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Fiscal Policy with Credit Constrained Households

by

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Abstract:

This paper explores the effects of discretionary fiscal policy in a DSGE model that explicitly models housing investment and allows for credit constrained households along the lines of the financial accelerator literature. The presence of credit constrained households raises the marginal propensity to consume out of transitory tax reductions and increases in transfers, and makes fiscal policy a more powerful tool for short run stabilisation. Fiscal policy is more effective when credit constraints increase, when measures are temporary, and when monetary policy is accommodative. This is a timely issue in the current financial crisis which can be characterised by a substantial negative demand shock and tighter credit constraints.

JEL Classification: E21; E62; F42; H31; H63
Keywords: Fiscal Policy, Fiscal Multiplier, Government Deficits, Credit Constraint, DSGE modelling

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1. Introduction

With the financial crisis spreading to the real economy, there has been a revival of interest in discretionary fiscal policy. As aggregate demand has plummeted, the sole reliance on the operation of automatic stabilisers has been called into question. In order to support efforts taken by central banks to stabilise the business cycle, there have been widespread calls for fiscal policy measures to prevent a sharp decline in output. The European Council approved in December 2008 a European Economic Recovery Plan, consisting of structural reforms and fiscal measures amounting to around EUR200 bn. to support demand and avoid a sharp recession[1]. In response to the crisis many European countries have announced measures raising public expenditure and/or reducing taxes. In addition, the incoming U.S. administration has announced plans for a large fiscal stimulus amounting to more than $800 bn..

This revival of fiscal policy has renewed the debate about the effectiveness of short term fiscal stabilisation. A decade ago, there was widespread agreement that it was best to "let fiscal policy have its main countercyclical impact through the automatic stabilizers" and that "…discretionary fiscal policy to be saved explicitly for longer term issues, requiring less frequent changes" (Taylor, 2000,2009). It was argued that countercyclical discretionary fiscal policy was "neither desirable nor politically feasible" (Eichenbaum, 1997) and "deliberate 'countercyclical' discretionary policy has not contributed to economic stability and may have actually been destabilizing in the past" (Feldstein, 2002). These pessimistic views on the effectiveness of fiscal policy might have been justified by specific factors. First, the last decades have been characterised by a dominance of supply shocks. Blinder and Rudd (2008) provide empirical evidence on the importance of supply factors for explaining the stagflation period from the beginning of the 1970s to the mid-1980s, with two recessions in 1973-74 and 1982 heavily influenced by strong increases in oil prices. The sudden increase in oil prices associated with the first Iraq war in 1991 also contributed to the recession in the early 1990s. When the economy is hit by supply shocks there is little active discretionary fiscal policy can do. A second factor that justified the scepticism on fiscal policy was the rapid financial liberalisation. As more households acquired access to financial markets and were able to smooth their consumption, fiscal policy became less powerful.

The present situation is different with a large negative demand shock and an increase in credit constraints. This has led many economists to reconsider a possible role for discretionary fiscal policy to complement the operation of automatic stabilisers. The concern that, with interest rates at an all time low, there remains little scope for conventional monetary policy measures, has reinforced this revival of interest in fiscal policy[2]. It is generally agreed that for fiscal policy to be effective, measures have to be designed to be timely, targeted, and temporary. But it is generally feared that this crisis could be longer lasting than average past recessions. Reinhart and Rogoff (2008) document the aftermath of severe financial crises and argue that these are protracted affairs, with output falling an average over 9 percent, over a duration of roughly two years. Given the expected duration of the crisis, the often-raised criticism against discretionary fiscal policy, i.e. that it arrives too late, seems less relevant at the current juncture.

[1] The plan provides a common framework for the efforts made by Member States and by the European Union, with a view to ensuring consistency and maximising effectiveness.
[2] See e.g. Feldstein (2009), Auerbach (2009) and Spilimbergo et al. (2008).

This paper examines the effectiveness of fiscal policy in a modern dynamic stochastic general equilibrium (DGSE) model in which credit constraints play an important role. The main transmission channels of the financial crisis into the real economy are thought to be through higher risk premia and credit rationing for households and firms. The crisis started in the U.S. with a sharp fall in house prices which led to higher default levels of less credit-worthy borrowers (see for example Reinhart and Rogoff (2008)). The economic situation was aggravated by the financial sector responding to defaulting loans by restricting mortgage lending and the so-called subprime mortgage market virtually collapsed. At the current juncture, it is of the utmost importance that this tightening of credit conditions is taken into account. The DSGE model we use is an extended version of the QUEST model [3] where we explicitly model housing investment and disaggregate the household sector into borrowers and lenders, so allowing for credit constrained households along the lines suggested by the recent literature on the financial accelerator mechanism[4]. Unlike in models with only Ricardian households, a fall in house prices with households facing a collateral constraint has severe effects on their current consumption and housing investment, especially in a situation where the loan to value ratio is high. First, by forcing down indebtedness, net borrowers will have to reduce both residential investment and consumption. Second, the impact on demand could be longer lasting, since a reduction in the stock of debt will reduce residential investment over an extended period of time. And third, there is a multiplier running from a tightening of the borrowing constraint via lower residential investment to a fall in house prices (housing wealth). This reduces the value of the collateral and feeds back into a further tightening of the borrowing constraint. These effects are obviously strengthened when banks respond by increasing their collateral requirements.

By disaggregating households into credit constrained and a non-constrained group, we can investigate the importance of increasing credit constraints on the effectiveness of discretionary fiscal policy. The presence of credit constrained households raises the marginal propensity to consume out of transitory tax reductions and increases in transfers, and hence makes fiscal policy a more powerful tool for short run stabilisation. We use a two-region version of this model, consisting of the EU and the rest of the world, to look at the effects of a fiscal stimulus in the EU alone as well as a global fiscal stimulus, and also consider spillovers accross the two regions.

The rest of the paper is structured as follows. The next section starts with a brief overview of the empirical literature. This is followed by a description of the model with a special emphasis on the household sector. In this section we also show that an economy with credit constrained households responds more strongly to temporary fiscal policy measures. The following section presents the simulation results and discusses the effect the introduction of credit constrained households has on the effectiveness of temporary and permanent tax and expenditure measures. This is followed by a sensitivity analysis with respect to the monetary policy assumptions. The final section concludes.

[3] For a description of the QUEST model, see Ratto et al. (2009a)

[4] See e.g. Kiyotaki and Moore (1997) , Iacoviello (2005), Iacoviello and Neri (2008), Monacelli (2007), Calza, Monacelli and Stracca (2007).

2. Overview of empirical literature

The empirical literature on the effects of discretionary fiscal policy shows estimates of fiscal multipliers vary widely. Approaches based on micro studies of past tax rebates show roughly half to two-third of the income effect is spent on higher consumption (e.g. Broda and Parker, 2008) but this contrasts sharply with macro evidence that shows no increase in consumption following the May 2008 US tax rebate (Taylor, 2009). Narrative studies of the effects of tax changes find very large effects, like a (permanent) 1 per cent of GDP tax increase leading to a 3 per cent contraction in GDP (Romer and Romer, 2007). On the other hand, narrative studies of episodes of extraordinary spending have tended to find much weaker or negative effects on output (Ramey and Shapiro, 1998).

Estimates from VAR studies also vary widely. Blanchard and Perotti (2002) applied structural vector autoregression (SVAR) methodology to study the effects of fiscal policy in the US. They find positive effects on output for increases in spending and negative effects for increases in taxes. In most cases the multipliers are small, often close to one. Gali et al. (2007) report VAR estimates for the US using data back to the 1950s and report a spending multiplier of 0.78 on impact and of 1.74 at the end of the second year. Using sign restrictions on the impulse response functions, Mountford and Uhlig (2005) estimate the effects of a "balanced budget" and a "deficit spending" shock. They find that government spending shocks crowd out both residential and non-residential investment, but they hardly change consumption (the response of the latter is small and insignificant). Various authors have extended the SVAR methodology to include other countries. Perotti (2005) looks at five OECD countries and finds generally weaker effects when including interest rates in the VAR. The effects of government spending shocks and tax cuts on GDP and its components have become substantially weaker over time: in the post-1980 period these effects are mostly negative, in particular on private investment. Only for the US is the consumption response found positive and did the GDP multiplier exceed one in the post-1980 period. De Castro and Fernandez de Cos (2006) find a positive relationship between government spending and output in the short term for Spain, but a negative one in the medium and long term, while Giordano et al. (2007) find a positive and persistent effects on output and consumption for Italy. Afonso and Sousa (2009) investigate the macroeconomic effects of fiscal policy using a Bayesian Structural Vector Autoregression approach on quarterly date for four countries and stress the importance of explicitly modelling government debt dynamics in the model. They find government spending shocks have in general a small effect on GDP, often negative, and lead to important crowding-out effects, in particular on investment.

Estimates from DSGE models also differ widely with respect to the effectiveness of fiscal policy. While there seems to be agreement that there is a crowding out effect of government spending on private investment, there is little consensus on the effect of government spending on private consumption both empirically and in the DSGE literature. A positive consumption multiplier is a prerequisite for a large expenditure multiplier. Ravn et al. (2007) introduce a market structure into the model which implies a strong decline in the mark up in the case of a government spending shock in order to generate a positive consumption effect. Monacelli et al. (2008) introduce a utility function which implies a stronger comovement between hours worked and consumption in order to generate the same effect. Gali et al. (2007) generate a positive effect on private consumption by introducing substantial capital market imperfections in the form of liquidity constrained households. Ratto et al. (2009a) estimate a first year multiplier for government consumption shocks of around 0.6 with an estimated share of

liquidity constrained households of about 30% for the euro area, similar for government investment but lower for transfers. Private consumption by liquidity-constrained households rises in response to a government spending shock, but that of non-constrained households falls, and aggregate consumption declines. Coenen and Straub (2005) also find for a similar share of non-Ricardian households a short-lived rise in liquidity-constrained consumption, but falling below its steady state level after a few quarters, and a decline in aggregate consumption. It appears that one needs extreme shares of liquidity constrained households - i. e. households who don't have access to capital markets at all - in order to generate at least a non negative response of private consumption. This seems to be at odds with observed estimates of the share of liquidity constrained households. Credit constraints constitute an attractive alternative hypothesis. Given the uncertainty about income and wealth developments of borrowers, banks typically impose collateral constraints. This paper therefore explores the consequences for fiscal policy of this credit market friction.

3. The Model

We consider a two region world economy where we distinguish between the European Union and the rest of the world. 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 [5] will generally be autocorrelated with autocorrelation coefficient ρ^k and innovation ε_t^k.

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

[5] 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

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*.

