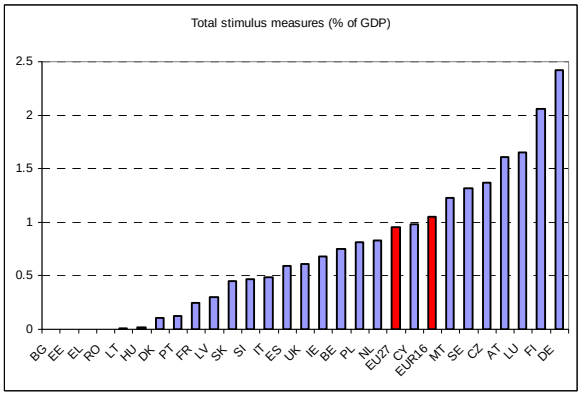
In response to the financial crisis, the EU Member States implemented large fiscal stimulus packages. The EU has combined structural reforms with active fiscal stimulus to address the economic downturn[1]. It is estimated that the overall discretionary fiscal stimulus over 2009 and 2010 in the European Union amounted to more than 2% of GDP, and this was further enhanced by the workings of automatic stabilisers. The stimulus packages have broadly followed desirable general principles, i.e. they were differentiated according to the available fiscal room for manoeuvre and relied on measures that were targeted, timely and temporary. The dispersion of package sizes is considerable (see Figure 1). On average in the EU, the fiscal stimulus in 2009 amounted to more than 1 % of GDP and slightly less than that in 2010, with generally a strong emphasis on measures supporting household income. Many of the countries most affected by the crisis, particularly among the new Member States, have had very limited room to implement stimulus measures (and have often predominantly adopted consolidation measures with a view to avoiding a further fall-out from the crisis).

Figure 1: Fiscal stimulus measures in the EU

2009:



2010:



Source: Commission services.

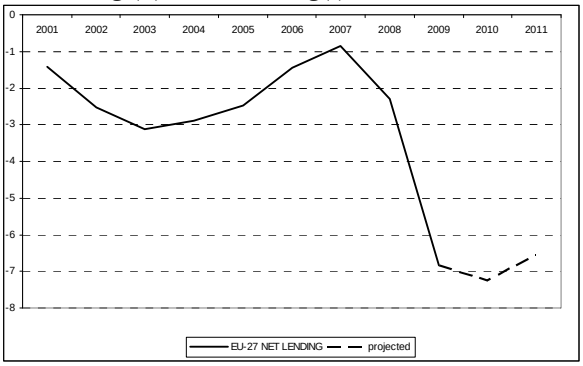
The fiscal stimulus added to the underlying deterioration in fiscal positions which manifested itself when the crisis unfolded. In many countries credit and asset price booms had led to improvements in fiscal positions in recent years. But the failure to fully account for the direct and indirect effect of strong asset prices on fiscal positions led to a distorted and overly optimistic picture of the underlying fiscal stance. In addition, the ongoing negative effects of the financial crisis on potential growth put further pressure on fiscal positions and have led to widespread concern about the long-run sustainability of public finances. The aggregate

[1] The European Economic Recovery Plan (EERP) was launched back in December 2008. The objective of the EERP was to restore confidence and bolster demand through a coordinated injection of purchasing power into the economy complemented by strategic investments and measures to shore up business and labour markets. The EERP is estimated to total around 2% of GDP over 2009-10, including EUR 20 billion (0.3 % of EU GDP) through loans funded by the European Investment Bank

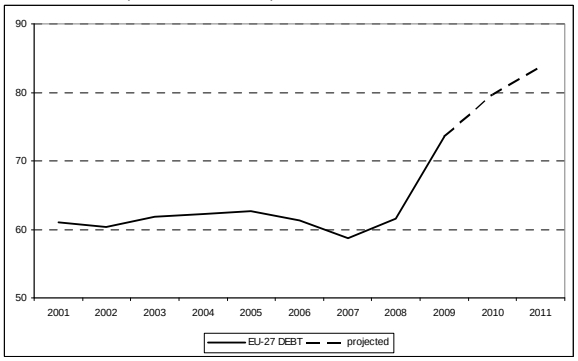
government budget deficit in the EU-27 increased sharply in the crisis, from less than 1% of GDP in 2007 to more than 7 % of GDP in 2009. This has led to a strong rise in the debt to GDP ratio for the EU27, to more than 80 % of GDP projected in 2011 (see Figure 2). Although the fiscal stimulus packages were not the main reason for the deterioration in the fiscal positions, and had probably only a relatively minor impact, the unsustainable path of public finances reinforced the calls for an early exit from the stimulus measures.

Figure 2: EU-27 Fiscal deficits and government debt

Net lending (+) net borrowing(-), as % of GDP:



Gross debt (as % of GDP)



Source: Commission services.

3. The model

The model used in this exercise is an extended version of the QUEST III model (Ratto et al., 2009) with collateral constrained households and residential investment (see Roeger and in 't Veld, 2009). We use a 2-region version of this model, calibrated for the European Union and the rest of the world. By disaggregating households into credit-constrained and a non-constrained group, along the lines suggested by the literature on collateral constraints[2], we can examine the importance of tighter credit constraints on the effectiveness of discretionary fiscal policy.

There are three production sectors in each region, namely a sector producing tradables, non tradables and houses. We distinguish between Ricardian households which have full access to financial markets, credit-constrained households facing a collateral constraint on their borrowing and liquidity-constrained households which do not engage in financial markets. And there is a monetary and fiscal authority, both following rules based stabilisation policies. Behavioural and technological relationships can be subject to autocorrelated shocks denoted by U_t^k, where k stands for the type of shock. The logarithm of U_t^k [3] will generally be autocorrelated with autocorrelation coefficient ρ^k and innovation ε_t^k.

[2] See e.g. Kiyotaki and Moore (1997) , Iacoviello (2005), Monacelli (2007).

[3] Lower cases denote logarithms, i.e. $z_t = log(Z_t)$. Lower cases are also used for ratios and rates. In particular we define $p_t^j = P_t^j / P_t^{GDP}$ as the relative price of good j w. r. t. the GDP deflator

3.1 Firms:

There is a tradable and a non tradable sector, and there is a housing sector.

3.1.1 Producers of tradables and non tradables

Firms operating in the tradable and non tradable sector are indexed by *T* and *NT* respectively *j=(T,NT).* Each firm produces a variety of the domestic good which is an imperfect substitute for varieties produced by other firms. Because of imperfect substitutability, firms are monopolistically competitive in the goods market and face a demand function for goods. Domestic firms in the tradable sector sell consumption goods and services to private domestic and foreign households and the domestic and foreign government and they sell investment and intermediate goods to other domestic and foreign firms. The non tradable sector sells consumption goods and services only to domestic households and the domestic government and they sell investment and intermediate goods only to domestic firms including the residential construction sector. Preferences for varieties of tradables and non tradables can differ resulting in different mark ups for the tradable and non tradable sector.
Output is produced with a CES production function nesting a Cobb Douglas technology for value added using capital K_t^j and production workers $L_t^j - LO_t^j$, augmented with public capital K_t^G , and a CES function for domestically produced (*INTD)*, imported (*INTF)* and non-tradable intermediates *INTNT* .

(1) $$O_t^j = \left\{ (1-s_{\text{int}})^{\frac{1}{\sigma in}} . Y^{j\,(\frac{\sigma in-1}{\sigma in})} + s_{\text{int}}^{\frac{1}{\sigma in}} . INT^{j\,(\frac{\sigma in-1}{\sigma in})} \right\}^{\frac{\sigma in}{\sigma in-1}}$$

(2) $$Y_t^j = (ucap_t^j K_t^j)^{1-\alpha} (L_t^j - LO_t^j)^{\alpha} U_t^{Y\,\alpha} \left(K_t^G\right)^{\alpha_G}, \qquad \text{with} \quad L_t^j = \left[\int_0^1 L_t^{i,j\,\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}}.$$

(3)

$$INT_t^j = \left\{ s_T^{\,1/\sigma nt} \left[\left\{ sdom^{\frac{1}{\sigma}} INTD^{\left(\frac{\sigma-1}{\sigma}\right)} + (1-sdom)^{\frac{1}{\sigma}} INTF^{\left(\frac{\sigma-1}{\sigma}\right)} \right\}^{(\frac{\sigma}{\sigma-1})} \right]^{(\frac{\sigma nt-1}{\sigma nt})} + (1-s_T)^{1/\sigma nt} INTNT^{(\frac{\sigma nt-1}{\sigma nt})} \right\}^{(\frac{\sigma nt}{\sigma nt-1})}$$

The term LO_t^j represents overhead labour. Total employment of the firm L_t^j is itself a CES aggregate of labour supplied by individual households *i.* The parameter $\theta > 1$ determines the degree of substitutability among different types of labour. Firms also decide about the degree of capacity utilisation ($UCAP_t^j$). There is an economy wide technology shock U_t^Y. The objective of the firm is to maximise profits *Pr*

(4) $$\text{Pr}_t^j = p_t^j Y_t^j - w_t L_t^j - i_t^K p_t^{K,j} K_t^j - (adj^P(P_t^j) + adj^L(L_t^j) + adj^{UCAP}(ucap_t^j)).$$

where i^K denotes the rental rate of capital. Firms also face technological and regulatory constraints which restrict their price setting, employment and capacity utilisation decisions. Price setting rigidities can be the result of the internal organisation of the firm or specific customer-firm relationships associated with certain market structures. Costs of adjusting labour have a strong job specific component (e.g. training costs) but higher employment

adjustment costs may also arise in heavily regulated labour markets with search frictions. Costs associated with the utilisation of capital can result from higher maintenance costs associated with a more intensive use of a piece of capital equipment. The following convex functional forms are chosen

$$
\begin{aligned}
& adj^{L}(L_t^j) = w_t(L_t^j u_t^L + \frac{\gamma_L}{2}\Delta L_t^{j\,2}) \\
& adj^{P}(P_t^j) = \frac{\gamma_P}{2}\frac{(P_t^j - P_{t-1}^j)^2}{P_{t-1}^j} \\
& adj^{UCAP}(ucap_t^j) = PI_t K_t(\gamma_{ucap,1}(ucap_t^j - 1) + \frac{\gamma_{ucap,2}}{2}(ucap_t^j - 1)^2)
\end{aligned}
\tag{5}
$$

The firm determines labour input, capital services and prices optimally in each period given the technological and administrative constraints as well as demand conditions. The first order conditions are given by:

$$\frac{\partial \Pr_t^j}{\partial L_t^j} => \left(\frac{\partial O_t^j}{\partial L_t^j}\eta_t^j - w_t u_t^L - w_t\gamma_L\Delta L_t^j + E_t(w_{t+1}\frac{\gamma_L}{(1+r_t)}\Delta L_{t+1}^j)\right) = w_t \tag{6a}$$

$$\frac{\partial \Pr_t^j}{\partial K_t^j} => \left(\frac{\partial O_t^j}{\partial K_t^j}\eta_t^j\right) = i_t^K p_t^{K,j} \tag{6b}$$

$$\frac{\partial \Pr_t^j}{\partial ucap_t^j} => \left(\frac{\partial O_t^j}{\partial ucap_t^j}\eta_t^j\right) = \frac{P_t^{K,j}}{P_t^j}K_t^j(\gamma_{ucap,1} + \gamma_{ucap,2}(ucap_t^j - 1)) \tag{6c}$$

$$\frac{\partial \Pr_t^j}{\partial O_t^j} => \eta_t^j = 1 - 1/\sigma^d - \gamma_P\left[\frac{1}{(1+r_t)}E_t\pi_{t+1}^j - \pi_t^j\right] \quad \text{with } \pi_t^j = P_t^j/P_{t-1}^j - 1\ . \tag{6d}$$

where η_t is the Lagrange multiplier of the technological constraint and r_t is the real interest rate. Firms equate the marginal product of labour, net of marginal adjustment costs, to wage costs. As can be seen from the left hand side of equation (6a), the convex part of the adjustment cost function penalises in cost terms accelerations and decelerations of changes in employment. Equations (6b-c) jointly determine the optimal capital stock and capacity utilisation by equating the marginal value product of capital to the rental price and the marginal product of capital services to the marginal cost of increasing capacity. Equation (6d) defines the mark up factor as a function of the elasticity of substitution and changes in inflation. The average mark up is equal to the inverse of the price elasticity of demand. We follow the empirical literature and allow for additional backward looking elements by assuming that a fraction (*1-sfp*) of firms index price increases to inflation in t-1. Finally we also allow for a mark up shock. This leads to the following specification:

$$\eta_t^j = 1 - 1/\sigma^d - \gamma_P\left|\beta(sfpE_t\pi_{t+1}^j + (1-sfp)\pi_{t-1}^j) - \pi_t^j\right| - u_t^\eta \quad 0 \le sfp \le 1 \tag{6d'}$$

3.1.2 Residential construction

Firms *h* in the residential construction sector use new land (J_t^{Land}) sold by (Ricardian) households and non tradable goods ($J_t^{inp,H}$) to produce new houses using a CES technology

$$J_t^H = \left(s_L^{\frac{1}{\sigma_L}} J_t^{Land\,\frac{(\sigma_L - 1)}{\sigma_L}} + (1 - s_L)^{\frac{1}{\sigma_L}} J_t^{inp,H\,\frac{(\sigma_L - 1)}{\sigma_L}}\right) \tag{7}$$

Firms in the residential construction sector are monopolistically competitive and face price adjustment costs. Thus the mark up is given by

$$(8) \qquad \eta_t^H = 1 - 1/\sigma^H - \gamma_H \left[\beta (sfp E_t \pi_{t+1}^H + (1 - sfp)\pi_{t-1}^H) - \pi_t^H \right] - u_t^H \qquad 0 \le sfp \le 1$$

New and existing houses are perfect substitutes. Thus households can make capital gains or suffer capital losses depending on house price fluctuations.