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

where

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

and

(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*

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

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

$$adj^{L}(L_t^j) = w_t(L_t^j u_t^L + \frac{\gamma_L}{2}\Delta L_t^{j\,2})$$

$$adj^{P}(P_t^j) = \frac{\gamma_P}{2}\frac{(P_t^j - P_{t-1}^j)^2}{P_{t-1}^j} \tag{5}$$

$$adj^{UCAP}(ucap_t^j) = PI_t K_t(\gamma_{ucap,1}(ucap_t^j - 1) + \frac{\gamma_{ucap,2}}{2}(ucap_t^j - 1)^2)$$

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:

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

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

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

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

$$(10) \qquad \eta_t^H = 1-1/\sigma^H - \gamma_H \left[\beta(sfpE_t\pi_{t+1}^H + (1-sfp)\pi_{t-1}^H) - \pi_t^H \right] - u_t^H \qquad 0 \le sfp \le 1$$

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

$$(11) \qquad U(C_t^h, 1-L_t^h, H_t^h) = \log\left(C_t^h - hC_{t-1}\right) + \vartheta\left(1-L_t^h\right)^{1-\kappa} + \omega \log\left(H_t^h\right)$$

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^{Gr}) 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, 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^r. 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. 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

(12)

$$
\begin{aligned}
&Max \quad V_0^r = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{r\,t} U(C_t^r, 1 - L_t^r, H_t^r) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \beta^{r\,t} \left(\begin{array}{l}
(1+t_t^c) p_t^C C_t^r + \sum_j p_t^{K,j} I_t^j + p_t^H (1+t_t^c) I_t^{H,r} + p_t^H (1+t_c^t) I_t^{HLC,r} + (B_t^{G,r} + B_t^r) + rer_t B_t^{F,r} - \\
(1+r_{t-1})(B_{t-1}^{G,r} + B_{t-1}^r) - (1+r_{t-1}^F)(1 - risk(.)) rer_t B_{t-1}^{F,r} \\
- \sum_j ((1-t_t^k) i_{t-1}^{K,j} + t_t \delta^{k,j}) p_{t-1}^{K,j} K_{t-1}^j - (1-t_t^W) w_t L_t^r + \frac{\gamma_W}{2} \frac{\Delta W_t^2}{W_{t-1}} - \\
((1-t^k) i_{t-1}^H + \delta^H) p_t^H H_{t-1}^{LC,r} - p_t^L J_t^{Land} - \sum_{j=1} \mathrm{Pr}_t^j - \mathrm{Pr}_t^H + T_t^{LS,r}
\end{array} \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \beta^{r\,t} \left(\sum_j \xi_t^j (K_t^j - J_t^j - (1-\delta^{K,j}) K_{t-1}^j) \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \zeta_t^r \beta^{r\,t} \left(H_t^r - J_t^{H,r} - (1-\delta^H) H_{t-1}^{H,r} \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \vartheta_t^r \beta^{r\,t} \left(H_t^{LC,r} - J_t^{HLC,r} - (1-\delta^H) H_{t-1}^{LC,r} \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^r \xi_t^r \beta^{r\,t} \left(Land_t + J_t^{Land} - (1+g_t^L) Land_{t-1} \right)
\end{aligned}
$$

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

$$
\text{(13a)} \quad I_t^j = J_t^j \left(1 + \frac{(\gamma_K^j + u_t^j)}{2} \left(\frac{J_t^j}{K_t^j} \right) \right) + \frac{\gamma_I^j}{2} (\Delta J_t^j)^2
$$

$$
\text{(13b)} \quad I_t^{H,r} = J_t^{H,r} \left(1 + \frac{(\gamma_H + u_t^H)}{2} \left(\frac{J_t^{H,r}}{H_t^r} \right) \right) + \frac{\gamma_{IH}}{2} (\Delta J_t^{H,r})^2
$$

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

(14) $$\frac{\mathrm{E}_t(C^r_{t+1} - hC_t)}{C^r_t - hC_{t-1}} = \beta^r(1+r_t)$$

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

(15) $$\left((\gamma^j_K + u^j_t)\left(\frac{J^{K,j}_t}{K^j_{t-1}}\right) + \gamma^j_I \Delta J^{K,j}_t\right) - E_t\left(\frac{1}{(1+r+\pi^{GDP}_{t+1} - \pi^{K,j}_{t+1})}\Delta J^{K,i}_{t+1}\right) = \frac{\xi^j_t}{p^K_t} - 1$$

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

(16) $$\frac{\xi^j_t}{p^{K,j}_t} = \mathrm{E}_t\left(\frac{1}{(1+r_t+\pi^{GDP}_{t+1} - \pi^{K,j}_{t+1})}\frac{\xi^j_{t+1}}{p^{K,j}_{t+1}}(1-\delta^K)\right) + ((1-t^K_t)i^K_t + t^K_t\delta^{K,j}) = 0$$

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

(17) $$\left((\gamma_H + u^H_t)\left(\frac{J^{H,r}_t}{H^r_{t-1}}\right) + \gamma_{IH}\Delta J^{H,r}_t\right) - E_t\left(\frac{1}{(1+r_t+\pi^{GDP}_{t+1} - \pi^H_{t+1} - \Delta t^c_{t+1})}\Delta J^{H,r}_{t+1}\right) = \frac{\zeta^r_t}{p^H_t(1+t^c_t)} - 1.$$

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

(18)

$$\frac{\zeta^r_t}{p^H_t(1+t^c_t)} = \omega^r\frac{(C^r_t - hC_{t-1})(1+t^c_t)p^C_t}{H^r_t(1+t^c_t)p^H_t} + \mathrm{E}_t\left(\frac{1}{(1+r_t+\pi^{GDP}_{t+1} - \pi^H_{t+1} - \Delta t^c_{t+1})}\frac{\zeta^r_{t+1}}{p^h_{t+1}(1+t^c_{t+1})}(1-\delta^H)\right)$$

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

$$p^{Land}_t = \mathrm{E}_t\left(\frac{1}{(1+r_t)}p^{Land}_{t+1}(1+g_L)\right)$$

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 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

(19)

$$
\begin{aligned}
&Max \quad V_0^c = \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^{ct} U(C_t^c, 1 - L_t^c, H_t^c) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \beta^{ct} \left((1 + t_t^c) p_t^C C_t^c + p_t^H (1 + t_t^H) I_t^{H,c} - B_t^c + (1 + r_{t-1}) B_t^c) - (1 - t_t^W) w_t L_t^c + \frac{\gamma_W}{2} \frac{\Delta W_t^2}{W_{t-1}} + T_t^{LS,c} \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \zeta_t^c \beta^{ct} \left(H_t^c - J_t^{H,c} - (1 - \delta^H) H_{t-1}^c \right) \\
&- \mathrm{E}_0 \sum_{t=0}^{\infty} \lambda_t^c \psi_t \beta^{ct} \left(B_t^c - (1 - \chi) p_t^H H_t^c \right)
\end{aligned}
$$

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

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

And housing investment

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

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

(22)

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

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

$$(23) \qquad (1+t_t^c)P_t^c C_t^l = (1-t_t^w)W_t L_{t_t}^l + TR_t^l - T_t^{LS,l}$$

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 of these two household types, adjusted for a wage mark up

$$(24) \qquad \frac{s^c U_{1-L,t}^c + s^r U_{1-L,t}^r + s^l U_{1-L,t}^l}{s^c U_{c,t}^c + s^r U_{c,t}^r + s^l U_{c,t}^l} = \frac{(1-t_t^W)}{(1+t_t^C)} \frac{W_t}{P_t^C} \eta_t^W$$

where η_t^W 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_t^W to inflation in the previous period.

(25)

$$\eta_t^W = 1 - 1/\theta - \gamma_W / \theta \left[\beta(\pi_{t+1}^W - (1-sfw)\pi_t) - (\pi_t^W - (1-sfw)\pi_{t-1}) \right] \qquad 0 \le sfw \le 1$$

Combining (17) and (18) 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_t^h in per capita terms is given by $X_t = \int_0^1 X_t^h dh = s^r X_t^r + s^c X_t^c + s^l X_t^l$ since households within each group are identical. Hence aggregate consumption is given by

(26a) $C_t = s^r C_t^r + s^c C_t^c + s^l C_t^l$

and aggregate employment is given by

(26b) $L_t = s^r L_t^r + s^c L_t^c + s^l L_t^l$ with $L_t^r = L_t^c = L_t^l$.

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

(27) $B_t^c = \frac{s^r}{s^c} B_t^r$.

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

(28a) $$Z^i = \left[(1 - s^M - u_t^M)^{\frac{1}{\sigma^M}} Z^{di} \frac{\sigma^M - 1}{\sigma^M} + (s^M + u_t^M)^{\frac{1}{\sigma^M}} Z^{fi} \frac{\sigma^M - 1}{\sigma^M} \right]^{\frac{\sigma^M}{(\sigma^M - 1)}}$$

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

(28b) $$Z^{di} = \left[\sum_{h=1}^{n} \left(\frac{1}{n} \right)^{\frac{1}{\sigma^d}} Z_h^{di} \frac{\sigma^d - 1}{\sigma^d} \right]^{\frac{\sigma^d}{\sigma^d - 1}} \quad , \quad Z^{fi} = \left[\sum_{h=1}^{m} \left(\frac{1}{m} \right)^{\frac{1}{\sigma^f}} Z_h^{fi} \frac{\sigma^f - 1}{\sigma^f} \right]^{\frac{\sigma^f}{\sigma^f - 1}}$$

The elasticity of substitution between bundles of domestic and foreign goods Z^{di} and Z^{fi} is σ^M. Thus aggregate imports are given by

$$(29) \qquad M_t = (s^M + u_t^M)\left[\rho^{PCPM}\frac{P_{t-1}^{\ C}}{P_{t-1}^{\ M}} + (1-\rho^{PCPM})\frac{P_t^C}{P_t^M}\right]^{\sigma^M}(C_t + I_t^{inp} + C_t^G + I_t^G)$$

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

$$(30) \quad X_t = (s^{M,W} + u_t^X)\left(\rho^{PWPX}\frac{P_{t-1}^{\ C,F}E_{t-1}}{P_{t-1}^{\ X}} + (1-\rho^{PWPX})\frac{P_t^{C,F}E_t}{P_t^X}\right)^{\sigma^X} Y_t^F$$

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

$$(31) \qquad \eta_t^X P_t^X = P_t$$

and import prices are given by

$$(32) \qquad \eta_t^M P_t^M = E_t P_t^F$$

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

$$(34) \qquad \eta_t^k = 1 - 1/\sigma^k - \gamma_{Pk}\left[\beta(sfp^k \cdot_t \pi_{t+1}^k + (1-sfp^k)\pi_{t-1}^k) - \pi_t^k\right] + u_t^{P,k} \qquad k = \{X, M\}$$

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

$$(35) \qquad E_t B_t^{\ F} = (1+i_t^F)E_t B_{t-1}^F + P_t^X X_t - P_t^M M_t$$

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

$$(36) \quad YGAP_t = \left(\frac{ucap_t}{ucap_t^{ss}}\right)^{(1-\alpha)} \left(\frac{L_t}{L_t^{ss}}\right)^{\alpha}.$$

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

$$(37) \quad ucap_t^{ss} = (1-\rho^{ucap})ucap_{t-1}^{ss} + \rho^{ucap} ucap_t^{j}$$

$$(38) \quad L_t^{ss} = (1-\rho^{Lss})L_{t-1}^{ss} + \rho^{Lss} L_t$$

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
(39)

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

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.

3.5 How sensitive is credit constrained consumption to changes in income?

Both temporary and permanent fiscal expansions have only a negligible effect on Ricardian consumers, since they respond to permanent income which is hardly affected by temporary fiscal measures and is likely to be zero or even negative in the case of permanent fiscal actions. The question arises, how do credit constrained households respond to fiscal policy? Since they optimise an intertemporal utility function, their consumption decisions will also be based on a concept of permanent income. But how does the fact that they have a higher rate of time preference and the fact that current changes in financial wealth are constrained by the value of the housing stock affect their consumption response to temporary and permanent income changes? In this section we analytically solve the decision problem of the credit

constrained households in order to get a better understanding on the magnitude of the consumption response.[6]

Using the first order conditions implied by the maximisation problem of credit constrained households (eq. 19) and the budget constraint and after some algebraic manipulations and linear approximation around the steady state, we can represent consumption and the housing stock as a system of two linear difference equations

$$C_{t+1}^{c} = \alpha_1 C_t^c - \alpha_2 H_t^c$$

$$H_t^c = -\theta_1 H_{t-1}^c - \theta_2 C_t^c + \theta_2 Y_t^c$$

The coefficients of this system are functions of the underlying structural parameters

$$\alpha_1 = \left(1 + \frac{\omega\overline{C}}{\chi\overline{H}}\right), \quad \alpha_2 = \left(\frac{\omega\overline{C}^2}{\chi\overline{H}^2}\right), \quad \theta_1 = \left(\frac{r + \delta^H - \chi}{\chi}\right), \; \theta_2 = \frac{1}{\chi}$$

As a solution to the law of motion of this system we obtain

$$C_t^c = \lambda_1 C_{t-1}^c + \phi E_t\left(\sum_{j=0}^{\infty}\left(\frac{1}{\lambda_2}\right)^j Y_{t+j}^c\right) \text{ and } \phi = \left(\frac{\alpha_2\theta_2}{\lambda_2}\right)$$

where λ_1 and λ_2 are the roots of this system. This solution shows that indeed credit constrained consumers base their consumption decisions on current as well as future expected income and they discount future income at rate $1/\lambda_2$. For parameter values close to the estimated values we get $\lambda_1 = -0.2$ and $\lambda_2 = 9.7$ and ϕ = 1.07[7]. These values are instructive since they show that credit constrained households do indeed behave similar to liquidity constrained households. In particular, there is a strong response of consumption to temporary changes in income as indicated by the size of ϕ. Also interesting is the large size of λ_2, which implies that future income beyond one year do not affect current consumption decisions significantly any longer.

[6] Since we concentrate on the response to a change in income we assume in this section an exogenous real interest rate. In order to make the solution more tractable we assume zero adjustment costs for residential investment.

[7] We use a rate of time preference of 0.04. The results are however robust to smaller values.

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. It incorporates some of the main stylised differences between the EU and the rest of world, where we base our calibration on estimates of the model on euro area and US data. 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[8]. 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 40 percent of households to be liquidity-constrained, which corresponds closely to our estimates (Ratto et al. (2009). We have little knowledge on the share of credit-constrained households and we assume in our benchmark model (CC) half of the non-liquidity constrained households to be credit-constrained. 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 40-0-60. 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 ($1-\chi$) 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 are 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.

[8] 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	0.4	0.4
Share of credit-constrained consumers s^c	0.3 (CC) 0 (RIC)	0.3 (CC) 0 (RIC)
Share of non-constrained consumers s^r	0.3 (CC) 0.6 (RIC)	0.3 (CC) 0.6 (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 consumption	0.18	0.15
Government investment	0.04	0.04
Exports	0.18	0.15
Imports	0.18	0.15
Transfers to households	0.16	0.13

5. Fiscal shocks

We use the model to examine different types of fiscal expansions. First we examine the difference the introduction of credit constrained households makes on the effectiveness of fiscal policy. We do this both for temporary fiscal shocks (section 5.1) and for permanent fiscal shocks (5.2). This will show the importance of credibility for temporary fiscal measures, and highlight the difference higher future tax liabilities makes on the size of fiscal multipliers. Next we consider the difference between fiscal expansions in one region (acting alone) versus an expansion in both regions together (global). This shows the size of spillovers of fiscal stimuli in one country on the other region and the benefits of coordination. The final subsection includes a sensitivity analysis with respect to monetary policy assumptions.

5.1 Temporary fiscal shocks

We first examine the difference the introduction of credit constraints has made in the model by comparing the model with credit constraints (CC) with the model that excludes this group (RIC). In this section we show temporary (one year) global fiscal shocks applied to both regions together and standardised to 1 per cent of (baseline) GDP. The fiscal policy variables considered are government consumption (unproductive), government investment (productive), transfers to households, labour taxes and consumption taxes. The fiscal rule that returns the debt to GDP ratio to baseline levels is turned off for the first year to allow us to see the impact of the shock on budget balances, 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.

The first scenario shown in Figure 1 is a temporary increase in *government consumption* of 1 per cent of GDP for one year. The results shown are for the EU, and detailed tables can be found in the annex. This temporary impulse raises GDP by 1 per cent in the model with credit constraints *CC* model and 0.95 per cent in the model without (*RIC)*. The main difference between the two model variants is the response of private consumption. In the *RIC* model, private consumption falls in response to the increase in public consumption, a well documented feature of many DSGE models[9]. This seems at first sight in conflict with the findings of Gali *et al.* (2007), who 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. However, empirical estimates show these parameters to be significantly different from zero. A sensitivity analysis in Ratto *et al.* (2009) shows that when these parameters tend to zero (as assumed in Gali *et al* (2007)), the consumption response to a government spending shocks tends to become positive in our model too[10]. Interestingly, in the model with credit-constrained households, there is a positive co-movement between public and private consumption even with non-zero labour adjustment costs. This is completely driven by the response of consumption by credit constrained households, who act more like liquidity-constrained households in response to

[9] See e.g. Coenen and Straub (2007).

[10] The economic interpretation of this result is simple. Negligible wage and labour adjustment costs imply a stronger positive short run impact of an increase in government consumption on labour income and therefore a stronger response of private consumption.

temporary government consumption shocks and raise their consumption. Residential investment falls due to the increase in real interest rates.

A temporary increase in *investment* has very similar effects. The GDP effect is slightly larger and remains slightly positive in the medium term, as public capital is assumed to be productive and depreciates only slowly. Higher growth in the medium term boosts consumption and consumption by non-constrained households falls by less compared to the government consumption shock. Consumption by credit and liquidity constrained households is somewhat higher as real wages remain higher for longer, reflecting the productivity gains from higher public capital. It should be borne in mind that the size of the difference relative to the shock to government consumption depends crucially on the assumed output elasticity of public investment.

The GDP effect of temporary increases in *transfers* are roughly half those of other spending increases, with a higher increase in savings (see Table A1 in annex). There is however a significant difference between the two alternative models. In the model without credit constrained households, GDP rises by only 0.3 per cent, while the increase is twice as large in the model with credit constraints. Ricardian, non-constrained households hardly respond to the temporary increase in transfers, but credit constraint households respond more similarly to liquidity constrained households and raise their consumption. Credit constrained households have a higher marginal propensity to consume out of transitory increases in transfers, and the increase in aggregate consumption is twice as large in this model. Corporate investment is down by more in the model with credit constraints as real interest rates rise by more. Housing investment by Ricardian unconstrained households does not change much, but credit constrained households can raise their housing investment after the increase in transfers.

The GDP effect of temporary reductions in *labour taxes* are very similar to those of an increase in transfers. The multiplier is smaller than for spending shocks, roughly half. But like for transfers, there is a significant difference between the two models. The presence of credit constrained households raises the marginal propensity to consume out of transitory tax reductions, and hence makes fiscal policy a more powerful tool for short run stabilisation. The effects are twice as large in the model with credit constraints than in the model without. The main difference is in the wage response, with real wages falling in case of a labour tax reduction, and rising in case of a transfer shock. The fall in real wages is however smaller in the model with credit constraints due to higher consumption (wealth effect).

Finally, temporary reductions in *consumption taxes* have a larger effect on GDP than temporary reductions in wage taxes. The difference is due to the response of Ricardian non-constrained households who in this case also raise their consumption in response to the change in intertemporal prices (when the shock comes off and VAT is raised back to baseline level). The same applies to housing investment which increases by more. As real interest rates increase, firms reduce their corporate investment. The difference between the two models is not as large as in the case of the labour tax reduction, but it is still sizeable, with credit constrained households acting more like liquidity constrained households[11].

In all these scenarios the deterioration in government balances is less than 1 percentage points. However, it is generally larger for tax shocks than expenditure shocks (see results

[11] Note that under a less than complete pass-through into consumer prices, multipliers could be lower.

reported in Table A1 in the annex). The degree of self-financing ranges from 0.35 to 0.55 and is roughly in line with the growth effects of the fiscal stimulus, with the automatic stabilisers from the tax system and lower unemployment benefit payments cushioning the impact on government balances[12].

5.2 Permanent fiscal shocks

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 much smaller, and, when financed by increases in labour taxes, generally become negative in the long run. This is shown in the following set of figures (Fig. 6-10) of scenarios of permanent increases in spending or reductions in taxes financed in the medium/long run by increases in labour taxes. In this case households anticipate future increases in taxes and reduce their consumption and save more[13].

Figure 6 shows the effects in the EU of a permanent increase in government consumption. Consumption of Ricardian non-constrained households declines, as does credit constrained consumption. Consumption of liquidity constrained households rises slightly on impact, but falls in the medium run as employment declines due to higher taxes. The overall GDP effect is positive in the first years but turns negative in later years as taxes are raised and employment falls.

Figure 7 shows the effects of a permanent increase in (productive) government *investment*, financed by labour taxes. Under the standard assumption in the model, the productivity enhancing effect of a permanently higher public capital stock is large enough to more than offset the negative impact of labour taxes and output is higher in the long run (by almost 3 per cent in the steady state). Consumption declines in the short run, but eventually becomes positive as higher growth raises permanent incomes. The short run impact of this shock is higher in the model with credit constraints than without, largely due to the fact that consumption falls by less in this model. The long run output effect of government investment shocks depends crucially on the assumed output elasticity of public capital. Unfortunately, there is much uncertainty about the productive impact of infrastructure investment and econometric studies show large variation in estimates, depending on how care is taken of common trends, missing variables, simultaneity bias and reverse causation[14]. The benchmark assumption in the model is that the rate of return on public capital equals that of private capital (cfr. Gramlich (1994), p.1187). However, this assumption may be too optimistic as it is questionable whether all public investment projects are as productive as private investment. The lower the productivity effect, the lower will be the long run GDP effect, with as lower bound the effect of a tax-financed increase in (unproductive) government

[12] For analytical reasons other expenditure components are kept exogenous in the simulations to isolate the effects of the expenditure shock considered and not to combine it with effects of other shocks. If transfers were indexed to inflation, the degree of self-financing would be lower.

[13] The fiscal rule that returns the debt to GDP ratio to baseline levels is turned off for the first year to see the impact of the shock on budget balances, but from the second year onwards (distortionary) labour taxes are raised to finance the expansion.

[14] For an overview see e.g the surveys by Gramlich (1994), Romp and de Haan (2005).

consumption (see Figure 11). The output effect of a government investment shock lies probably somewhere in between these two lines [15].

Permanent increases in transfers (Fig. 8) have almost no positive GDP impact in the model without credit constraints as the decline in Ricardian non-constrained consumption (in response to higher tax liabilities) offsets the increase in consumption by liquidity constrainted households. In the model with credit constraints, those households respond more akin to liquidity constrained households and overall consumption is higher on impact. In the long run however, there is not much difference and GDP declines in both variants.

The scenario shown in Fig.9 is a shock to labour taxes of 1 percent of GDP (a roughly 1.5 percentage point reduction in the tax rate). But from the second year onwards taxes are raised again gradually to return the debt-to-GDP ratio to baseline, and eventually have to be raised to pay for the higher interest burden. Hence, the scenario shows the effect of a temporary tax reduction that is gradually phased-out. It has positive output and employment effects in the short run, and these are larger in the model with credit constrained households.

Finally, Fig. 10 shows the effects of a permanent reduction in consumption taxes (roughly 1.6 percentage points). As this shock is permanent, it does not affect intertemporal prices and unlike in the case of a temporary shock, Ricardian non-constrained households do not react to this. But they do face higher future labour taxes financing this VAT reduction. They respond to this reduction in permanent income by reducing their consumption. Liquidity constrained households raise their consumption as consumer prices fall, and so do credit constrained households (they are more impatient and have a higher discount rate). The short run effects are larger in the model with credit constraints.

5.3 Spillover effects of temporary fiscal shocks

The fiscal shocks discussed in the previous section were global expansions in both regions. To show the importance of the spillover effects, Table 2 below shows the difference between global expansions in both regions and fiscal expansions in one region alone, in the model that includes credit constrained households (*CC*). The table shows the first year GDP effects for the same standardised temporary (one year) fiscal shocks, in the first column for a shock in the EU, in the second column in rest of the world, and in the third column for a global shock in both regions together (as discussed in section 5.1). Government spending shocks have higher fiscal multipliers than revenue shocks, and the effects of (productive) government investment shocks are slightly higher than consumption shocks. Fiscal multipliers for transfers and wage tax shocks are the lowest. Spillovers of a fiscal expansion in the EU to the rest of the world are around 10 percent, while the reversed spillovers of a shock in the other region to the EU are somewhat larger, reflecting the difference in size and trade openness. Multipliers are generally smaller in the EU due to higher nominal and real rigidities and benefit and transfer generosity.

[15] Varga and in 't Veld (2008) show a sensitivity analysis with respect to the output elasticity for the GDP impact of Structural and Cohesion Funds in this model. The GDP impact depends heavily on this elasticity, even tough in that case investment is not tax-financed, but financed by fiscal transfers received from the EU.