3.2 Households:

The household sector consists of a continuum of households $h \in [0,1]$. There are $s^l \le 1$ households which are liquidity constrained and indexed by *l.* These households do not trade on asset markets and consume their disposable income each period. A fraction s^r of all households are Ricardian and indexed by *r* and s^c households are credit constrained and indexed by *c.* The period utility function is identical for each household type and separable in consumption (C_t^h) , leisure ($1 - L_t^h$) and housing services (H_t^h). We also allow for habit persistence in consumption and leisure. Thus temporal utility for consumption is given by

$$(9) \qquad U(C_t^h, 1 - L_t^h, H_t^h) = \log\left(C_t^h - hC_{t-1}\right) + \vartheta\left(1 - L_t^h\right)^{1-\kappa} + \omega \log\left(H_t^h\right)$$

All three types of households supply differentiated labour services to unions which maximise a joint utility function for each type of labour *i.* It is assumed that types of labour are distributed equally over the three household types. Nominal rigidity in wage setting is introduced by assuming that the household faces adjustment costs for changing wages. These adjustment costs are borne by the household.

3.2.1 Ricardian households

Ricardian households have full access to financial markets. They hold domestic government bonds($B_t^{G\,r}$) and bonds issued by other domestic and foreign households ($B_t^r, B_t^{F,r}$), real capitals (K_t^j) of the tradable and non tradable sector as well as the stock of land ($Land_t$) which is still available for building new houses and cash balances (M_t^r). The household receives income from labour, both in the private and public sector, financial assets, rental income from lending capital to firms, selling land to the residential construction sector plus profit income from firms owned by the household (tradables, non tradables, residential construction). We assume that all domestic firms are owned by Ricardian households. Income from labour is taxed at rate t^w, rental income at rate t^k and investors can receive an investment subsidy (itc_t). In addition households pay lump-sum taxes T^{LS}. We assume that income from financial wealth is subject to different types of risk. Domestic bonds yield risk-free nominal return equal to i_t. Domestic and foreign bonds are subject to (stochastic) risk premia linked to net foreign indebtedness. Current spending is allocated to consumption (C_t^r), investment in equipment and structures (I_t^j) as well as residential investment ($I_t^{H,r}, I_t^{HLC,r}$). An equity premium on real assets arises because of uncertainty about the future value of real assets. The Lagrangian of this maximisation problem is given by

$$Max \quad V_0^r = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{rt} U(C_t^r, 1-L_t^r, H_t^r)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \beta^{rt} \left(\begin{array}{l} (1+t_t^c) p_t^C C_t^r + \sum_j p_t^{K,j} (1-itc_t) I_t^j + p_t^H (1+t_t^c) I_t^{H,r} + p_t^H (1+t_t^c) I_t^{HLC,r} + (B_t^{G,r} + B_t^r) \\ + rer_t B_t^{F,r} - (1+r_{t-1})(B_{t-1}^{G,r} + B_{t-1}^r) - (1+r_{t-1}^F)(1-risk(.)) rer_t B_{t-1}^{F,r} \\ - \sum_j ((1-t_t^k) i_{t-1}^{K,j} + t_t \, \delta^{k,j}) p_{t-1}^{K,j} K_{t-1}^j - (1-t_t^W)(w_t^P L_t^{P,r} + w_t^G L_t^{G,r}) + \frac{\gamma_W}{2} \frac{\Delta W_t^{\,2}}{W_{t-1}} - \\ ((1-t^k) i_{t-1}^H + \delta^H) p_t^H H_{t-1}^{LC,r} - p_t^L J_t^{Land} - \sum_{j=1} \mathrm{Pr}_t^j - \mathrm{Pr}_t^H + t_t^H p_{t-1}^H (H_{t-1}^r + H_{t-1}^{LC,r}) + T_t^{LS,r} \end{array} \right)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \beta^{rt} \left(\sum_j \xi_t^j (K_t^j - J_t^j - (1-\delta^{K,j}) K_{t-1}^j) \right)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \zeta_t^r \beta^{rt} \left(H_t^r - J_t^{H,r} - (1-\delta^H) H_{t-1}^{H,r} \right)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \vartheta_t^r \beta^{rt} \left(H_t^{LC,r} - J_t^{HLC,r} - (1-\delta^H) H_{t-1}^{LC,r} \right)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \xi_t^r \beta^{rt} \left(Land_t + J_t^{Land} - (1+g_t^L) Land_{t-1} \right) \tag{10}$$

The investment decisions w.r.t. physical capital and housing are subject to convex adjustment costs, therefore we make a distinction between real investment expenditure (I_t^j, I_t^H) and physical investment (J_t^j, J_t^H). Investment expenditure of households including adjustment costs is given by

$$I_t^j = J_t^j \left(1 + \frac{(\gamma_K^j + u_t^j)}{2} \left(\frac{J_t^j}{K_t^j} \right) \right) + \frac{\gamma_I^j}{2} (\Delta J_t^j)^2 \tag{11a}$$

$$I_t^{H,r} = J_t^{H,r} \left(1 + \frac{(\gamma_H + u_t^H)}{2} \left(\frac{J_t^{H,r}}{H_t^r} \right) \right) + \frac{\gamma_I H}{2} (\Delta J_t^{H,r})^2 \tag{11b}$$

The budget constraint is written in real terms with all prices expressed relative to the GDP deflator (*P*). Investment is a composite of domestic and foreign goods. From the first order conditions we can derive the following consumption rule, where the ratio of the marginal utility of consumption in period t and t+1 is equated to the real interest rate adjusted for the rate of time preference

$$\frac{\mathrm{E}_t (C_{t+1}^r - hC_t)}{C_t^r - hC_{t-1}} = \beta^r (1+r_t) \tag{12}$$

From the arbitrage condition of investment we can derive an investment rule which links capital formation to the shadow price of capital.

$$\left((\gamma_K^j + u_t^j) \left(\frac{J_t^{K,j}}{K_{t-1}^j} \right) + \gamma_I^j \Delta J_t^{K,j} \right) - E_t \left(\frac{1}{(1+r+\pi_{t+1}^{GDP} - \pi_{t+1}^{K,j})} \Delta J_{t+1}^{K,i} \right) = \frac{\xi_t^j}{p_t^K (1-itc_t)} - 1 \tag{13}$$

Where the shadow price of capital is given as the present discounted value of the rental income from physical capital

$$(14) \qquad \frac{\xi_t^j}{p_t^{K,j}} = \mathrm{E}_t\left(\frac{1}{(1+r_t+\pi_{t+1}^{GDP}-\pi_{t+1}^{K,j})} \frac{\xi_{t+1}^j}{p_{t+1}^{K,j}} (1-\delta^K) \right) + ((1-t_t^K) i_t^K + t_t^K \delta^{K,j}) = 0$$

From the FOC for housing investment we can derive a housing investment rule, which links investment to the shadow price of housing capital

$$(15) \qquad \left((\gamma_H + u_t^H) \left(\frac{J_t^{H,r}}{H_{t-1}^r} \right) + \gamma_{IH} \Delta J_t^{H,r} \right) - E_t \left(\frac{1}{(1+r_t+\pi_{t+1}^{GDP}-\pi_{t+1}^H-\Delta t_{t+1}^c)} \Delta J_{t+1}^{H,r} \right) = \frac{\zeta_t^r}{p_t^H (1+t_t^c)} - 1.$$

The shadow price of housing capital can be represented as the present discounted value of the ratio of the marginal utility of housing services and consumption

(16)

$$\frac{\zeta_t^r}{p_t^H (1+t_t^c)} = \omega^r \frac{(C_t^r - hC_{t-1})(1+t_t^c) p_t^C}{H_t^r (1+t_t^c) p_t^H} + \mathrm{E}_t \left(\frac{1}{(1+r_t+\pi_{t+1}^{GDP}-\pi_{t+1}^H - t_t^H p_{t-1}^H - \Delta t_{t+1}^c)} \frac{\zeta_{t+1}^r}{p_{t+1}^h (1+t_{t+1}^c)} (1-\delta^H) \right)$$

For the price of land we one obtain a (quasi) Hotelling rule

$$(17) \qquad p_t^{Land} = \mathrm{E}_t \left(\frac{1}{(1+r_t)} p_{t+1}^{Land} (1+g_L) \right)$$

The growth rate of the price of land must guarantee a rate of return which can be earned by other assets, i.e. the growth rate of the price of land must be equal to $r_t - g_L$.

3.2.2 Credit constrained households

Credit constrained households differ from Ricardian households in two respects. First they have a higher rate of time preference ($\beta^c < \beta^r$) and they face a collateral constraint on their borrowing. They borrow B_t^c exclusively from domestic Ricardian households. Ricardian households have the possibility to refinance themselves via the international capital market. The Lagrangian of this maximisation problem is given by

(18)

$$Max \quad V_0^c = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{c\,t} U(C_t^c, 1-L_t^c, H_t^c)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \beta^{c\,t} \left(\begin{array}{l} (1+t_t^c) p_t^C C_t^c + p_t^H (1+t_t^H) I_t^{H,c} - B_t^c + (1+r_{t-1}) B_{t-1}^c - \\ (1-t_t^W)(w_t^P L_t^{P,c} + w_t^G L_t^{G,c}) + \frac{\gamma_W}{2} \frac{\Delta W_t^{\,2}}{W_{t-1}} + t_t^H p_{t-1}^H H_{t-1}^C + T_t^{LS,c} \end{array} \right)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \zeta_t^c \beta^{c\,t} \left(H_t^c - J_t^{H,c} - (1-\delta^H) H_{t-1}^c \right)$$

$$- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \psi_t \beta^{c\,t} \left(B_t^c - (1-\chi) p_t^H H_t^c \right)$$

From the first order conditions we can derive the following decision rules for consumption

$$(19) \qquad \frac{\mathrm{E}_t(C_{t+1}^c - hC_t)}{C_t^c - hC_{t-1}} = \beta^c \frac{(1+r_t)}{(1-\psi_t)}$$

and housing investment

$$(20) \qquad \left((\gamma_H + u_t^H)\left(\frac{J_t^{H,c}}{H_{t-1}^c}\right) + \gamma_{IH}\Delta J_t^{H,c}\right) - E_t\left(\frac{(1-\psi_t)}{(1+r_t+\pi_{t+1}^{GDP}-\pi_{t+1}^H-\Delta t_{t+1}^c)}\Delta J_{t+1}^{H,c}\right) = \frac{\zeta_t^c}{p_t^H(1+t_t^c)} - 1$$

Where again the shadow price of housing capital is the present discounted value of the ratio of the marginal utility of housing services and consumption

(21)

$$\frac{\zeta_t^c}{p_t^H(1+t_t^c)} = \omega^c \frac{(C_t^c - hC_{t-1})(1+t_t^c)p_t^C}{H_t^c(1+t_t^c)p_t^H} + \psi_t(1-\chi) + \mathrm{E}_t\left(\frac{(1-\psi_t)}{(1+r_t+\pi_{t+1}^{GDP}-\pi_{t+1}^H-t_t^H p_{t-1}^H-\Delta t_{t+1}^c)}\frac{\zeta_{t+1}^c}{p_{t+1}^H(1+t_{t+1}^c)}(1-\delta^H)\right)$$

The major difference between credit constrained and Ricardian households is the presence of the Lagrange multiplier of the collateral constraint in both the consumption and the investment rule of the former. The term ψ_t acts like premium on the interest rate which fluctuates positively with the tightness of the constraint.

3.2.3 Liquidity constrained households

Liquidity constrained households do not optimize but simply consume their entire labour income at each date. Real consumption of household *k* is thus determined by net wage income plus transfers minus a lump-sum tax

$$(22) \qquad (1+t_t^c)P_t^c C_t^l = (1-t_t^w)W_t L_{tt}^l + TR_t^l - T_t^{LS,l}$$

It is assumed that liquidity constrained households possess the same utility function as Ricardian households.

3.2.4 Wage setting

A trade union is maximising a joint utility function for each type of labour *i* where it is assumed that types of labour are distributed equally over constrained and unconstrained households with their respective population weights. The trade union sets wages by maximising a weighted average of the utility functions of these households. The wage rule is obtained by equating a weighted average of the marginal utility of leisure to a weighted average of the marginal utility of consumption times the real wage, adjusted for a wage mark up

(23) $$\frac{s^c U^c_{1-L,t} + s^r U^r_{1-L,t} + s^l U^l_{1-L,t}}{s^c U^c_{c,t} + s^r U^r_{c,t} + s^l U^l_{c,t}} = \frac{(1-t^W_t)}{(1+t^C_t)} \frac{W_t}{P^C_t} \eta^W_t$$

where η^W_t is the wage mark up factor, with wage mark ups fluctuating around $1/\theta$ which is the inverse of the elasticity of substitution between different varieties of labour services. The trade union sets the consumption wage as a mark up over the reservation wage. The reservation wage is the ratio of the marginal utility of leisure to the marginal utility of consumption. This is a natural measure of the reservation wage. If this ratio is equal to the consumption wage, the household is indifferent between supplying an additional unit of labour and spending the additional income on consumption and not increasing labour supply. Fluctuation in the wage mark up arises because of wage adjustment costs and the fact that a fraction (*1-sfw*) of workers is indexing the growth rate of wages π^W_t to inflation in the previous period.

(24)
$$\eta^W_t = 1 - 1/\theta - \gamma_W / \theta \left[\beta(\pi^W_{t+1} - (1-sfw)\pi_t) - (\pi^W_t - (1-sfw)\pi_{t-1}) \right] \quad 0 \le sfw \le 1$$

Combining (23) and (24) one can show that the (semi) elasticity of wage inflation with respect to the employment rate is given by (κ/γ_W), i.e. it is positively related to the inverse of the labour supply elasticity and inversely related to wage adjustment costs.

3.2.5 Aggregation

The aggregate of any household specific variable X^h_t in per capita terms is given by $X_t = \int_0^1 X^h_t dh = s^r X^r_t + s^c X^c_t + s^l X^l_t$ since households within each group are identical. Hence aggregate consumption is given by

(25a) $C_t = s^r C^r_t + s^c C^c_t + s^l C^l_t$

and aggregate employment is given by

(25b) $L_t = s^r L^r_t + s^c L^c_t + s^l L^l_t$ with $L^r_t = L^c_t = L^l_t$.