Table 2 First year GDP effects of temporary fiscal shocks of 1% of GDP

	EU	RoW	Global
Government consumption			
EU GDP	0.74	0.26	0.99
RoW GDP	0.09	0.96	1.04
Government investment			
EU GDP	0.84	0.24	1.07
RoW GDP	0.08	1.04	1.12
Government transfers			
EU GDP	0.40	0.15	0.55
RoW GDP	0.05	0.53	0.58
Labour tax			
EU GDP	0.41	0.12	0.53
RoW GDP	0.04	0.52	0.56
Consumption tax			
EU GDP	0.49	0.18	0.67
RoW GDP	0.06	0.64	0.70

Note: GDP difference from baseline in first year of simulation, for resp. EU acting alone, RoW acting alone and global coordinated expansions. All shocks are credibly temporary for one year and of equal size, 1% of baseline GDP.

5.4 Sensitivity analysis

The size of the fiscal multiplier depends on a range of factors. First, the design of the fiscal policy is important. As shown here, the duration of the shocks plays a key role, and fiscal policy is most effective if it is *credibly* temporary. The assumption on how the fiscal stimulus is financed in the long run is also important. Multipliers would be higher under financing by lump-sum taxes but this would in the real world be a less viable option. The multipliers shown here assume financing in the long run through distortionary wage taxes. Real effects could be larger under alternative financing assumptions.

The role of monetary policy is also crucial. Empirical studies that hold interest rates constant show larger multipliers than studies that allow for interest rate responses by central banks. At the present juncture with sharp falls in output and no significant inflationary risks, central banks might be more accommodative and respond less strongly to fiscal stimulus packages, and the scenarios reported here assumed lower response parameters than estimated on euro area data. As a result, in the scenarios described above, there are no large interest rate increases in response to the fiscal stimulus. But in order to show the sensitivity of the results to the monetary policy assumption, we compare the results in the table below to an alternative assumption of a fully accommodative monetary policy, in which interest rates are kept unchanged in the first year when the stimulus occurs, and resume to the normal response in the years thereafter. As can be seen in Table 3, this raises the fiscal multipliers for all shocks considerably. The fiscal stimulus is only for one year, and monetary policy does not react to the increase in inflation in that year or to the resulting increase in the price level. There is a sharp fall in the real interest rate and this increases aggregate demand. The fiscal stimulus in one single region is also accompanied by a depreciation of the exchange rate

which boosts trade in the country concerned, but reduces the spillover effects to the other region. Under this accommodative monetary stance, a coordinated global fiscal expansion has also larger multipliers, ranging from 0.7 for tax reductions to 1.5 for spending increases.

Table 3 First year GDP effects of temporary fiscal shocks under accommodative monetary policy

	EU	RoW	Global
Government consumption			
EU GDP	1.23	0.08	1.40
RoW GDP	0.04	1.48	1.52
Government investment			
EU GDP	1.26	0.09	1.40
RoW GDP	0.04	1.48	1.52
Government transfers			
EU GDP	0.69	0.04	0.78
RoW GDP	0.02	0.85	0.87
Labour tax			
EU GDP	0.60	0.05	0.68
RoW GDP	0.02	0.74	0.76
Consumption tax			
EU GDP	0.87	0.04	0.99
RoW GDP	0.02	1.07	1.10

Note: GDP difference from baseline in first year of simulation, for resp. EU acting alone, RoW acting alone and global coordinated expansions. All shocks are temporary for one year and of equal size, 1% of baseline GDP. Accommodative monetary policy is unchanged interest rates in first year.

6. Conclusions

The current financial crisis has renewed interest in discretionary fiscal policy. This paper has shown that fiscal policy can be more effective at the current juncture with higher credit constraints and a sharp and prolonged fall in demand. Our analysis can be summarised as follows. First, temporary fiscal policy shocks can have sizeable effects. These effects are larger for spending shocks (government consumption and investment) than for transfers and tax reductions. Of the latter, a larger share ends up as an increase in the savings rate. Second, the introduction of credit-constrained households raises the multiplier for transfer and tax shocks, almost doubling the impact when half the Ricardian households are assumed to be in fact credit-constrained. This suggests that at the present juncture, with a tightening of credit constraints as a result of the financial crisis, fiscal policy might be more effective than in the past. Third, permanent shocks have much smaller impacts as the anticipatory effects of larger tax liabilities weigh heavier. In the medium to long run, the GDP effects can become negative as the distortionary effects of higher taxes come to dominate. Fourth, the introduction of credit-constrained households also raises the multiplier for permanent transfer and tax shocks, but the GDP effects are smaller. The long run effects are not affected by the introduction of credit constraints in the model. Fifth, the large difference between temporary and permanent fiscal shocks means it is of crucial importance that temporary tax shocks do not become permanent, and that this policy is credible. Sixth, spillover effects of fiscal shocks are positive, and effects

of a joint fiscal stimulus are larger than when acting alone. And finally, the response of monetary policy to a fiscal stimulus matters. Fiscal multipliers are higher under a more accommodative monetary policy.

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Figure 1 Temporary increase government consumption

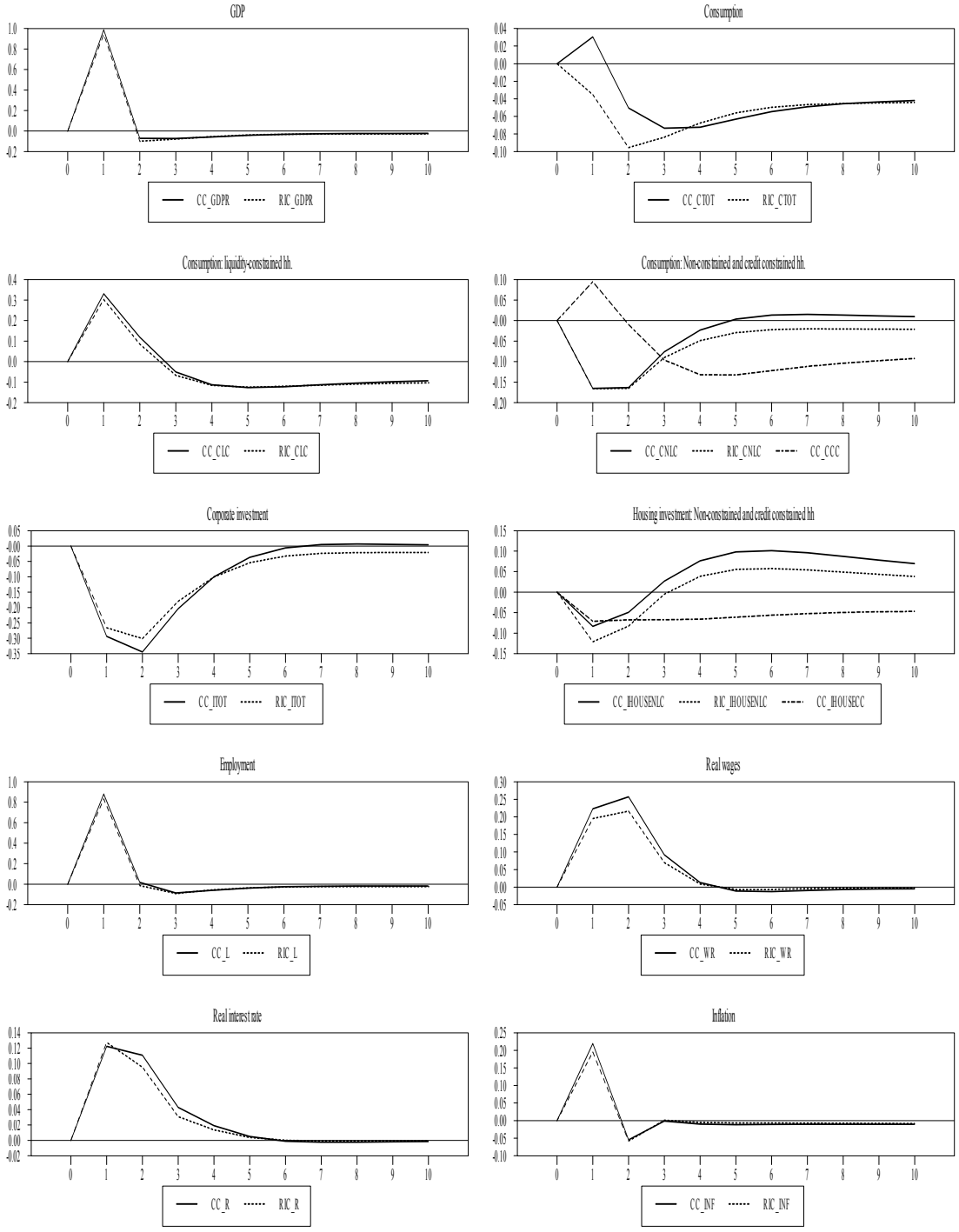


Figure 2 Temporary increase government investment

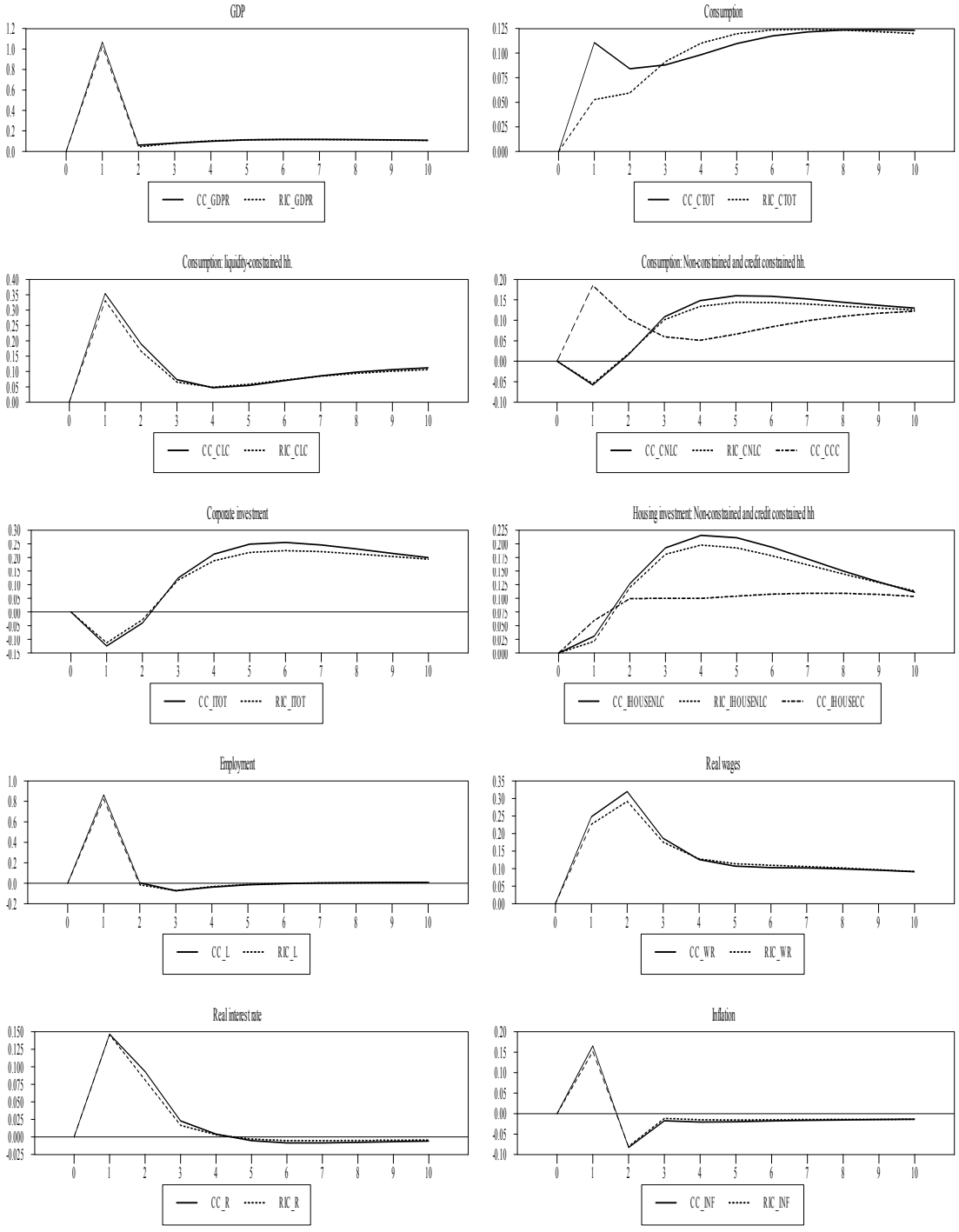


Figure 3 Temporary increase government transfers

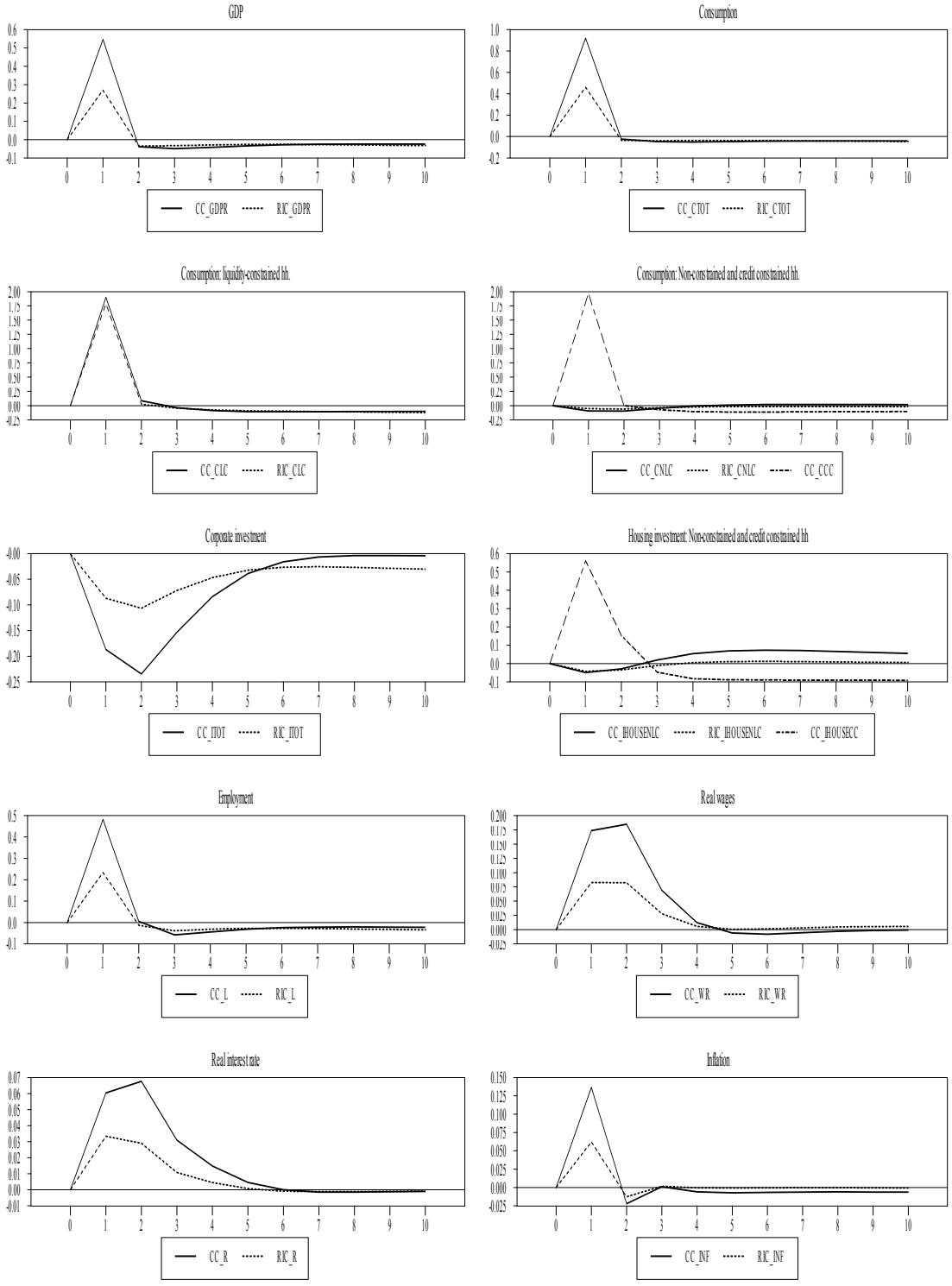


Figure 4 Temporary reduction labour taxes

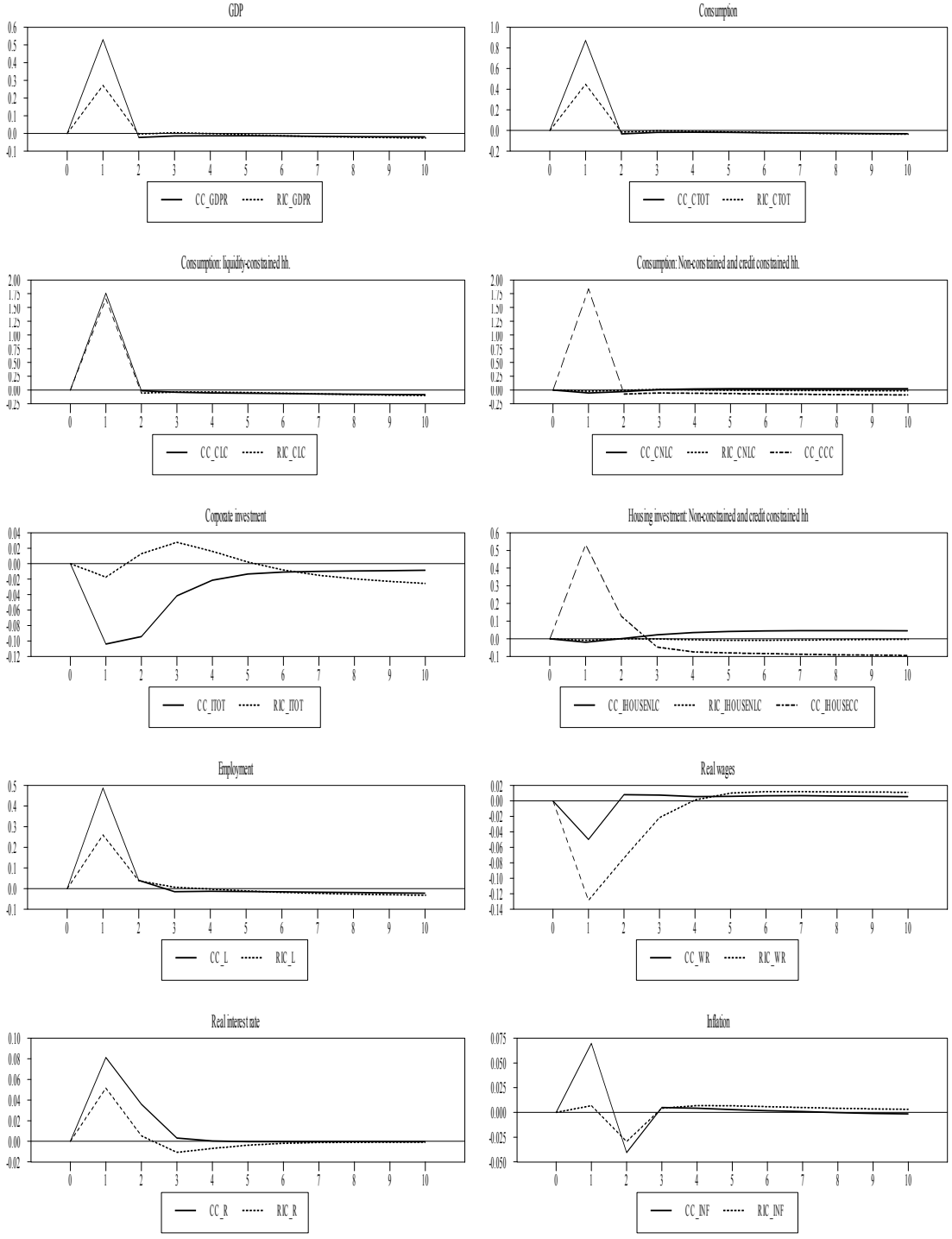


Figure 5 Temporary reduction consumption taxes

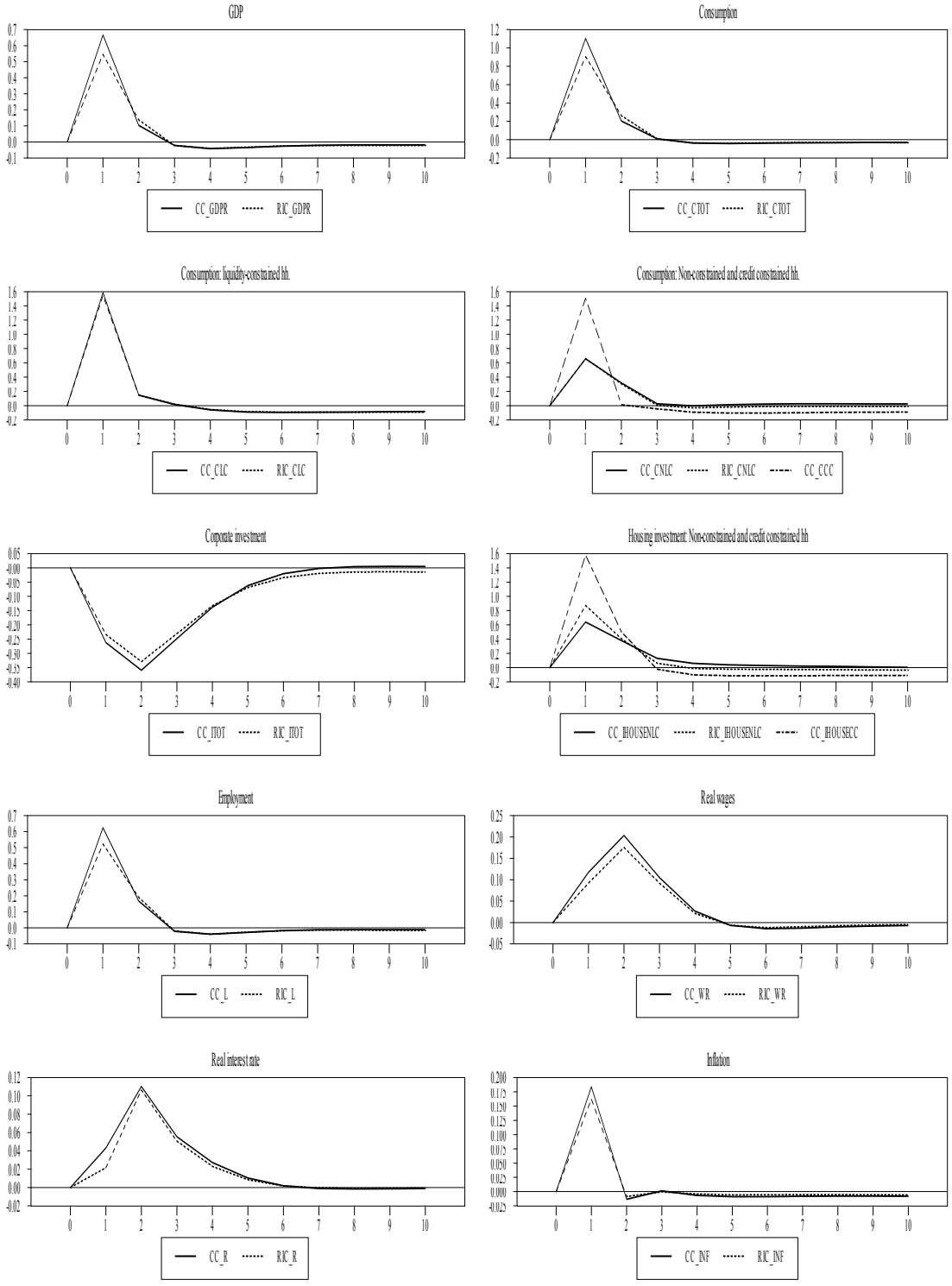


Figure 6 Permanent increase government consumption – tax financed

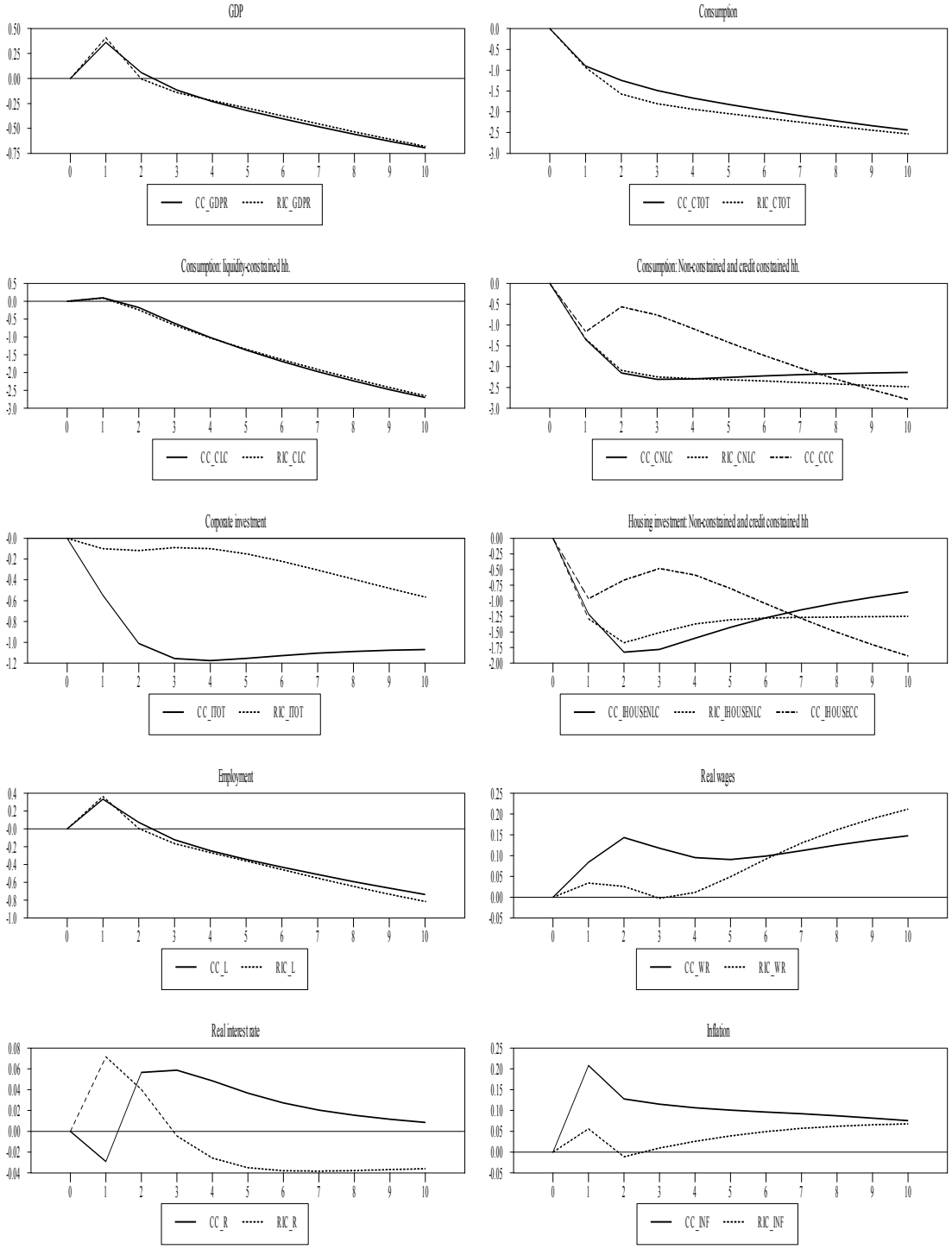


Figure 7 Permanent increase government investment – tax financed

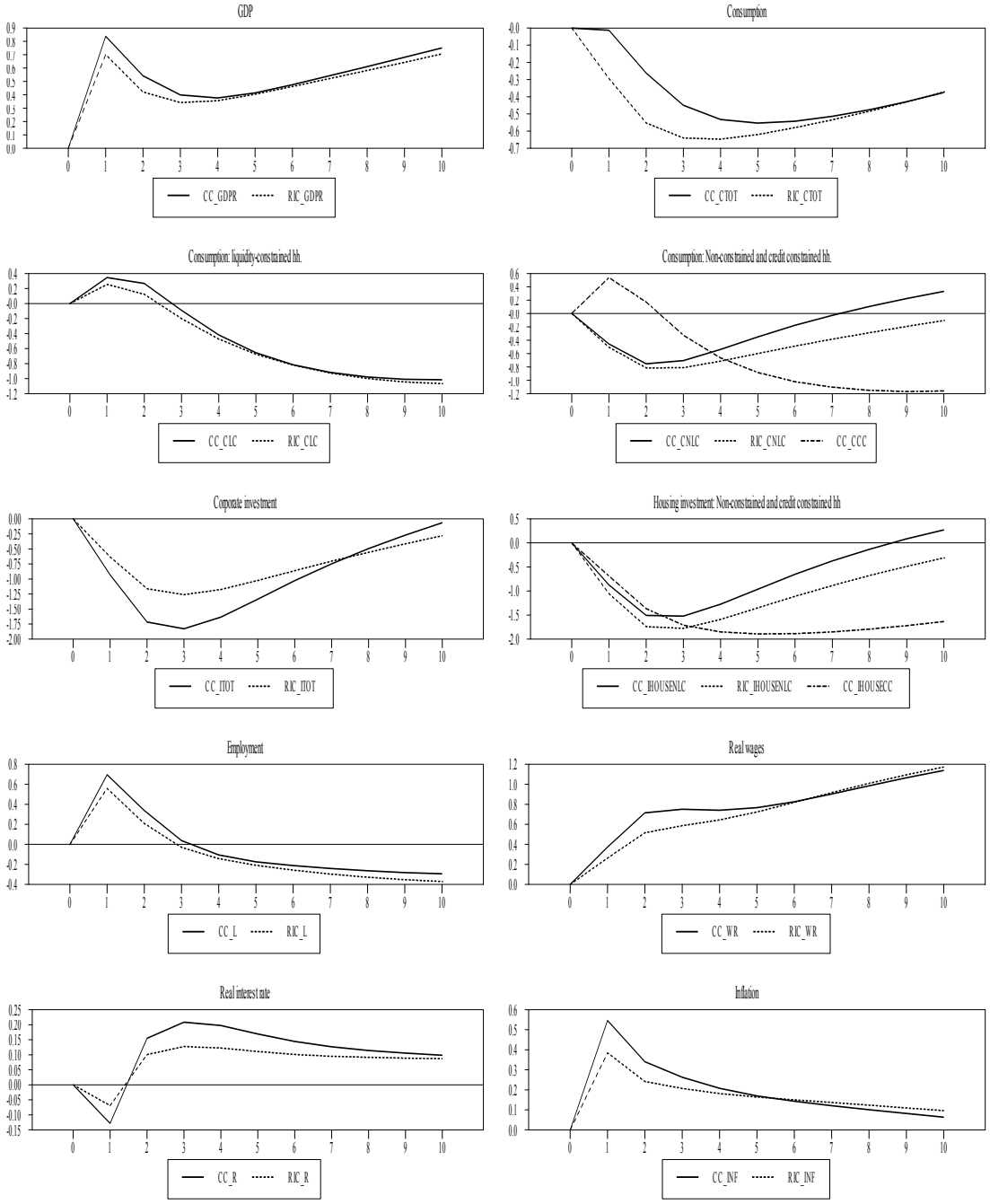


Figure 8 Permanent increase government transfers – tax financed

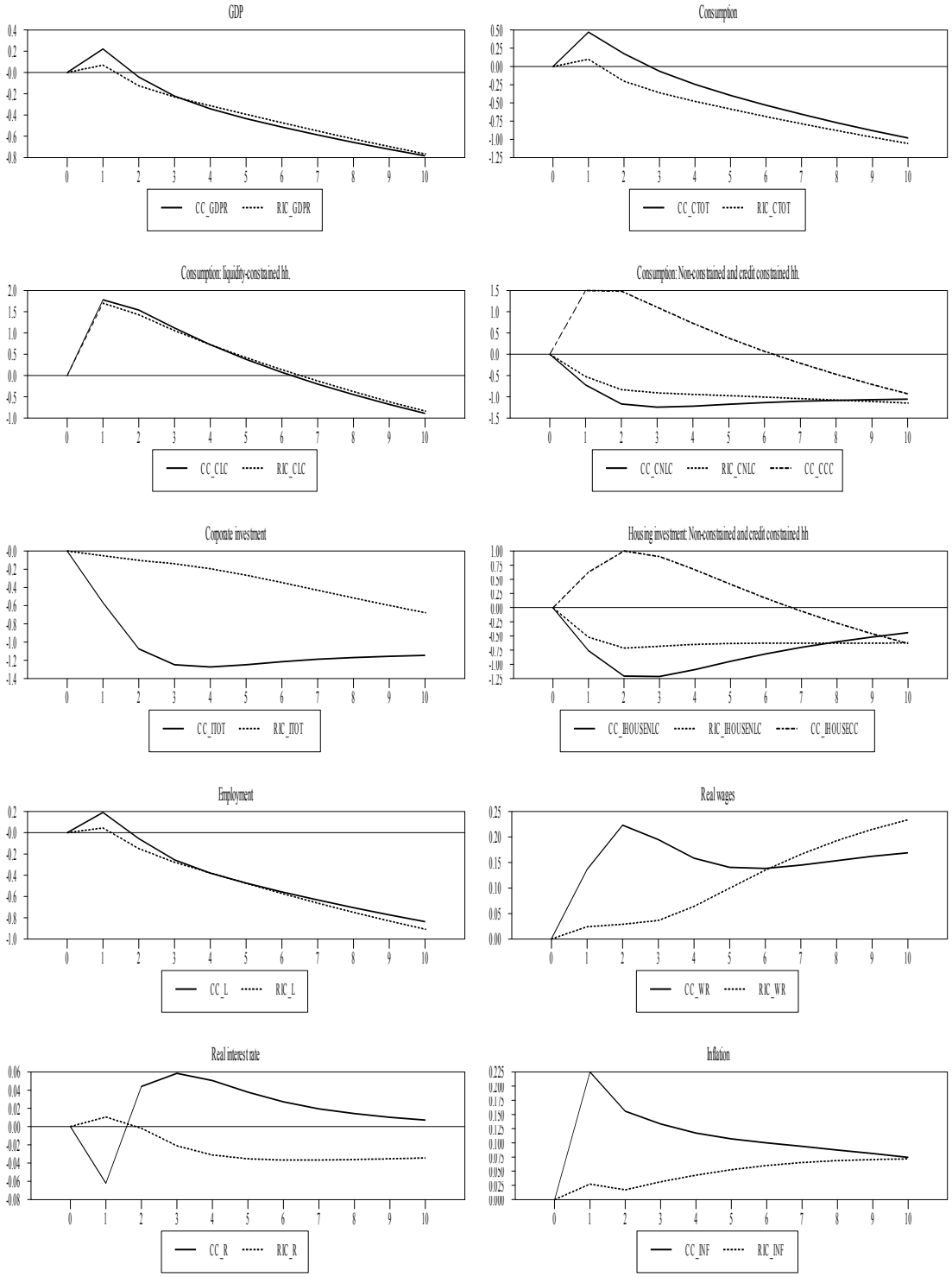


Figure 9 Reduction labour taxes – gradually reversed

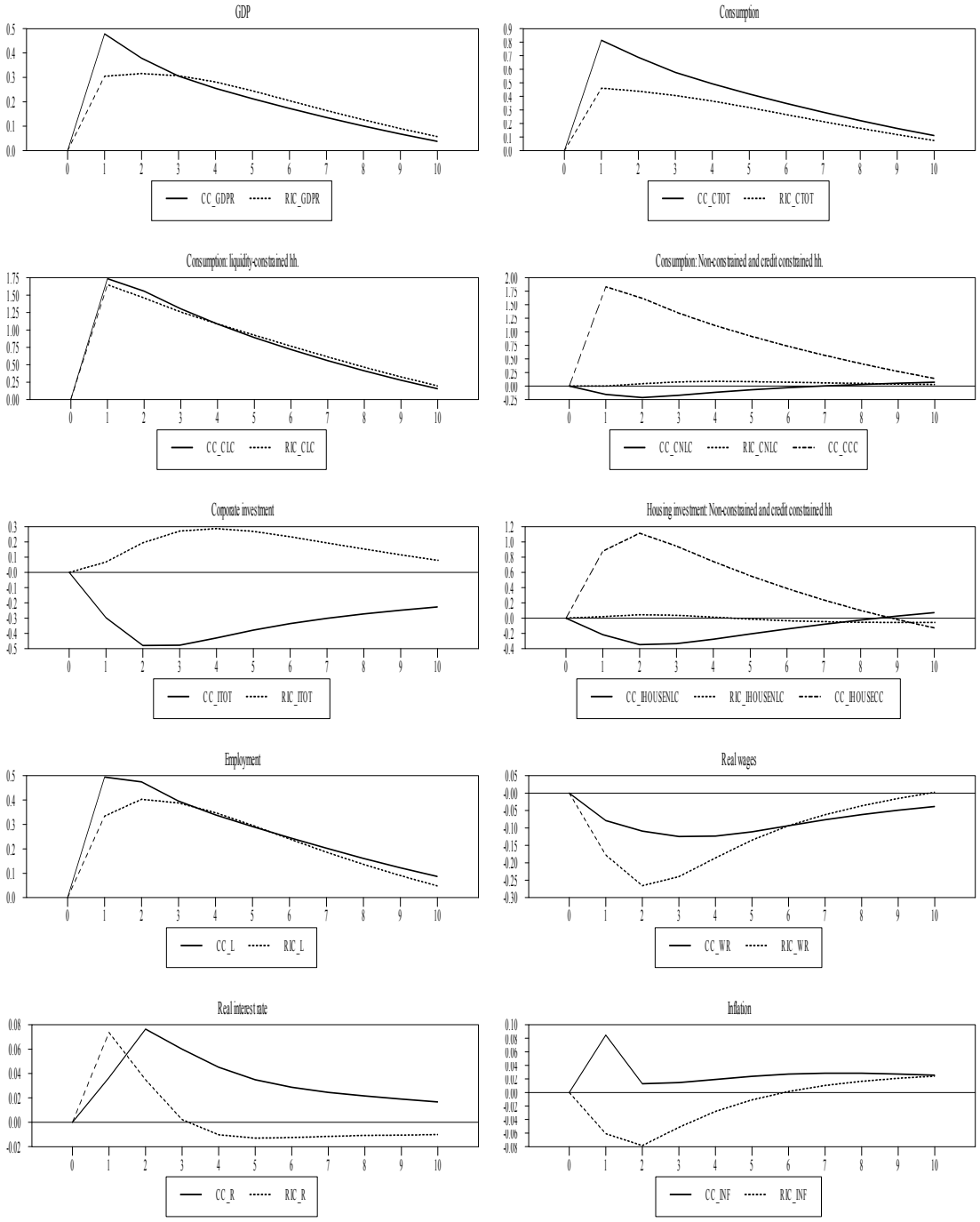