Since liquidity constrained households do not own financial assets we have $B^l_t = B^{lF}_t = K^l_t = 0$ .Credit constrained households only engage in debt contracts with Ricardian households, therefore we have

(26) $$B^c_t = \frac{s^r}{s^c} B^r_t .$$

3.3 Trade and the current account

So far we have only determined aggregate consumption, investment and government purchases but not the allocation of expenditure over domestic and foreign goods. In order to facilitate aggregation we assume that households, the government and the corporate sector have identical preferences across goods used for private consumption, public expenditure and

investment. Let $Z^i \in \{C^i, I^i, C^{G,i}, I^{G,i}\}$ be demand of an individual household, investor or the government, and then their preferences are given by the following utility function

$$(27a) \quad Z^i = \left[(1 - s^M - u_t^M)^{\frac{1}{\sigma^M}} Z^{d\,i}{}^{\frac{\sigma^M - 1}{\sigma^M}} + (s^M + u_t^M)^{\frac{1}{\sigma^M}} Z^{f\,i}{}^{\frac{\sigma^M - 1}{\sigma^M}} \right]^{\frac{\sigma^M}{(\sigma^M - 1)}}$$

where the share parameter s^M can be subject to random shocks and $Z^{d\,i}$ and $Z^{f\,i}$ are indexes of demand across the continuum of differentiated goods produced respectively in the domestic economy and abroad, given by.

$$(27b) \quad Z^{d\,i} = \left[\sum_{h=1}^{n} \left(\frac{1}{n}\right)^{\frac{1}{\sigma^d}} Z_h^{d\,i}{}^{\frac{\sigma^d - 1}{\sigma^d}} \right]^{\frac{\sigma^d}{\sigma^d - 1}} \quad , \quad Z^{f\,i} = \left[\sum_{h=1}^{m} \left(\frac{1}{m}\right)^{\frac{1}{\sigma^f}} Z_h^{f\,i}{}^{\frac{\sigma^f - 1}{\sigma^f}} \right]^{\frac{\sigma^f}{\sigma^f - 1}}$$

The elasticity of substitution between bundles of domestic and foreign goods $Z^{d\,i}$ and $Z^{f\,i}$ is σ^M. Thus aggregate imports are given by

$$(28) \quad M_t = (s^M + u_t^M) \left[\rho^{PCPM} \frac{P_{t-1}^{\ C}}{P_{t-1}^{\ M}} + (1 - \rho^{PCPM}) \frac{P_t^{\ C}}{P_t^{\ M}} \right]^{\sigma^M} (C_t + I_t^{inp} + C_t^G + I_t^G)$$

where P^C and P^M is the (utility based) consumer price deflator and the lag structure captures delivery lags.. We assume similar demand behaviour in the rest of the world, therefore exports can be treated symmetrically and are given by

$$(29) \quad X_t = (s^{M,W} + u_t^X) \left(\rho^{PWPX} \frac{P_{t-1}^{\ C,F} E_{t-1}}{P_{t-1}^{\ X}} + (1 - \rho^{PWPX}) \frac{P_t^{\ C,F} E_t}{P_t^{\ X}} \right)^{\sigma^X} Y_t^F$$

where P_t^X, $P_t^{C,F}$ and Y_t^F are the export deflator, an index of world consumer prices (in foreign currency) and world demand. Prices for exports and imports are set by domestic and foreign exporters respectively. The exporters in both regions buy goods from their respective domestic producers and sell them in foreign markets. They transform domestic goods into exportables using a linear technology. Exporters act as monopolistic competitors in export markets and charge a mark-up over domestic prices. Thus export prices are given by

$$(30) \quad \eta_t^X P_t^X = P_t$$

and import prices are given by

$$(31) \quad \eta_t^M P_t^M = E_t P_t^F$$

Mark-up fluctuations arise because of price adjustment costs. There is also some backward indexation of prices since a fraction of exporters (*1-sfpx*) and (*1-sfpm*) is indexing changes of prices to past inflation. The mark ups for import and export prices is also subject to random shocks

$$(32) \quad \eta_t^k = 1 - 1/\sigma^k - \gamma_{Pk} \left[\beta (sfp^k \cdot_t \pi_{t+1}^k + (1 - sfp^k) \pi_{t-1}^k) - \pi_t^k \right] + u_t^{P,k} \qquad k = \{X, M\}$$

Exports and imports together with interest receipts/payments determine the evolution of net foreign assets denominated in domestic currency.

$$(33) \qquad E_t B_t^F = (1+i_t^F)E_t B_{t-1}^F + P_t^X X_t - P_t^M M_t$$

3.4 Policy

We assume that monetary policy is partly rules based and partly discretionary. Policy responds to an output gap indicator of the business cycle. The output gap is not calculated as the difference between actual and efficient output but we try to use a measure that closely approximates the standard practice of output gap calculation as used for fiscal surveillance and monetary policy (see Denis et al. (2006)). Often a production function framework is used where the output gap is defined as deviation of capital and labour utilisation from their long run trends. Therefore we define the output gap as

$$(34) \qquad YGAP_t = \left(\frac{ucap_t}{ucap_t^{ss}}\right)^{(1-\alpha)} \left(\frac{L_t}{L_t^{ss}}\right)^{\alpha}.$$

where L_t^{ss} and $ucap_t^{ss}$ are moving average steady state employment rate and capacity utilisation:

$$(35) \qquad ucap_t^{ss} = (1-\rho^{ucap})ucap_{t-1}^{ss} + \rho^{ucap} ucap_t^j$$

$$(36) \qquad L_t^{ss} = (1-\rho^{Lss})L_{t-1}^{ss} + \rho^{Lss} L_t$$

which we restrict to move slowly in response to actual values.

Monetary policy is modelled via the following Taylor rule, which allows for some smoothness of the interest rate response to the inflation and output gap

$$(37) \qquad \begin{aligned} i_t = {} & \tau_{lag}^{INOM} i_{t-1} + (1-\tau_{lag}^{INOM})[r^{EQ} + \pi^T + \tau_{\pi}^{INOM}(\pi_t^C - \pi^T) + \tau_{y,1}^{INOM} ygap_{t-1}] \\ & + \tau_{y,2}^{INOM} ({}_t ygap_{t+1} - ygap_t) + u_t^{INOM} \end{aligned}$$

The Central bank has a constant inflation target π^T and it adjusts interest rates whenever actual consumer price inflation deviates from the target. The central bank also responds to the output gap. There is also some inertia in nominal interest rate setting. There is no active fiscal policy.

In the government budget constraint, we disaggregate government consumption into government wage bill and purchases of goods and services. We further include government investment, transfer payments to households and investment subsidies. Revenue consists of taxes on labour income, on consumption and housing investment, on housing property, profit income, and lump-sum taxes. Government debt (B_t) evolves according to

$$
\begin{aligned}
(38)\quad & B_t = (1+i_t+rp_t^B)B_{t-1} + W_t^G L_t^G + P_t^C C_t^G + P_t^C I_t^G + TR_t + itc_t\, P_t^I I_t \\
& - t_t^w (W_t^P L_t^P + W_t^G L_t^G) - t_t^c P_t^c C_t - t_t^c P_t^H I_t^H - t_t^H P_{t-1}^H H_{t-1} - t_t^K i_t^K P_t^I K_{t-1} - T_t^{LS}
\end{aligned}
$$

where we allow for a sovereign risk premium rp_t^B depending on the debt-to-GDP ratio.

The labour income tax rate is used for controlling the debt to GDP ratio, or alternatively target a deficit to GDP ratio, according to the following rule

$$
(39)\quad \Delta t_t^w = \tau^B \left(\frac{B_{t-1}}{GDP_{t-1}P_{t-1}} - b^T\right) + \tau^{\Delta B}\Delta\left(\frac{B_t}{GDP_t P_t}\right) + \tau^{DEF}\left(\frac{\Delta B_t}{GDP_t P_1} - def^T\right)
$$

where b^T is the government debt target and def^T the deficit target.

3.5 Equilibrium

Equilibrium in our model economy is an allocation, a price system and monetary and fiscal policies such that both non-constrained and constrained households maximise utility, final goods producing firms, firms in the construction sector and investment goods producer maximise profits and the following market clearing condition for final goods holds:

$$
(47)\quad Y_t = C_t + J_t^{inp} + J_t^{Constr} + C_t^G + I_t^G + X_t - M_t
$$

Inputs of final goods are used in the investment goods sector and in residential construction and the allocation of aggregate consumption and housing investment over different groups of households is as specified in equations 27.

Total GDP is defined as

$$
(48)\quad GDP_t = Y_t + w_t^G L_t^G
$$

4. Model calibration

The model used in this exercise consists of two regions: the European Union and the rest of the world. The regions are differentiated from one another by their economic size and the model is calibrated on bilateral trade flows. Our calibration incorporates some of the main stylised differences between the EU and the rest of world, and we base it as much as possible on estimates of the model on euro area and US data (see Ratto *et al*., 2010).

Table 1 summarises the main differences between the two blocks. These are, for the EU, higher transfers and unemployment benefits, higher wage taxes, higher price rigidities and labour adjustment costs, and a lower elasticity of labour supply. In terms of nominal and real rigidities, our estimates reveal clear differences which are largely consistent with prior expectations and other empirical evidence. This is most clear when it comes to price adjustment rigidities. European firms keep prices fixed for more quarters than US firms. Our estimates suggest that the duration of wage spells in the US is similar to those in the EA. There are however significant differences in the labour supply elasticity. A significantly higher elasticity in the US translates into a smaller response in US wages to changes in

employment[4]. Another estimation result that coincides well with a priori beliefs on employment protection are higher labour adjustment costs in the EU. According to these estimates, administrative costs of increasing employment amount to about 13% of total additional wage costs in the EA and only 10% in the US. There is less evidence on differences in capital adjustment costs. Concerning financial market frictions, we assume 30 percent of households to be liquidity-constrained, which corresponds closely to our estimates, and we keep this share unchanged. We assume in our benchmark model (CC) the share of credit-constrained households to be 30 percent, and the remaining 40 percent to be unconstrained (Ricardian). We compare this to an alternative model *RIC* where the credit-constrained group is shifted to the non-constrained Ricardian group and the ratios liquidity constrained–credit constrained–non constrained are 30-0-70. This allows us to focus on the impact the introduction of credit-constrained households makes in the response of the private sector to the fiscal expansions. The loan-to-value ratio (1-χ) is set at 0.75 for both regions, calibrated to fit a mortgage debt ratio as share of GDP on the baseline of around 50 percent. The estimated Taylor rules do not point to sizeable differences in monetary policy behaviour and we set these parameters identical.

Another important stylised fact is the difference between the EU and the US in the generosity of the transfer system. The share of government transfers to households is higher in the Euro area than in the US. The main difference is a more generous unemployment benefit system and a higher emphasis on PAYG pension schemes in the EU. Apart from the generosity difference there is also a difference in benefit-and pension entitlements because of a higher unemployment rate and a higher old age dependency ratio in the EU compared to the US.

[4] This is consistent with our Phillips curve estimates which also show a stronger response of wage inflation to unemployment in the Euro area compared to the US.

Table 1: Model calibration

	EU	*US*
Nom. Rigidities:		
Avg. duration between price adjustments (Quarters)	5.5	5
Avg. wage contract length (Quarters)	4.5	4.5
Real Rigidities:		
Labour adjustment cost (% of total add. wage costs) (γ_L)	13	10
Labour supply elasticity ($1/\kappa$)	1/5	1/3
Semi-wage elasticity w.r.t. employment rate (κ/γ_w)	0.33	0.20
Capital adjustment cost (γ_K)	20	20
Investment adjustment cost (γ_I)	75	75
Consumption:		
Share of liquidity-constrained consumers s^l	0.3	0.3
Share of credit-constrained consumers s^c	0.3 (CC) 0 (RIC)	0.3 (CC) 0 (RIC)
Share of non-constrained consumers s^r	0.4 (CC) 0.7 (RIC)	0.4 (CC) 0.7 (RIC)
Downpayment rate χ	0.25	0.25
Habit persistence h	0.7	0.7
Monetary policy:		
Lagged interest rate τ_{lag}^{INOM}	0.85	0.85
Consumer price inflation τ_{π}^{INOM}	1.5	1.5
Output gap τ_{Y}^{INOM}	0.05	0.05
National accounts decomposition:		
Consumption	0.59	0.64
Investment tradedables	0.06	0.05
Investment non-tradables	0.07	0.06
Investment residential	0.06	0.06
Government wage bill	0.10	0.07
Government purchases	0.08	0.08
Government investment	0.04	0.04
Exports	0.18	0.15
Imports	0.18	0.15
Transfers to households	0.16	0.13

5. Temporary fiscal shocks

We first consider temporary fiscal expansions to show the importance of tighter credit constraints on the effectiveness of discretionary fiscal policy. We do this by comparing the results in the model with collateral constraints (CC) to those from the model that excludes this group (RIC). We focus on two types of temporary (one year) fiscal shocks in the EU: an increase in government purchases (unproductive) and a reduction in labour taxes, both standardised to 1 per cent of (baseline) GDP. We compare fiscal multipliers under normal circumstances, i.e. with an active monetary policy rule, to a situation where the zero lower bound on nominal interest rates is binding for one year and nominal interest rates are kept unchanged for that period[5].

Figure 3 shows the effects of a temporary increase in government purchases for the EU in three scenarios: 1) in the model with credit-constrained households (*GC*), 2) in this same model but with monetary accommodation (*IGC*), and 3) in a model without credit-constrained households, and no accommodation (*RICGC*). The last case serves as a benchmark for comparison to illustrate the effects of introducing credit constraints and monetary accommodation into the model. This temporary impulse raises GDP by 0.78 per cent on impact in the model in the model without credit constraints (*RIC)* and 0.81 per cent in the model with credit constraints (*CC*). After four quarters, the stimulus is removed and GDP falls slightly below baseline. Liquidity-constrained households react positively to the spending shock, as employment and real wages are higher. Consumption of non-constrained Ricardian households falls in anticipation of higher future tax liabilities. Collateral-constrained households initially increase their consumption as disposable income rises, like liquidity constrained consumers, but in later periods this effect is offset by the effect of higher real interest rates. Aggregate consumption initially increases but falls in later periods below baseline, thus to some degree avoiding the negative co-movement of public and private consumption, a well documented feature of many DSGE models[6]. Residential investment by non-constrained Ricardian households falls due to the increase in real interest rates, while that of collateral-constrained households rises as disposable income increases. Corporate investment falls due to the increase in real interest rates.