Figure 10 Permanent reduction consumption taxes – financed by wage taxes

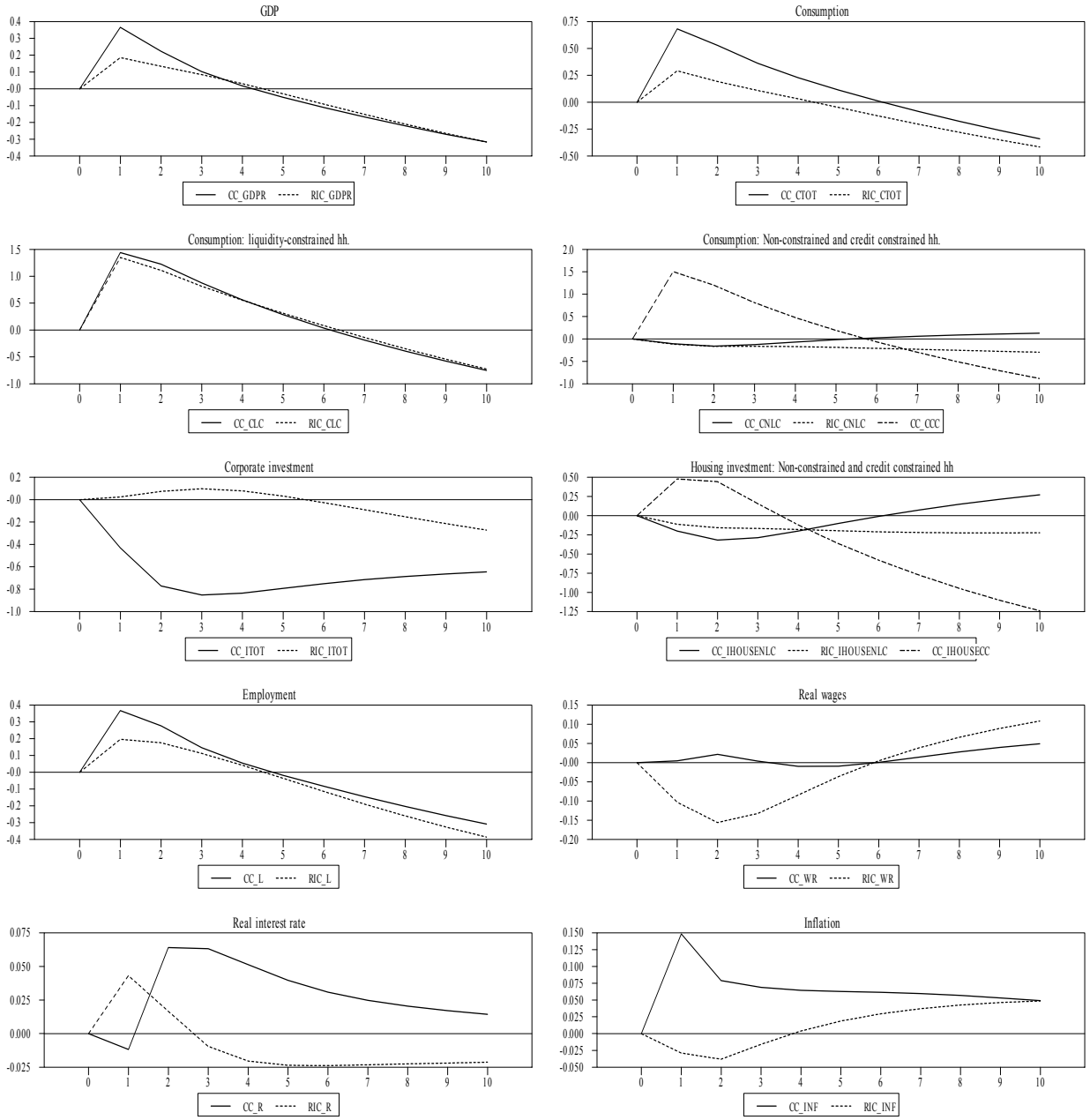
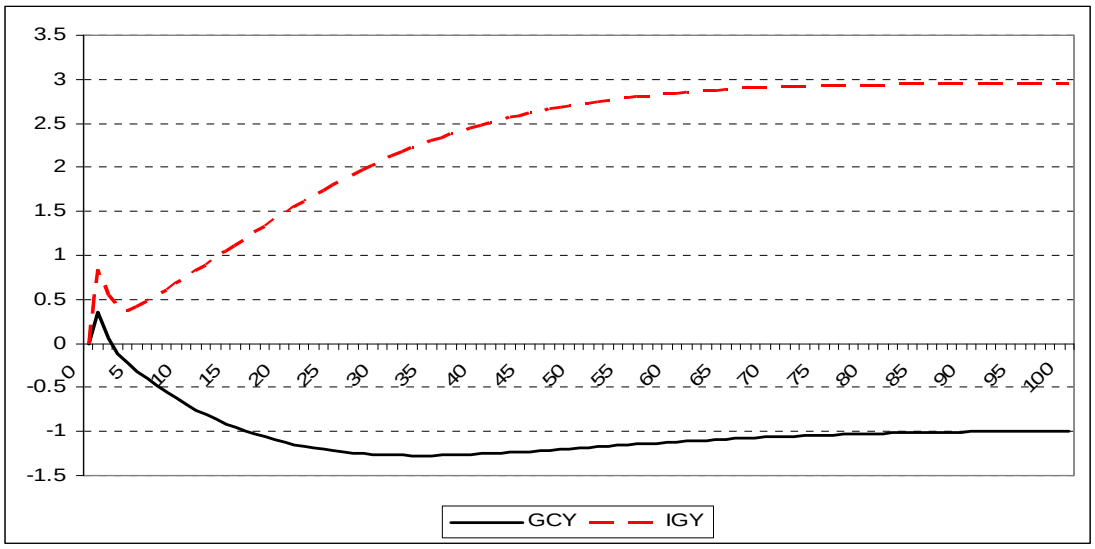


Figure 11 GDP effects of a permanent increase in government consumption and investment



Note: percentage difference from baseline. Permanent tax-financed increases in (unproductive) government consumption and (productive) government investment.

Annex

Table A1: Macro-economic impact on EU of temporary one year global fiscal stimuli of 1% of GDP

Government consumption

	1	2	3	4	5	10	20
GDP	0.99	-0.07	-0.07	-0.06	-0.04	-0.02	-0.02
EMPLOYMENT	0.88	0.02	-0.09	-0.06	-0.04	-0.02	-0.02
CONSUMPTION	0.03	-0.05	-0.07	-0.07	-0.06	-0.04	-0.03
.CLC	0.33	0.12	-0.05	-0.11	-0.13	-0.09	-0.06
.CCC	0.10	-0.01	-0.10	-0.13	-0.13	-0.09	-0.06
.CNLC	-0.17	-0.16	-0.08	-0.02	0.00	0.01	-0.00
INVESTMENT	-0.31	-0.34	-0.21	-0.10	-0.04	0.00	-0.01