Fiscal policy multipliers become very much larger when the fiscal stimulus is accompanied by monetary accommodation (*IGC*). Under normal circumstances a fiscal stimulus puts upward pressure on inflation and gives rise to an increase in interest rates. With interest rates at, or close to, their lower zero bound, a fiscal stimulus is accommodated by monetary policy and nominal interest rates are held constant. In that case higher inflation leads to a decrease in real interest rates and this indirect monetary channel amplifies the GDP impact of the fiscal stimulus (Christiano *et al.* , 2009, Erceg and Linde, 2009, Woodford, 2010). As shown in Roeger and in 't Veld (2009) collateral-constrained consumers react strongly with a large

[5] The fiscal rule that returns the debt to GDP ratio to baseline levels is turned off for the first year, but from the second year onwards labour taxes are raised to return the debt-to-GDP ratio to baseline. Hence, these scenarios are budgetary neutral in the medium run.

[6] In contrast to our results, Gali *et al.* (2007) show that allowing for a fraction of liquidity constrained consumers exceeding 25 per cent, a model with sticky prices can account for a positive consumption response to a government spending shock. But their result depends crucially on the assumed labour adjustment cost parameter γ_L . Gali *et al.* assume no nominal wage rigidities and no labour adjustment costs, which imply a stronger positive short run impact of an increase in government consumption on labour income and therefore a stronger response of private consumption. However, empirical estimates show these parameters to be significantly different from zero (for a sensitivity analysis see Ratto *et al.* (2009)).

increase in consumption, larger than liquidity constrained consumers, as there is a small loosening of the collateral constraint due to a simultaneous increase in the housing stock, and because there is an additional effect from lower real interest rates. When real interest rates gradually rise back towards baseline levels, the increase in consumption also gradually declines. The model with credit constraints displays a strong increase in aggregate consumption. Note also that with monetary accommodation, there is an increase in corporate and residential investment due to the fall in real interest rates.

Government consumption consists of government purchases and government wage bill, and there is a marked difference in multipliers between these two components. Figure 4 illustrates this, for the model with credit constrained households. On the left it shows the responses to a temporary increase in government purchases as discussed above, on the right hand side the responses to a 1% of GDP shock to government wages. The increase in government wage expenditure directly boosts GDP, as measured in the national accounts, and yields an additional private sector GDP multiplier of 0.3. The increase in government wages raises disposable incomes of public sector employees and leads to a rise in consumption and residential investment. Note however that compared to a government purchases shock, the impact on private sector value added *Y* is smaller, as purchases directly enter the resource constraint for private sector GDP.

The GDP effect of a temporary reduction in *labour taxes* is smaller than that of an increase in spending, as it is partly offset by an increase in savings (see Figure 5). There is however a significant difference when collateral-constrained households are introduced into the model. In the model without credit constrained households (*RICTL*), GDP rises by only 0.2 per cent on impact, while the increase is twice as large (0.4) in the model with credit constraints (*TL*). Non-constrained Ricardian households do not respond to the temporary reduction in taxes as permanent income is not much affected. In contrast, collateral-constrained households have a higher marginal propensity to consume out of disposable income and increase their consumption by a similar degree as liquidity-constrained households. As a result, the increase in aggregate consumption is twice as large in the model with collateral constraints. Real interest rates rise slightly more as a consequence and corporate investment falls by more. Housing investment by collateral-constrained households increases after the tax reduction, as disposable income rises, while that of Ricardian non-constrained households does not change much. The fall in real wages is slightly smaller in the model with credit constraints due to higher consumption (wealth effect). Note that when collateral-constrained consumers are included, there is a small increase in inflationary pressures, at least on impact, as the stronger demand effect now dominates the supply effect of the cut in labour taxes. In both cases there is a small increase in nominal interest rates (not shown here), but this increase is larger in the model with collateral constrained households.

At the zero lower bound, when nominal interest rates are kept unchanged, the impact multiplier of a tax reduction is slightly larger (*ITL*). Real interest rates fall slightly on impact, and consequently there is higher consumption and investment. The finding of positive multipliers of tax cuts is in sharp contrast to a result obtained by Eggertsson (2009), who claims that the labour tax multiplier at the zero bound will be negative. His argument is based on the assumption that a labour tax reduction will only shift the aggregate supply (*AS*) curve to the right in the inflation-GDP space, while the aggregate demand (*AD*) curve does not shift and is upward sloping in the case of a zero bound (B in Figure 6). In contrast to this analysis, in our model there is also a shift of aggregate demand associated with a tax cut (C in Figure 6). There are at least three important sources for such a shift. First, in a single country case

there is an international competitiveness effect as a result of declining costs, which increases net external demand. Second, there is a shift in corporate investment because of an increase in the marginal product of existing capital because of an increase in employment. These effects are not present in Eggertson's model. A tax reduction also shifts consumer spending either via higher net labour income or higher employment. These three demand effects taken together make it unlikely that the labour tax multiplier turns negative at the zero bound in our model.

Figure 6: The effect of cutting taxes at the zero bound

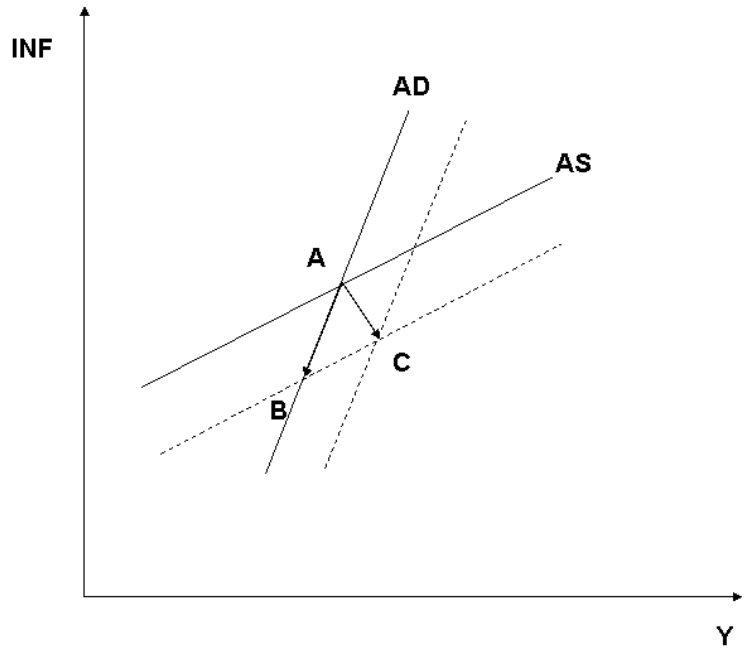
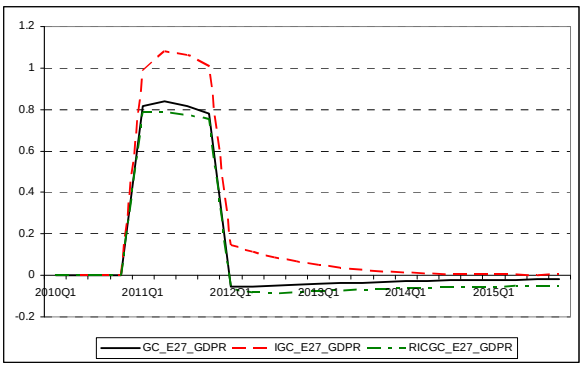
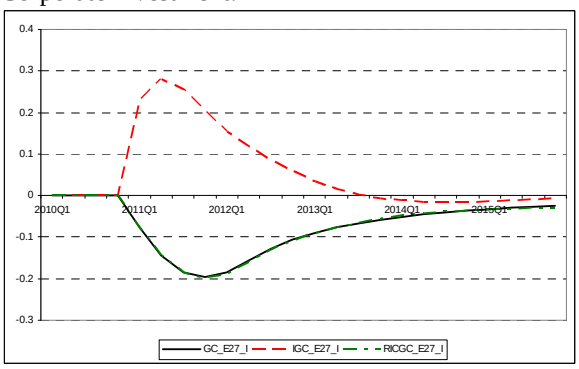


Figure 3: Temporary increase government purchases

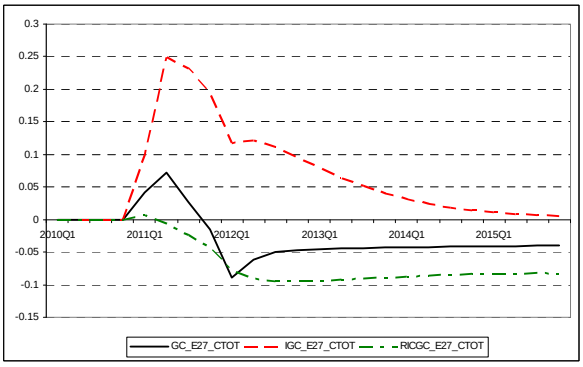
GDP:



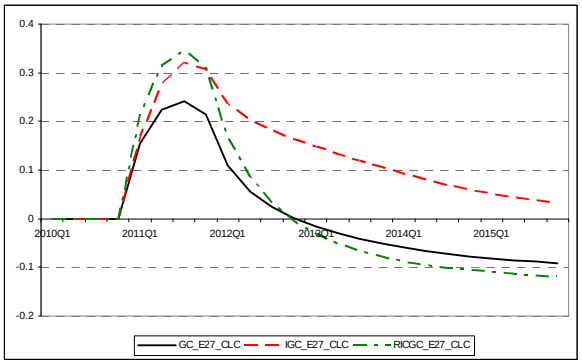
Corporate investment:



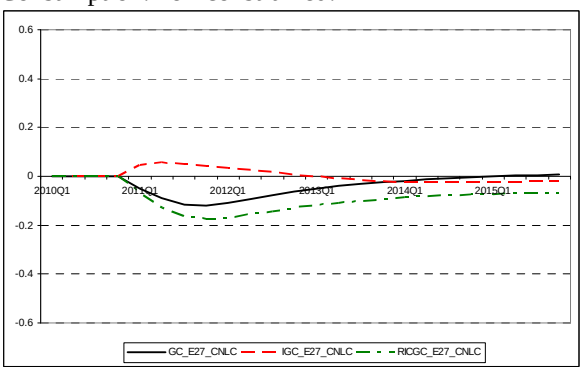
Consumption: aggregate



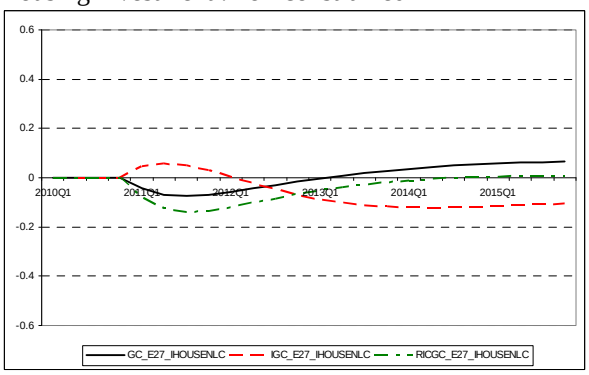
Consumption: liquidity constrained:



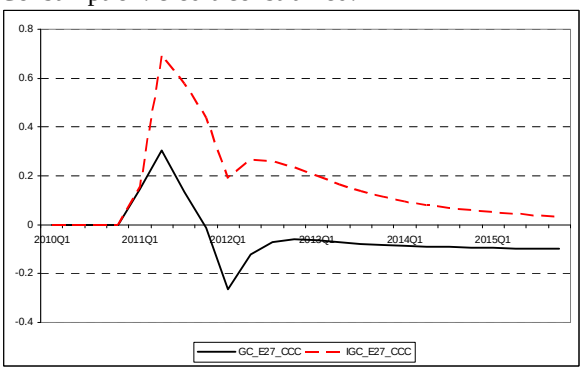
Consumption: non-constrained:



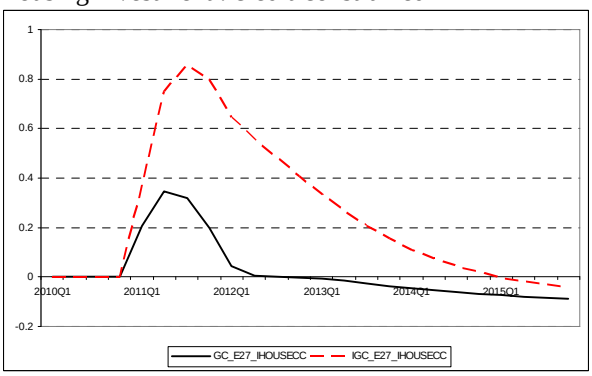
Housing investment : non-constrained



Consumption: credit-constrained:



Housing investment : credit-constrained

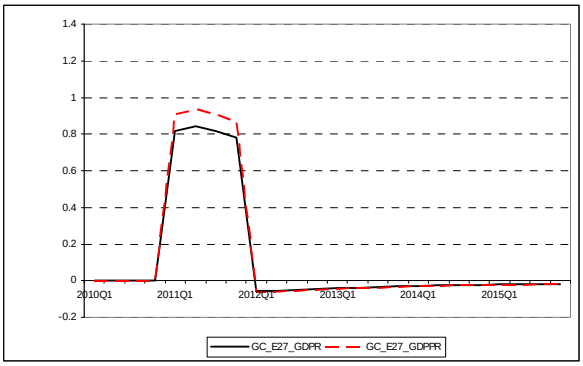


Note: increase in government purchases 1% of GDP for 1 year. GC_: model with collateral constraints; RICGC_: model without collateral constraints; IGC_: model with collateral constraints and monetary accommodation.

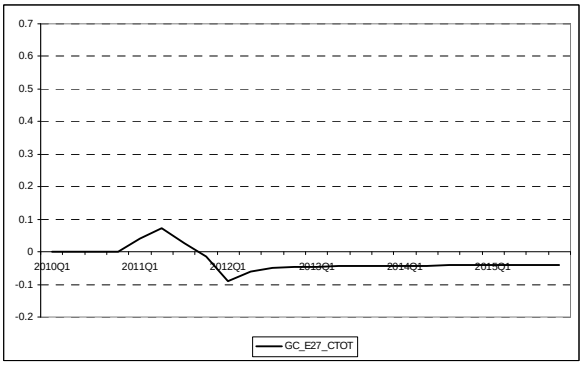
Figure 4: Increase government purchases vs. increase government wages

Government purchases

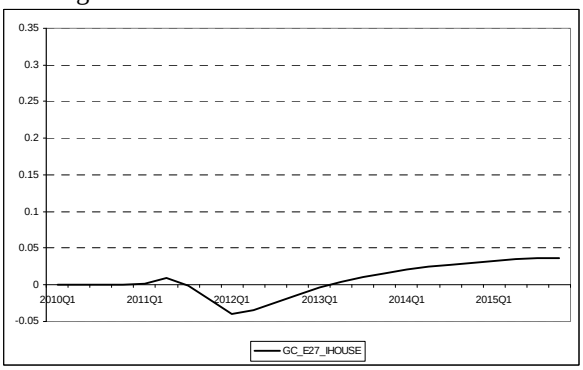
GDP and Private sector Value-added



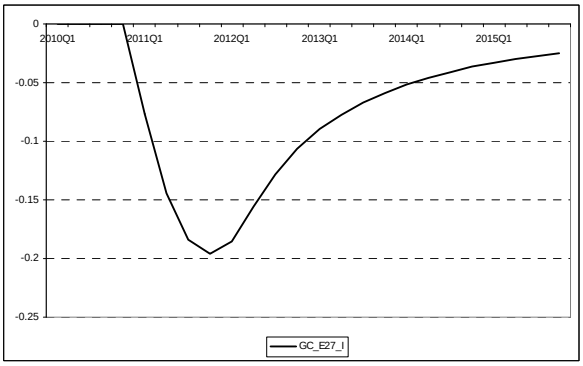
Consumption:



Housing investment

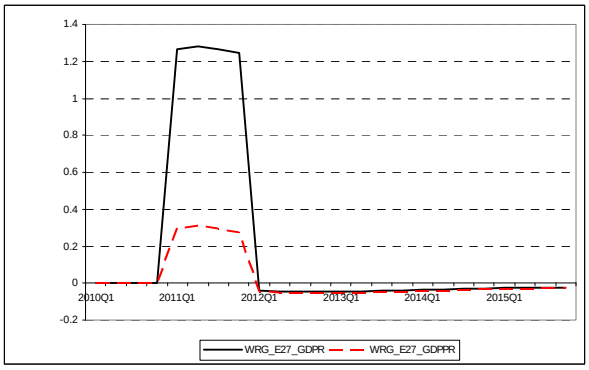


Corporate investment:

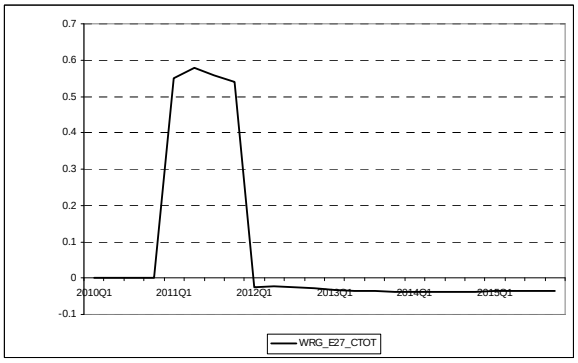


Government wages

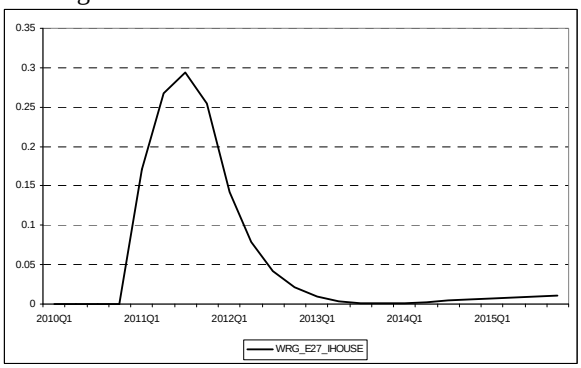
GDP and Private sector Value-added:



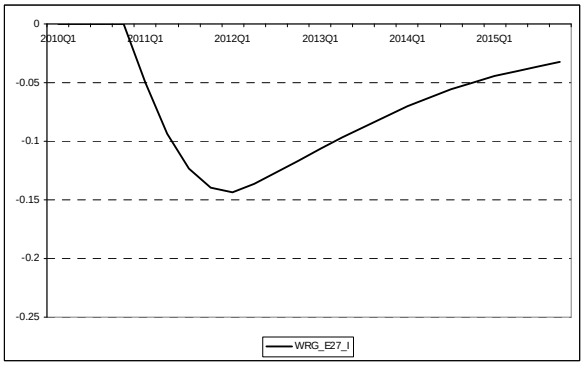
Consumption:



Housing investment:



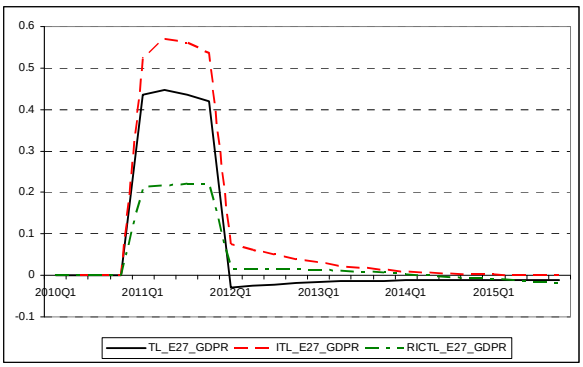
Corporate investment



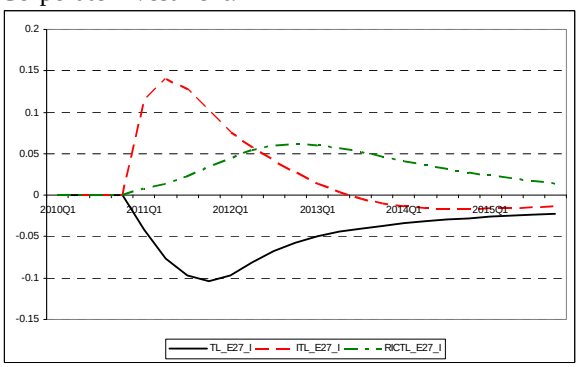
Note: increase in government purchases and government wages resp. 1% of GDP for 1 year. Model with credit constrained households.

Figure 5: Temporary reduction labour taxes

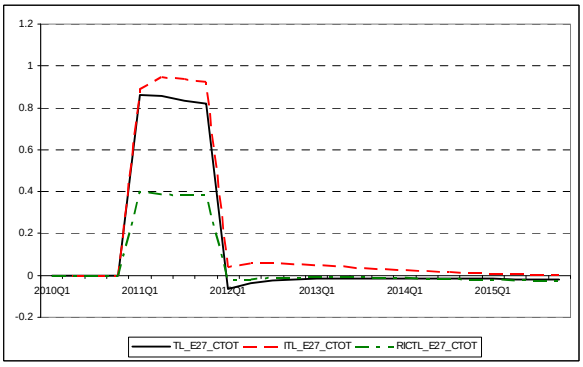
GDP:



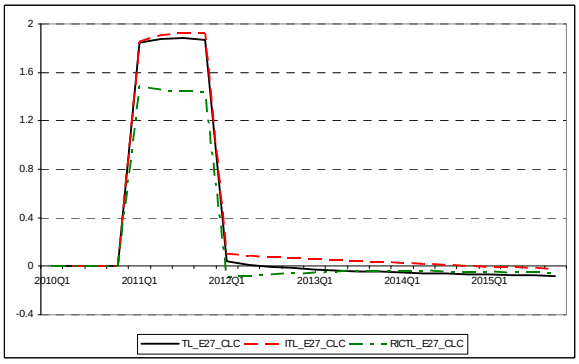
Corporate investment:



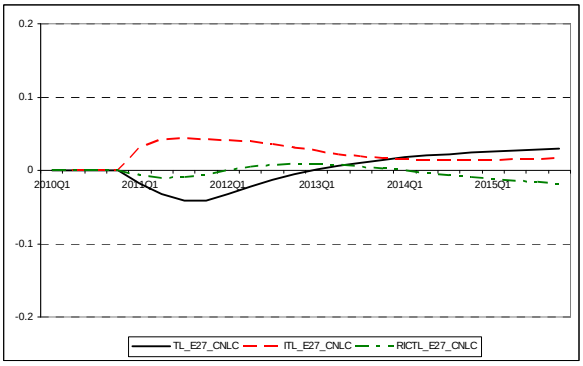
Consumption: aggregate



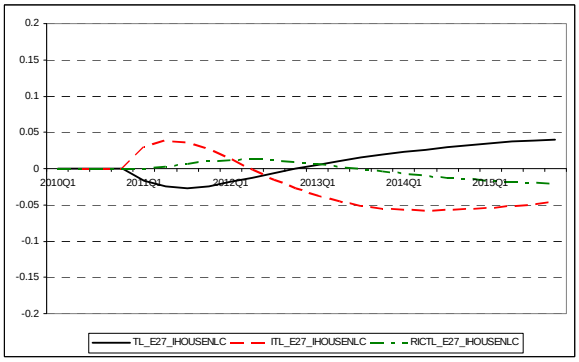
Consumption: liquidity constrained:



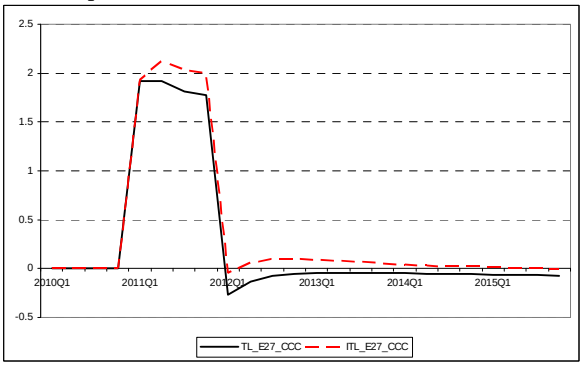
Consumption: non-constrained:



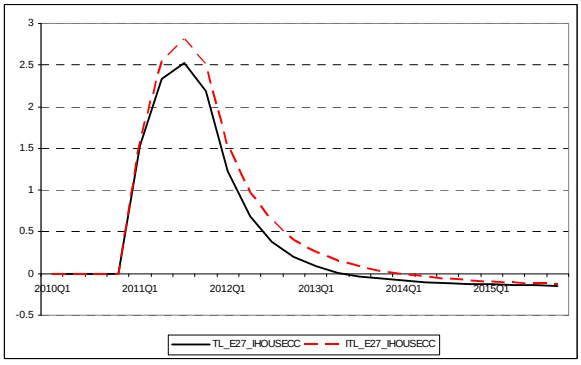
Housing investment : non-constrained



Consumption: credit-constrained:



Housing investment : credit-constrained



Note: reduction in labour taxes 1% of GDP for 1 year. TL_: model with collateral constraints; RICTL_: model without collateral constraints; ITL_: model with collateral constraints and monetary accommodation.

5.2. Fiscal instruments and their multipliers

Table 2 gives an general overview of fiscal multipliers of the various fiscal instruments in 1) a model without collateral constraints, 2) in the model with collateral constrained households, and 3) in a model with collateral constrained households and with monetary accommodation. The multipliers reported in this table are for the EU as an aggregate region, temporary fiscal stimulus, one year shocks of 1% of baseline GDP.

The presence of credit-constrained agents raises fiscal multipliers significantly. The multiplier increases especially for those fiscal measures which increase current income of households directly, such as labour taxes and transfers. Credit constrained households not only have a higher marginal propensity to consume out of current income but their spending is also highly sensitive to changes in real interest rates. When fiscal stimulus is accommodated by monetary policy, as is the case at the zero lower bound, multipliers increase by even more. This is because the collateral constraint requires that spending must be adjusted to changes in interest payments. In other words, the interest rate exerts an income effect on spending of credit constrained households.[7]

In general, GDP effects are larger for public spending shocks (government purchases and investment) than for tax reductions and transfers to households. Temporary increases in *investment subsidies* yield sizeable GDP effects since it leads to a reallocation of investment spending into the period the purchase of new equipment and structures is subsidised. *Government investment* yields a somewhat larger GDP multiplier than *purchases of goods and services*. As shown in Figure 4, an increase in *government wages* has a larger impact on GDP than *purchases* (but a smaller impact on private sector value-added). The multiplier of *government transfers* is smaller, as it goes along with negative labour supply incentives. However, transfers targeted to liquidity constrained consumers provide a more powerful stimulus as these consumers have a larger marginal propensity to consume out of current net income. Temporary reductions in *value added* and *labour taxes* show smaller multipliers, but in these cases it is nearly entirely generated by higher spending of the private sector. A temporary reduction in consumption taxes is more effective than a reduction in labour taxes as forward looking households respond to this change in the intertemporal terms of trade[8]. Temporary reductions in *housing tax* have little impact for Ricardian households, who smooth their spending, but a non-negligible impact for credit constrained households. Temporary *corporate tax* reduction would not yield positive short run GDP effects since firms calculate the tax burden from an investment project over its entire life cycle.

There are also sizeable positive *spill-over effects* from fiscal stimuli. The effects of a global fiscal stimulus (as in the final three columns in Table 2) are larger than when the EU acts alone. In the present crisis there has been a global fiscal stimulus with large fiscal packages implemented in all G20 countries, and model simulations suggest this resulted in larger multipliers.

[7] For realistic magnitudes of indebtedness, the interest sensitivity exceeds the interest elasticity of spending of Ricardian households substantially, see Roeger and in 't Veld (2009).

[8] Note that this assumes the VAT reduction is fully passed through into consumer prices. This intertemporal effect will be strongest in the period just before taxes are raised again (in t+1).