INVESTMENT.HOUSE	-0.08	-0.05	0.01	0.05	0.07	0.04	-0.01
.INVESTMENT.H.CC	-0.07	-0.07	-0.07	-0.07	-0.06	-0.05	-0.06
.INVESTMENT.H.NLC	-0.08	-0.05	0.03	0.08	0.10	0.06	-0.00
EXPORTS	1.90	-0.26	-0.07	-0.07	-0.05	-0.03	-0.03
IMPORTS	1.78	-0.34	-0.07	-0.05	-0.04	-0.02	-0.02
REAL WAGES	0.22	0.26	0.09	0.01	-0.01	-0.00	-0.00
NET REAL CONS WAGES	0.22	0.22	0.02	-0.08	-0.11	-0.09	-0.09
TERMS OF TRADE	-0.02	-0.01	-0.00	0.00	0.00	0.00	0.00
NOM.INT.RATE	0.19	0.10	0.04	0.01	-0.01	-0.01	-0.01
REAL.INT.RATE	0.12	0.11	0.04	0.02	0.01	-0.00	-0.00
INFL	0.22	-0.05	-0.00	-0.01	-0.01	-0.01	-0.01
GOV.DEBT(%GDP)	-0.34	0.53	0.59	0.60	0.59	0.44	0.32
GOV.BALANCE(%GDP)	-0.47	-0.07	-0.05	-0.01	0.01	0.02	0.01
CURRENT.ACC.(%GDP)	0.01	0.01	0.00	-0.00	-0.00	0.00	0.00
PRIV.INV. (%GDP)	-0.24	-0.04	-0.02	-0.00	0.01	0.01	0.00
SAVINGS(%GDP)	0.24	0.04	0.04	0.01	-0.00	-0.01	-0.00