Table 2 Fiscal multipliers

	EU alone			Global stimulus		
	Without collateral constraints.	With collateral constraints.	With collateral constraints and monetary accommo-dation	Without collateral constraints.	With collateral constraints.	With collateral constraints and monetary accommo-dation.
investment subsidies	1.52	1.59	2.04	2.00	2.11	2.63
government investment	0.89	0.91	1.08	1.04	1.08	1.24
government purchases	0.78	0.81	1.03	0.94	1.00	1.21
government wages	1.11	1.26	1.39	1.15	1.34	1.46
general transfers	0.20	0.41	0.53	0.24	0.51	0.62
transfers targetted to collateral-constrained hh.	-	0.67	0.86	-	0.82	1.01
transfers targetted to liquidity-constrained hh.	0.66	0.69	0.89	0.81	0.86	1.05
labour tax	0.22	0.44	0.55	0.26	0.53	0.64
consumption tax	0.40	0.48	0.65	0.49	0.59	0.76
property tax	0.01	0.12	0.18	0.01	0.16	0.21
corporate income tax	0.02	0.03	0.04	0.03	0.04	0.05

Note: Effect on EU GDP (% diff. from baseline) for a temporary one year fiscal stimulus of 1% of baseline GDP.

6. Permanent fiscal expansions and higher debt

While fiscal policy can be an effective stabilisation tool when used as a temporary instrument, the effects of *permanent* changes in spending and taxes are smaller, and the long-run consequences of permanently higher debt are likely to be negative. Reinhart and Rogoff (2010) shows evidence of a link between growth and debt when debt-to-GDP levels are high. The authors use an extensive database of forty-four countries and about 200 years of observations. They find that the growth impact of government debt is negligible for levels of debt below a threshold of 90 percent of GDP, but above that threshold median growth rates fall by one percent, and average growth falls considerably more. It is not clear, however, whether the direction of causality is unidirectional or whether this observation partly reflects the fact that countries with low growth are more likely to have encountered debt sustainability problems.
There are three main channels through which government debt can affect long term growth: an effect on national savings/interest rates, an effect of distortionary taxes, and an effect on risk premia.

The Ricardian equivalence proposition (Barro, 1974) states the conditions under which government debt would *not* have an effect on the level of output in the long run. This proposition essentially states that no such link exists with infinitely-lived consumers (or

finitely-lived consumers with highly developed bequest motives) with only non-distortionary (lump-sum) taxes and a zero probability that the government defaults on its debt. To the extent these conditions are violated in the real world, government debt can have an effect on real economic activity.

While infinitely-lived households (or households which care about the well-being of their children) will anticipate that taxes on government debt will eventually have to be paid, government debt only affects the composition of spending (i.e. lower private consumption) but not the level of output. In contrast, in overlapping generations environment (where households leave no bequests to their descendents), government debt will be associated with a smaller decline in private consumption. However, for realistic life expectancies (above 50 years) the effect on the interest rate in an OLG framework is negligible. Kumhof and Laxton (2009) show there is no difference in the interest rate response between a 50 year OLG model and an infinitely-lived-agent model and significant interest rate effects emerge from OLG models only with very short time horizons (5 years)[9]. In QUEST model simulations, simulated either as an infinitely-lived-agent model or as an OLG model with 50 years of life expectancy, the savings channel of government debt is negligible[10].

The negative impact of debt on GDP results from the financing of deficits via *distortionary taxes*. Higher government debt implies higher interest charges and government revenue will need to be higher (for given expenditure levels) to service this debt. If taxes are distortionary, this has a negative impact on potential GDP. How large these long run steady state effects are depends on the distortionary nature of the taxes used to service the debt. In the QUEST model the distortions are largest for corporate profit taxes, due to their negative impact on capital accumulation. Labour taxes distort employment decisions and are the second most distortionary tax. Taxes on consumption (VAT) are least distortionary in the model.

Taxes on labour have a larger negative output effect if unemployment benefits are indexed to gross wages, instead of net wages, as unemployment benefits act as a reservation wage in the wage setting in the model and a change in the gap between after-tax wages and unemployment benefits affect labour supply. Similarly, the output effects of an increase in consumption taxes depend on whether unemployment benefit and transfer recipients are compensated for the increase in consumer prices. If they are, it will affect the reservation wage and labour supply. The scenarios shown here assume unemployment benefits are indexed to net after tax wages and not indexed to consumer prices. Alternative assumptions would increase distortions and lead to larger negative output effects of debt.

There is some empirical evidence which suggests that government debt is associated with an increase in real interest rates on government bonds. Laubach (2009) reports an effect ranging from a 1 to 6 basispoints increase in interest rates on government bonds from a 1 percentage point increase of the government debt to GDP ratio. There is however no consensus on whether this increase is confined to government bonds or whether it affects the general level of interest rates in the respective country. It may well be that for countries which rely heavily

[9] A 5 year life expectancy leads to the counterfactual implication that the marginal propensity to consume out of financial wealth is above 0.20, while empirical estimates suggest values in the range between 0.02 and 0.04 which is roughly in the range of models with planning horizons above 50 years.

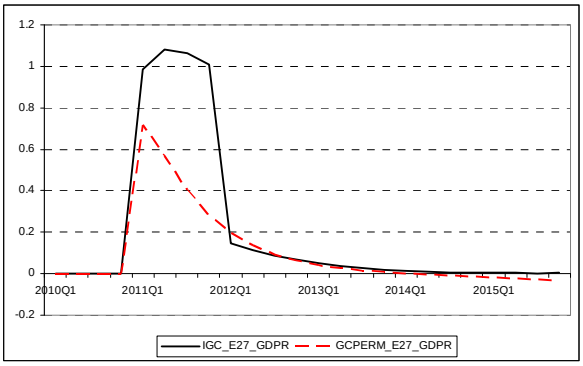
[10] In QUEST only a fraction of households has an infinite planning horizon. Liquidity constrained households have a zero planning horizon and credit (or collateral) constrained households have an effective planning horizon of about 10 years. However, what matters is that savers (no matter how large their share in the total population) have an infinite planning horizon (Mankiw, 1990).

of foreign financing of investment an increase in government debt could lead to a general increase in the risk premium for the currency and raise interest rates for both government and private bonds. However, evidence for the US suggests that an increase in government debt reduces primarily the spread between government and corporate bonds. Krishnamurthy and Vissing-Jorgensen (2007) show that an increase in Treasury debt held by public leads to decline in yield spread of AAA corporate debt over Treasuries. The QUEST model includes a risk premium term to government bonds rates that depends endogenously on debt levels. This sovereign risk premium is calibrated such that a 1 percentage point increase in the debt-to-GDP ratio leads to a 3 basispoints increase in government bond rates, roughly in the middle of the range estimated by Laubach (2009).

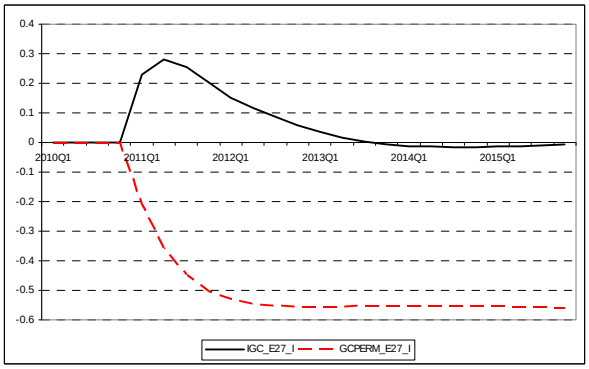
To illustrate the differences between permanent and temporary shocks, Figures 7 compares two scenarios of increases in spending. The first is the temporary one year increase in government purchases as described in the previous section, with monetary accommodation. The second scenario is a permanent increase in purchases, also of 1% of baseline GDP, accompanied by a permanent increase in government's deficit to GDP ratio by 1% point, with labour taxes adjusting to target this deficit increase. A permanent increase in the deficit to GDP ratio of 1 percentage point implies in the long run an increase in the debt to GDP ratio of more than 20 percentage points, given our assumptions on nominal growth rates in the steady state (Figure 7.b). In case agents believe the fiscal expansion is permanent, they will anticipate future increases in taxes to service this increase in debt. This increase in the present discounted value of taxes will lead to a desire to increase savings and agents will respond by reducing their consumption. Private consumption and corporate investment decline sharply. GDP falls in the medium term below baseline and is more than 0.4 percent below baseline in the long run (Figure 7.b). This comparison highlights the importance of credibility of the temporary nature of the fiscal stimulus. If agents were to perceive the measures as permanent, the GDP multiplier would be smaller and become negative in the medium to long term.

Figure 7: Temporary vs. permanent increase government purchases

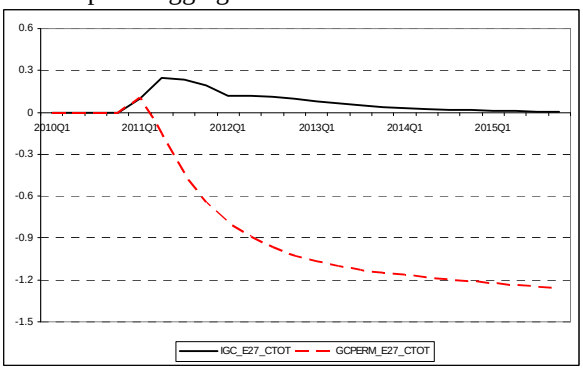
GDP:



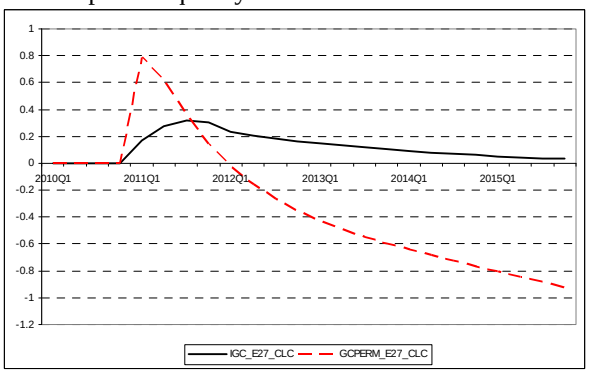
Corporate investment:



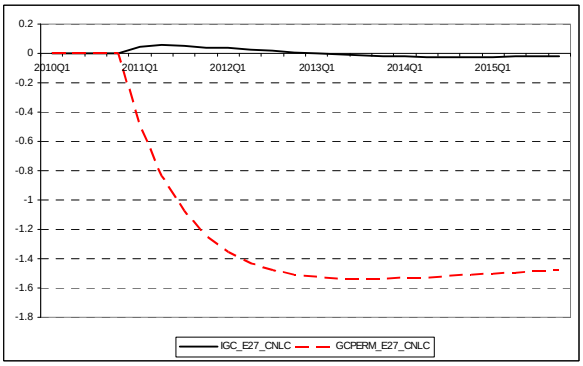
Consumption: aggregate



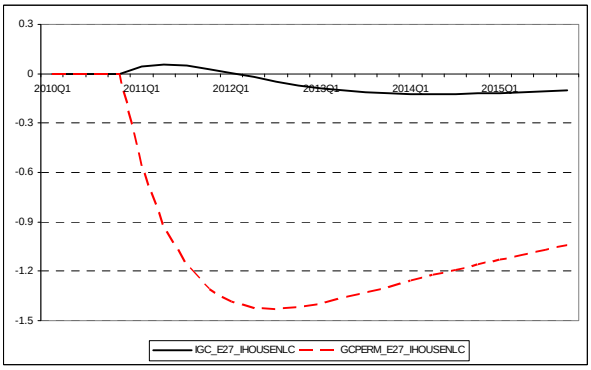
Consumption: liquidity constrained:



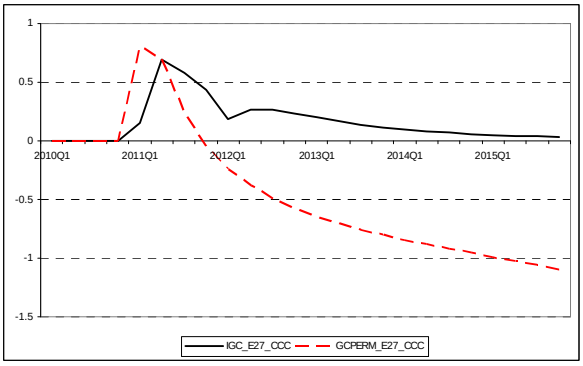
Consumption: non-constrained:



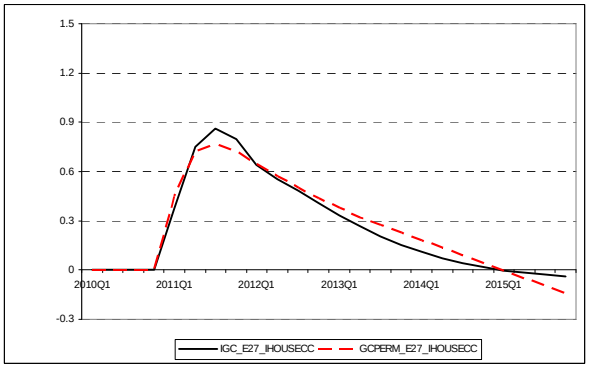
Housing investment : non-constrained



Consumption: credit-constrained:



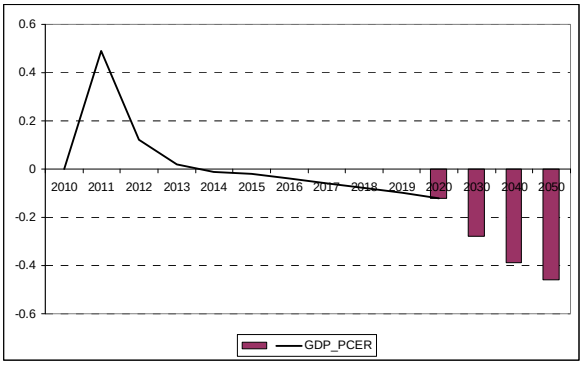
Housing investment : credit-constrained



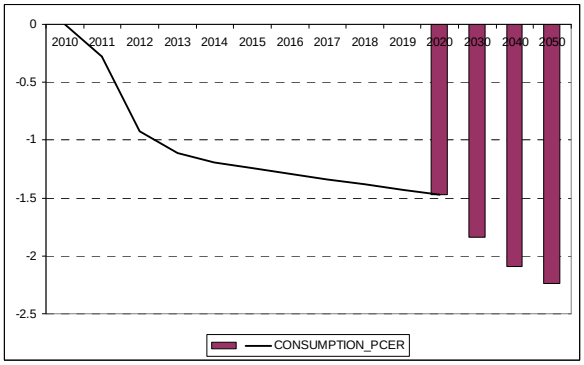
Note: Solid line: temporary 1 year increase in government purchases 1% of baseline GDP. Dashed line: permanent increase of 1% of baseline GDP (accompanied by permanent increase in government's deficit to GDP ratio by 1%p, labour taxes adjusting to target deficit increase).

Figure 7.b: Long run effects permanent increase government purchases (increase deficit to GDP ratio 1%p)

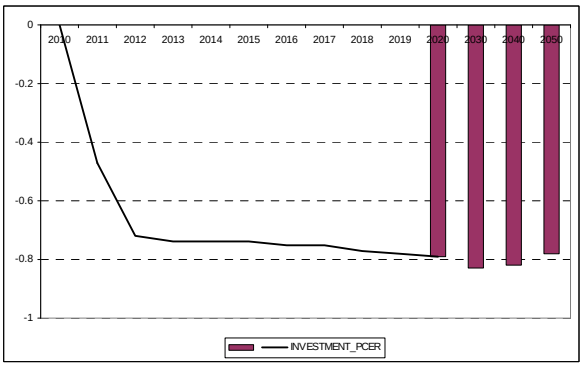
GDP:



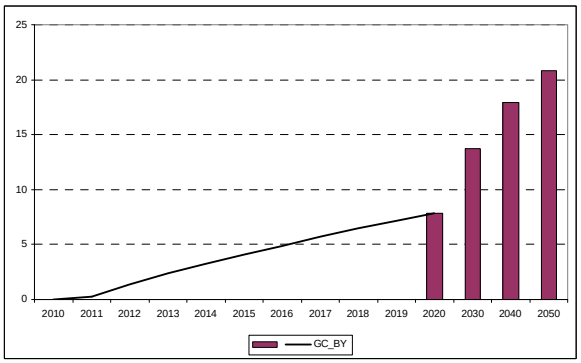
Consumption:



Investment:



Government debt to GDP ratio:



Note: permanent change in fiscal instrument of 1% of baseline GDP, accompanied by permanent increase in government's deficit to GDP ratio by 1%p. Labour taxes adjust to target deficit increase.

7. Fiscal consolidations

As highlighted in the introduction, escalating government deficits and public debt have led to widespread concerns about the long-run sustainability of public finances. Government budget deficits in the EU-27 have increased sharply, to more than 7% of GDP in 2009 for the EU27 on average, and the debt-to-GDP ratio, currently at 80% of GDP, is projected to increase further. There have been calls for an early exit from the stimulus measures and these calls have become stronger in recent months. Although the fiscal stimulus packages only made a relatively minor contribution to the widening of deficits, the underlying deterioration in the fiscal positions has reinforced the view that a possible further prolongation of stimulus measures might be damaging growth prospects. For many countries the recent reappraisal in financial markets of associated sovereign risks has led to sharp increases in the cost of borrowing and made sharp retrenchment inevitable. In this section we focus first on the effects of the withdrawal of fiscal stimulus measures, and, second, on the effects of permanent fiscal consolidations that will be required to put public finances back on a sustainable path.

7.1 Withdrawal of fiscal stimulus measures

As shown in the previous section, fiscal policy was a powerful instrument in supporting growth in the economic crisis due to two main factors: the significant tightening of credit conditions, and the zero lower bound on nominal interest rates. Just as these two factors make fiscal multipliers larger, they also make the cost of a withdrawal of the stimulus higher. The multipliers shown in Table 2 above also indicate the loss in output that will occur when these measures are withdrawn, and this will similarly depend on the instruments used, the presence of credit constraints, monetary accommodation and on whether the stimulus (withdrawal) is global or one region acting alone.

As long as credit conditions remain tight and more households face a binding collateral constraint on their borrowing, the costs of a withdrawal of fiscal stimulus will be larger. An important implication of this is that it would be better to wait with a fiscal exit till credit conditions have returned to pre-crisis levels. Fiscal policy multipliers are also enhanced by monetary accommodation when interest rates are at their lower zero bound. One could argue that this also has important implications for the optimal timing of a withdrawal. As long as interest rates remain low, monetary policy might be less likely to support a fiscal tightening by reducing interest rates. An early withdrawal of fiscal stimulus, while monetary policy remains at the zero lower bound, risks a much sharper contraction in output than when the exit is delayed till monetary conditions have returned to normal. Finally, there are also sizeable positive spill-over effects from fiscal stimuli. If fiscal stimuli are withdrawn in all countries at the same time, output losses are likely to be larger.

7.2 Permanent fiscal consolidations

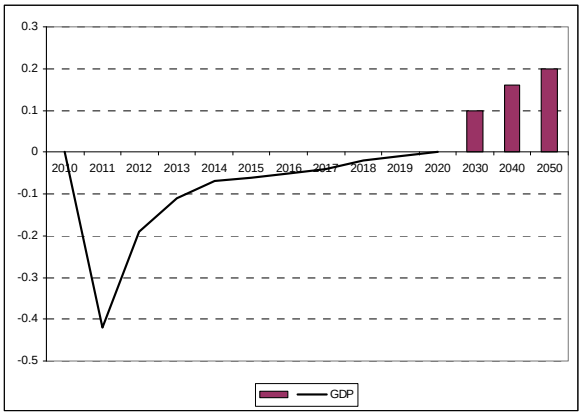
While the above suggests extreme care should be taken when determining the timing of the stimulus withdrawal, there is a general consensus that significant consolidations are now required to bring public finances on a sustainable path. What are the likely costs of such consolidations in terms of output? There is an important asymmetry in multipliers of a temporary fiscal stimulus and those of a permanent fiscal consolidation. As was shown above,

the impact of a permanent shock is generally smaller than that of a temporary shock, as the former leads to partly offsetting changes in private savings (Figure 7). This indicates that GDP losses associated with fiscal consolidations could be significantly smaller that the short run multipliers of temporary fiscal shocks would suggest. Secondly, GDP effects become positive in the medium run as fiscal positions improve and the reduction in interest burden frees up budgetary space that can be used to reduce distortionary taxes.

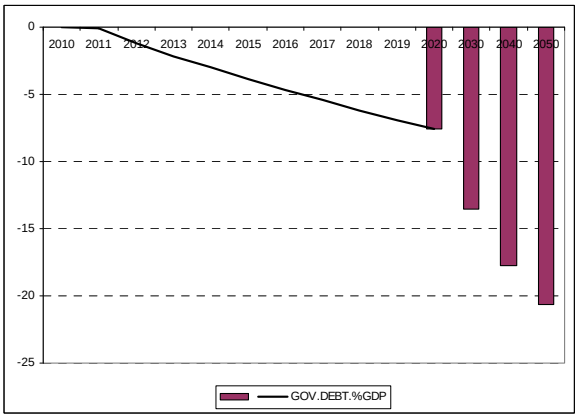
Below we describe some stylised scenarios of fiscal consolidations that illustrate the potential impact of permanent reductions in deficits. The first scenario we consider is a permanent consolidation of 1 percent of (baseline) GDP through an across-the-board adjustment in spending and taxes, roughly proportionally to their respective shares in government budget. Figure 8 and Table 3 illustrate the model's dynamic transition between the short run and the long run for this fiscal consolidation. The composition of the consolidation is equally divided between expenditure and revenue categories[11]. Given the assumptions on the nominal growth rates in the model, a permanent reduction in the government deficit to GDP ratio of 1 percent of GDP leads to a reduction in the debt to GDP ratio of approximately 25 percentage points in the very long run. Lower government debt reduces the sovereign risk premium, which in this scenario is 60 basispoints lower after 40 years.

Figure 8 GDP effects fiscal consolidation

GDP:



Debt-to-GDP ratio:



Note: consolidation through an across-the-board adjustment in spending and taxes, roughly proportionally to their respective shares.

[11] To be precise, on the expenditure side cuts in transfers of 0.2%p, government wages of 0.15%p, government purchases of 0.1%p and in government investment of 0.05 %p, and on the revenue side increases of 0.2 %p in labour taxes and VAT, and 0.05%p in corporate profit taxes and house property taxes. As this is a long-run scenario, we assume a standard monetary policy response with the central bank targeting inflation and output gap according to a Taylor type rule. The short run impact could be larger when monetary policy cannot lower interest rates.

Table 3 Fiscal consolidation: permanent reduction deficit to GDP ratio 1% of GDP

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030	2040	2050
GDP	-0.42	-0.19	-0.11	-0.07	-0.06	-0.05	-0.04	-0.02	-0.01	0	0.1	0.16	0.2
VA.PRIV.SECTOR	-0.3	-0.05	0.05	0.08	0.1	0.11	0.13	0.14	0.15	0.17	0.28	0.35	0.39
EMPLOYMENT	-0.17	0	0.08	0.11	0.13	0.14	0.15	0.16	0.17	0.18	0.26	0.31	0.35
CONSUMPTION	-0.57	-0.2	-0.05	0.02	0.07	0.11	0.15	0.19	0.23	0.26	0.56	0.74	0.84
INVESTMENT	0.28	0.49	0.54	0.55	0.55	0.56	0.56	0.56	0.56	0.56	0.54	0.49	0.42
NOM.INTEREST.RATE	-0.09	-0.13	-0.14	-0.13	-0.12	-0.11	-0.11	-0.1	-0.1	-0.09	-0.05	-0.03	-0.02
RISK.PREMIUM.GOV.BONDS	0	-0.04	-0.06	-0.09	-0.12	-0.14	-0.16	-0.19	-0.21	-0.23	-0.41	-0.53	-0.62
INFLATION.PC	-0.13	-0.1	-0.09	-0.09	-0.08	-0.07	-0.07	-0.06	-0.06	-0.05	-0.02	-0.01	0
UNEMPL.RATE	0.11	0	-0.05	-0.07	-0.08	-0.09	-0.1	-0.1	-0.11	-0.11	-0.17	-0.2	-0.23
GOV.DEBT.%GDP	-0.12	-1.21	-2.15	-3.02	-3.85	-4.65	-5.42	-6.17	-6.9	-7.6	-13.51	-17.72	-20.68
GOV.BALANCE.%GDP	1	1.01	1	1	1	1	1	1	1	1	1	1	1
. GOV.PURCHASES.%GDP	-0.06	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.1	-0.1	-0.1	-0.11	-0.11	-0.12
. GOV.WAGE.BILL.%GDP	-0.11	-0.13	-0.14	-0.14	-0.14	-0.15	-0.15	-0.15	-0.15	-0.15	-0.16	-0.17	-0.17
. GOV.INVESTMENT.%GDP	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06
. GOV.TRANSFERS.%GDP	-0.12	-0.16	-0.18	-0.18	-0.18	-0.19	-0.19	-0.19	-0.19	-0.2	-0.22	-0.23	-0.23
. BENEFIT.PAYM.%GDP	0.03	-0.01	-0.02	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
. INTEREST.PAYM.%GDP	-0.05	-0.2	-0.27	-0.33	-0.39	-0.44	-0.49	-0.54	-0.59	-0.64	-1.02	-1.29	-1.47
. CONS.TAX.REV.%GDP	0.19	0.2	0.21	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.25	0.26	0.27
. LABOUR.TAX.REV.%GDP	0.37	0.05	-0.11	-0.21	-0.29	-0.36	-0.44	-0.51	-0.58	-0.65	-1.21	-1.6	-1.86
. CORP.TAX.REV.%GDP	0.07	0.09	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
. HOUSE.PROP.TAX.REV.%GDP	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CURRENT.ACC.%GDP	0.15	0.12	0.11	0.1	0.1	0.09	0.09	0.09	0.08	0.08	0.05	0.03	0.02

Note: consolidation through an across-the-board adjustment in spending and taxes, roughly proportionally to their respective shares: cuts in transfers of 0.2%p of GDP, government wages of 0.15%p, government purchases of 0.1%p and in government investment of 0.05 %p, and on the revenue side taxes increases of 0.2 %p in labour taxes and VAT, and 0.05%p in corporate profit taxes and house property taxes.

The reduction in spending and increase in taxes lowers output on impact, by approximately 0.4 percent. This multiplier is lower than that for temporary changes in fiscal instruments (as shown in Table 2), as the permanent nature of the fiscal consolidation is fully credible and leads to anticipations of a lower tax burden in the future. As the government deficit is permanently reduced by 1 percent of GDP, the stock of outstanding debt gradually declines, and the cost of servicing this debt also falls. This creates additional fiscal space to gradually reduce labour income taxes, offsetting the initial increase in taxes that was part of the consolidation package. In the medium and long run, labour taxes are actually reduced relative to the no-consolidation baseline, and this boost employment and output.

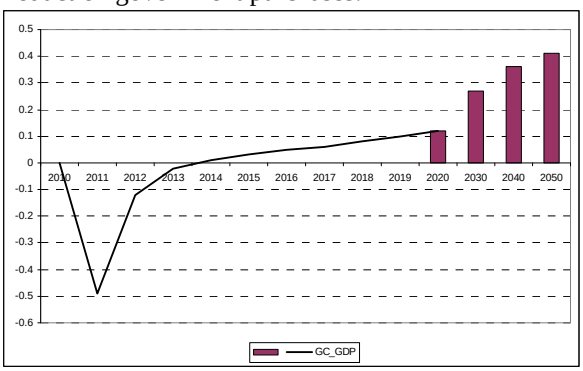
The impact of fiscal consolidations depends crucially on the composition. Figure 9 shows the effects for individual instruments on revenue and expenditure side. All scenarios are standardised reductions in the government deficit to GDP ratio by 1 percentage point, achieved by an adjustment in the respective instrument that equals ex-ante 1% of (baseline) GDP, in combination with a targeting rule for labour taxes that targets this new lower target in the deficit. The persistent improvement in government balances leads to a gradual decumulation of government debt, and the debt to GDP ratio declines by around 8 percentage point after 10 years and by around 20 percent after 40 years. With lower debt interest payments there is space for tax reductions, and this raises employment and boosts GDP in the medium and long run.

On the expenditure side, the main difference is between productive and unproductive spending. Reductions in government investment (productive) are most detrimental in the model and show the largest GDP losses, both in short and in the long run. Transfers are unproductive in the model and only serve distributional purposes. Reducing such transfers - and lowering distortionary labour taxes in the medium/long run - leads rapidly to positive output effects in the model. Government purchases are unproductive spending, a reduction in which has no significant output costs when compensated by cuts in labour taxes in the medium/long run. Lowering government wages has a direct impact on GDP as defined by the national accounts. But this is gradually more than offset by increases in private sector GDP which is boosted by the reduction in goverment debt.

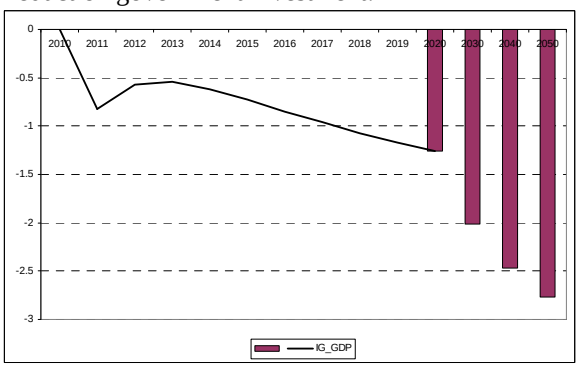
Short term effects of tax increases depend partly on adjustment costs in capital and labour. An increase in corporate profit tax has, with relatively high adjustment costs on capital, a relatively small short term impact but GDP losses build up over following years as investment is depressed and the capital stock declines. It has the largest long run GDP loss of all tax based consolidations. In contrast, a consolidation through labour taxes yields an initial GDP loss, but in the long run labour taxes can be reduced due to the fiscal space that comes available as a result of the reduction in government debt, and GDP eventually turns positive. Taxes on consumption (VAT and other consumption taxes) and taxes on housing property have smaller short term impacts. GDP falls by 0.2-0.1 percent below base but gradually recovers and becomes positive after 3-4 years.

Figure 9: Permanent fiscal consolidations (reduction deficit to GDP ratio 1%p)

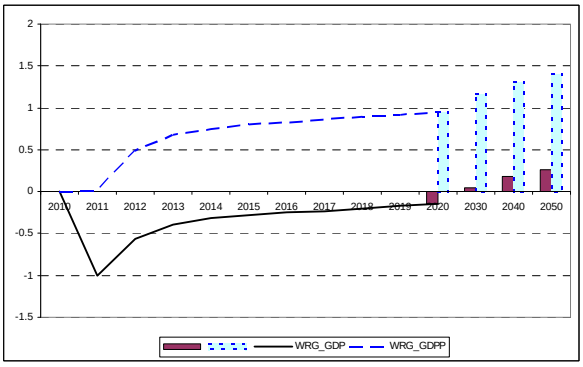
Reduction government purchases:



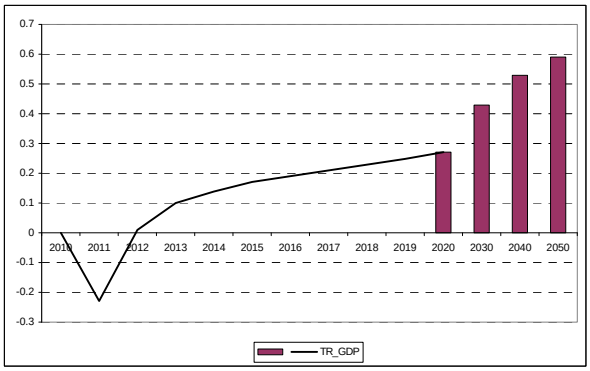
Reduction government investment:



Reduction government wages:

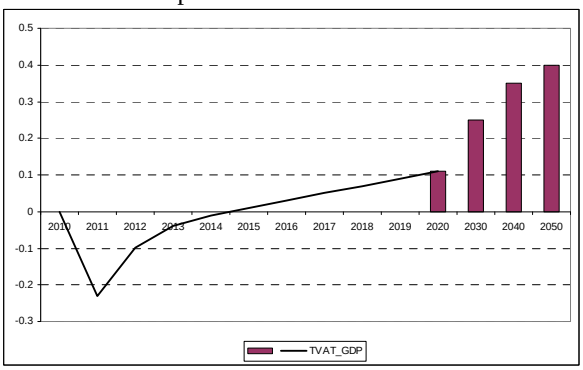


Reduction government transfers:

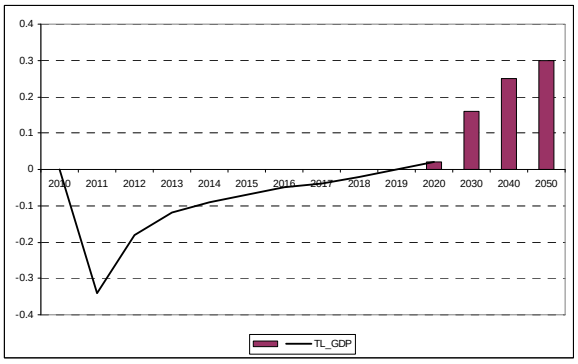


Note: GDP (solid line) and private sector GDP (dashed line)

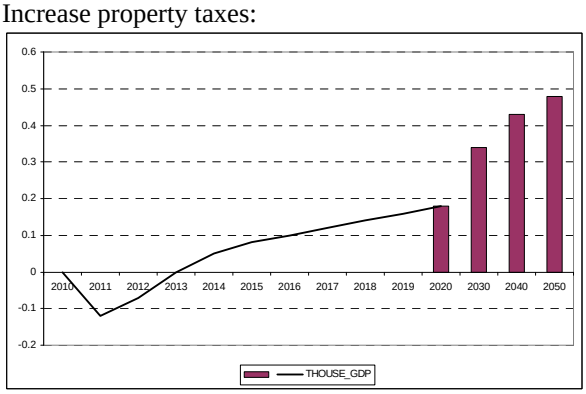
Increase consumption taxes:



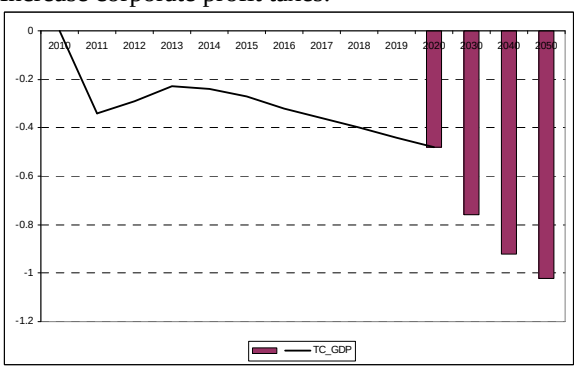
Increase labour taxes:



Increase property taxes:



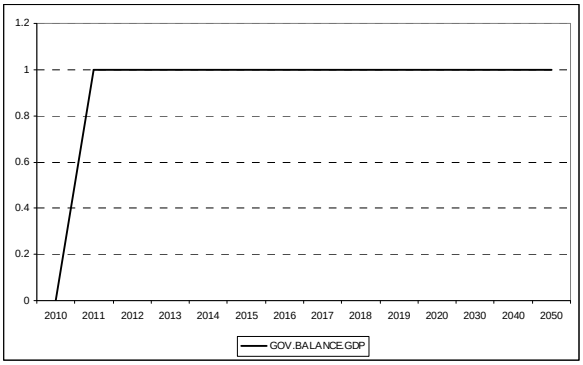
Increase corporate profit taxes:



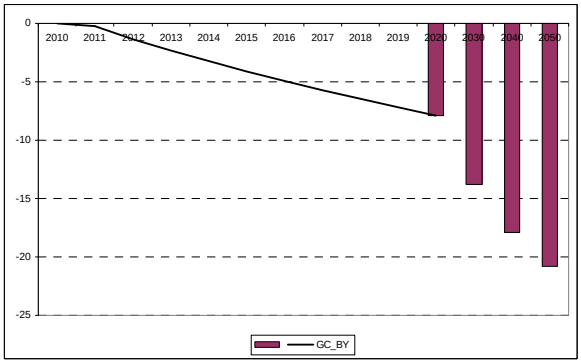
Note: permanent change in fiscal instrument of 1% of baseline GDP, accompanied by permanent reduction in government's deficit to GDP ratio by 1%p. Labour taxes adjust to target deficit increase.

Figure 9.b: Permanent fiscal consolidations (reduction deficit to GDP ratio 1%p)

Government budget balance (% of GDP):



Government debt to GDP ratio:



Note: permanent change in fiscal instrument of 1% of baseline GDP, accompanied by permanent reduction in government's deficit to GDP ratio by 1%p. Labour taxes adjust to target deficit increase.

7.3 Fiscal consolidations combined with tax reform

These differences in short and long run effects indicate a consolidation package can be designed that minimises the short term losses in GDP and maximises the long run gains. Such a package could consist of reductions in unproductive spending (purchases, transfers) and increases in the least distortionary taxes (consumption, housing), while at the same time reducing the most distortionary taxes (on labour and capital). This would combine the positive effects of structural reforms raising potential output with the necessary fiscal retrenchment.

Table 4 shows an example of such a package which relies heavily on taxing consumption and housing, while reducing taxes on labour and corporate profits. The positive effects of reducing these distortionary taxes help to minimise the short term output costs of the consolidation. Private consumption falls by less while private investment increases. The fall in GDP is short-lived and output increases above baseline the following years, as this tax reform raises potential output. This scenario illustrates the importance of the two-sided approach adopted by the EU, of combining fiscal consolidations with structural reforms that raise the long term growth potential. Well designed measures can help to mitigate the output losses associated with fiscal consolidations.

Table 4 Fiscal consolidation combined with tax reform:

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030	2040	2050
GDP	-0.19	0.02	0.11	0.16	0.21	0.25	0.29	0.32	0.36	0.4	0.67	0.84	0.94
VA.PRIV.SECTOR	-0.21	0.02	0.12	0.18	0.23	0.27	0.32	0.36	0.4	0.44	0.75	0.93	1.04
EMPLOYMENT	-0.11	0.02	0.08	0.1	0.12	0.13	0.14	0.16	0.17	0.18	0.27	0.33	0.38
CONSUMPTION	-0.33	-0.02	0.11	0.2	0.28	0.35	0.42	0.49	0.56	0.62	1.13	1.44	1.62
INVESTMENT	1.68	2.45	2.56	2.58	2.59	2.59	2.6	2.61	2.62	2.62	2.64	2.61	2.56
NOM.INTEREST.RATE	-0.05	-0.07	-0.07	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.04	-0.02	-0.01	0
RISK.PREMIUM.GOV.BONDS	-0.01	-0.04	-0.07	-0.1	-0.13	-0.15	-0.18	-0.2	-0.22	-0.24	-0.42	-0.55	-0.63
INFLATION.PC	-0.07	-0.05	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	0	0.01	0.01
UNEMPL.RATE	0.07	-0.02	-0.05	-0.07	-0.08	-0.09	-0.09	-0.1	-0.11	-0.12	-0.18	-0.22	-0.25
GOV.DEBT.%GDP	-0.35	-1.47	-2.44	-3.35	-4.22	-5.06	-5.88	-6.66	-7.42	-8.14	-14.15	-18.3	-21.16
GOV.BALANCE.%GDP	1	1.01	1	1	1	1	1	1	1	1	1	1	1
. GOV.PURCHASES.%GDP	-0.28	-0.3	-0.3	-0.31	-0.31	-0.31	-0.32	-0.32	-0.32	-0.33	-0.35	-0.36	-0.37
. GOV.WAGE.BILL.%GDP	0.02	0	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.07	-0.08	-0.09
. GOV.INVESTMENT.%GDP	0.01	0	0	0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.03	-0.04
. GOV.TRANSFERS.%GDP	-0.26	-0.29	-0.31	-0.32	-0.32	-0.33	-0.34	-0.34	-0.35	-0.36	-0.4	-0.43	-0.44
. BENEFIT.PAYM.%GDP	0.04	0.01	0.01	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
. INTEREST.PAYM.%GDP	-0.04	-0.16	-0.24	-0.3	-0.36	-0.42	-0.48	-0.53	-0.58	-0.63	-1.04	-1.31	-1.49
. CONS.TAX.REV.%GDP	0.49	0.5	0.51	0.51	0.51	0.52	0.52	0.52	0.53	0.53	0.55	0.57	0.58
. LABOUR.TAX.REV.%GDP	-0.18	-0.44	-0.58	-0.69	-0.79	-0.88	-0.97	-1.06	-1.14	-1.22	-1.87	-2.3	-2.59
. CORP.TAX.REV.%GDP	-0.42	-0.41	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42	-0.42
. HOUSE.PROP.TAX.REV.%GDP	0.5	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.48	0.48	0.48
CURRENT.ACC.%GDP	0.14	0.1	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.04	0.03	0.01

Note: permanent reduction deficit-to-GDP ratio of 1% of GDP through a targeted adjustment in spending and taxes: cuts in transfers of 0.3%p of GDP, government purchases of 0.3%p, reduction in tax on labour of 0.3%p, corporate profit tax 0.3%p, and increases in tax on consumption (0.5%p) and housing property (0.5%p)

8. Conclusions

The paper has described a DSGE model that, by disaggregating households into credit-constrained and a non-constrained groups, can capture the importance of tighter credit constraints on the effectiveness of discretionary fiscal policy. The presence of credit constrained households raises the marginal propensity to consume out of current net income and makes fiscal policy shocks that directly impact on households' purchasing power a more powerful tool for short run stabilisation. It also reinforces the effects from monetary accommodation as credit-constrained consumers react more strongly to a fall in real interest rates which occurs when the zero lower bound on nominal interest rates is binding. Just as the positive effects of a fiscal stimulus are larger than under normal conditions in the presence of credit constrained households and monetary policy at the zero lower bound, the cost of a withdrawal will also be larger if these conditions still hold.
However, the GDP costs of permanent fiscal consolidations are lower than those of temporary changes in the fiscal stance, and this implies an asymmetry between the fiscal multipliers of a temporary stimulus and the multipliers of a permanent fiscal consolidation. Fiscal consolidations are likely to have short term negative output effects, but as government debt is reduced this creates space for cuts in distortionary taxes and this can boost growth in the medium and long run. Designing consolidations in such as was as to maximise the long term growth benefits from tax reforms can help to minimise the short term costs.

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