Government investment

	1	2	3	4	5	10	20
GDP	1.07	0.06	0.08	0.10	0.11	0.11	0.07
EMPLOYMENT	0.86	0.01	-0.07	-0.04	-0.02	0.01	0.00
CONSUMPTION	0.11	0.08	0.09	0.10	0.11	0.12	0.09
.CLC	0.35	0.19	0.07	0.05	0.05	0.12	0.10
.CCC	0.18	0.10	0.06	0.05	0.07	0.13	0.10
.CNLC	-0.06	0.02	0.11	0.15	0.16	0.12	0.08
INVESTMENT	-0.14	-0.03	0.13	0.22	0.26	0.19	0.09
INVESTMENT.HOUSE	0.04	0.12	0.18	0.19	0.19	0.10	-0.00
.INVESTMENT.H.CC	0.06	0.10	0.10	0.10	0.10	0.10	0.02
.INVESTMENT.H.NLC	0.03	0.13	0.19	0.22	0.21	0.09	-0.01
EXPORTS	1.95	-0.16	0.08	0.08	0.10	0.10	0.06
IMPORTS	1.84	-0.23	0.07	0.09	0.10	0.10	0.07
REAL WAGES	0.25	0.32	0.19	0.13	0.11	0.09	0.06
NET REAL CONS WAGES	0.25	0.29	0.15	0.10	0.09	0.14	0.08
TERMS OF TRADE	-0.02	-0.01	-0.00	0.00	0.00	-0.00	0.00
NOM.INT.RATE	0.16	0.06	0.00	-0.02	-0.02	-0.02	-0.01
REAL.INT.RATE	0.15	0.09	0.02	0.00	-0.01	-0.01	-0.00
INFL	0.17	-0.08	-0.02	-0.02	-0.02	-0.01	-0.00
GOV.DEBT(%GDP)	-0.39	0.42	0.41	0.38	0.33	0.16	0.19
GOV.BALANCE(%GDP)	-0.44	-0.01	0.01	0.04	0.05	0.02	-0.01
CURRENT.ACC.(%GDP)	0.01	0.01	0.00	-0.00	0.00	0.00	0.00
PRIV.INV.(%GDP)	-0.22	-0.01	0.01	0.02	0.03	0.01	0.00
SAVINGS.(%GDP)	0.22	0.01	0.00	-0.01	-0.02	-0.00	0.01

Government transfers

	1	2	3	4	5	10	20
GDP	0.55	-0.04	-0.05	-0.04	-0.03	-0.02	-0.03
EMPLOYMENT	0.48	0.01	-0.06	-0.04	-0.03	-0.02	-0.03
CONSUMPTION	0.92	-0.02	-0.05	-0.05	-0.05	-0.04	-0.04
.CLC	1.90	0.09	-0.04	-0.09	-0.10	-0.10	-0.09
.CCC	1.97	-0.00	-0.07	-0.10	-0.11	-0.10	-0.09
.CNLC	-0.09	-0.09	-0.04	-0.01	0.01	0.02	0.01
INVESTMENT	-0.20	-0.23	-0.16	-0.09	-0.04	-0.00	-0.01
INVESTMENT.HOUSE	0.06	0.00	0.01	0.03	0.04	0.02	-0.01
.INVESTMENT.H.CC	0.56	0.15	-0.05	-0.08	-0.09	-0.09	-0.09
.INVESTMENT.H.NLC	-0.05	-0.03	0.02	0.05	0.07	0.05	0.01
EXPORTS	1.07	-0.12	-0.04	-0.05	-0.04	-0.03	-0.03
IMPORTS	0.97	-0.19	-0.05	-0.04	-0.03	-0.02	-0.02
REAL WAGES	0.17	0.18	0.07	0.01	-0.01	-0.00	0.00
NET REAL CONS WAGES	0.17	0.16	0.01	-0.07	-0.10	-0.11	-0.11
TERMS OF TRADE	-0.02	-0.01	-0.00	0.00	0.00	0.00	0.00
NOM.INT.RATE	0.11	0.07	0.03	0.01	-0.00	-0.01	-0.01
REAL.INT.RATE	0.06	0.07	0.03	0.01	0.00	-0.00	-0.00
INFL	0.14	-0.02	0.00	-0.01	-0.01	-0.01	-0.01
GOV.DEBT(%GDP)	0.03	0.65	0.69	0.71	0.71	0.60	0.44
GOV.BALANCE(%GDP)	-0.62	-0.06	-0.05	-0.02	-0.00	0.01	0.01
CURRENT.ACC.(%GDP)	0.01	0.01	0.00	-0.00	-0.00	0.00	0.00
PRIV.INV.(%GDP)	-0.13	-0.03	-0.01	-0.00	0.00	0.01	0.00
SAVINGS(%GDP)	0.50	0.04	0.04	0.02	0.01	-0.01	-0.01

Labour taxes

	1	2	3	4	5	10	20
GDP	0.53	-0.02	-0.01	-0.01	-0.01	-0.02	-0.02
EMPLOYMENT	0.49	0.04	-0.01	-0.01	-0.01	-0.02	-0.03
CONSUMPTION	0.87	-0.03	-0.02	-0.02	-0.02	-0.03	-0.04
.CLC	1.76	-0.01	-0.04	-0.05	-0.06	-0.09	-0.09
.CCC	1.84	-0.07	-0.05	-0.06	-0.06	-0.09	-0.09
.CNLC	-0.05	-0.03	0.01	0.02	0.02	0.02	0.02
INVESTMENT	-0.11	-0.09	-0.04	-0.02	-0.01	-0.01	-0.01
INVESTMENT.HOUSE	0.08	0.02	0.01	0.02	0.02	0.02	-0.00
.INVESTMENT.H.CC	0.53	0.13	-0.05	-0.07	-0.08	-0.09	-0.09
.INVESTMENT.H.NLC	-0.02	0.00	0.02	0.04	0.04	0.04	0.02
EXPORTS	0.99	-0.14	-0.01	-0.02	-0.02	-0.03	-0.03
IMPORTS	0.89	-0.21	-0.03	-0.01	-0.01	-0.02	-0.02
REAL WAGES	-0.05	0.01	0.01	0.01	0.01	0.01	0.00
NET REAL CONS WAGES	2.38	-0.02	-0.04	-0.05	-0.06	-0.10	-0.12
TERMS OF TRADE	-0.02	-0.01	-0.00	0.00	0.00	0.00	0.00
NOM.INT.RATE	0.08	0.02	0.01	0.00	0.00	-0.00	-0.00
REAL.INT.RATE	0.08	0.04	0.00	0.00	-0.00	-0.00	-0.00
INFL	0.07	-0.04	0.01	0.00	0.00	-0.00	-0.00
GOV.DEBT(%GDP)	0.06	0.68	0.70	0.70	0.70	0.65	0.49
GOV.BALANCE(%GDP)	-0.63	-0.04	-0.03	-0.02	-0.01	0.00	0.01
CURRENT.ACC.(%GDP)	0.01	0.01	0.00	0.00	-0.00	-0.00	-0.00
PRIV.INV.(%GDP)	-0.11	-0.01	-0.00	0.00	0.00	0.00	0.00
SAVINGS(%GDP)	0.53	0.04	0.03	0.02	0.01	0.00	-0.01

Consumption taxes

	1	2	3	4	5	10	20
GDP	0.67	0.10	-0.02	-0.04	-0.03	-0.02	-0.02
EMPLOYMENT	0.62	0.17	-0.02	-0.04	-0.03	-0.01	-0.02
CONSUMPTION	1.11	0.20	0.01	-0.04	-0.04	-0.03	-0.03
.CLC	1.59	0.15	0.02	-0.06	-0.09	-0.08	-0.07
.CCC	1.51	0.01	-0.04	-0.09	-0.10	-0.09	-0.07
.CNLC	0.66	0.32	0.03	-0.00	0.01	0.02	0.02
INVESTMENT	-0.27	-0.36	-0.25	-0.14	-0.06	0.01	-0.00
INVESTMENT.HOUSE	0.82	0.41	0.10	0.03	0.01	-0.02	-0.06
.INVESTMENT.H.CC	1.58	0.50	-0.02	-0.10	-0.11	-0.11	-0.12
.INVESTMENT.H.NLC	0.64	0.38	0.13	0.06	0.04	0.00	-0.04
EXPORTS	1.21	0.07	-0.01	-0.05	-0.05	-0.03	-0.02
IMPORTS	1.09	-0.03	-0.03	-0.04	-0.03	-0.02	-0.01
REAL WAGES	0.12	0.20	0.11	0.03	-0.01	-0.01	-0.00
NET REAL CONS WAGES	1.55	0.21	0.10	-0.01	-0.05	-0.07	-0.08
TERMS OF TRADE	-0.02	-0.02	-0.01	-0.00	0.00	0.00	0.00
NOM.INT.RATE	0.14	0.11	0.05	0.02	0.00	-0.01	-0.01
REAL.INT.RATE	0.04	0.11	0.06	0.03	0.01	-0.00	-0.00
INFL	0.18	-0.01	0.00	-0.01	-0.01	-0.01	-0.01
GOV.DEBT(%GDP)	-0.04	0.47	0.56	0.61	0.61	0.52	0.40
GOV.BALANCE(%GDP)	-0.62	0.03	-0.04	-0.03	-0.01	0.01	0.01
CURRENT.ACC.(%GDP)	0.01	0.01	0.00	0.00	-0.00	0.00	0.00
PRIV.INV.(%GDP)	-0.11	-0.04	-0.02	-0.01	-0.00	0.00	0.00
SAVINGS(%GDP)	0.52	-0.06	0.02	0.02	0.01	-0.01	-0.00

Note: Top half of each table percentage difference from baseline, bottom half percentage point difference from baseline.

Table A2: Macro-economic impact on EU of permanent global fiscal stimuli of 1% of GDP

Government consumption

	1	2	3	4	5	10	20
GDP	0.36	0.06	-0.12	-0.23	-0.32	-0.75	-1.15
EMPLOYMENT	0.33	0.07	-0.12	-0.24	-0.34	-0.80	-1.21
CONSUMPTION	-0.90	-1.25	-1.49	-1.67	-1.82	-2.54	-3.17
.CLC	0.10	-0.18	-0.61	-1.01	-1.37	-2.90	-4.14
.CCC	-1.16	-0.56	-0.76	-1.09	-1.42	-2.99	-4.24
.CNLC	-1.34	-2.15	-2.30	-2.30	-2.26	-2.13	-2.15
INVESTMENT	-0.57	-1.04	-1.20	-1.22	-1.20	-1.09	-1.08
INVESTMENT.HOUSE	-1.17	-1.61	-1.54	-1.41	-1.31	-1.02	-0.92
.INVESTMENT.H.CC	-0.97	-0.67	-0.48	-0.59	-0.80	-2.05	-2.89
.INVESTMENT.H.NLC	-1.21	-1.82	-1.78	-1.60	-1.42	-0.79	-0.47
EXPORTS	0.89	0.38	0.17	0.02	-0.10	-0.60	-1.01
IMPORTS	0.49	-0.03	-0.18	-0.26	-0.32	-0.59	-0.83
REAL WAGES	0.08	0.14	0.12	0.09	0.09	0.16	0.18
NET REAL CONS WAGES	0.08	-0.17	-0.69	-1.18	-1.62	-3.50	-5.01
TERMS OF TRADE	-0.07	-0.06	-0.05	-0.04	-0.02	0.04	0.11
NOM.INT.RATE	0.14	0.18	0.17	0.15	0.14	0.07	0.01
REAL.INT.RATE	-0.03	0.06	0.06	0.05	0.04	0.01	-0.01
INFL	0.21	0.13	0.12	0.11	0.10	0.07	0.02
TAX LAB.	0.00	0.19	0.50	0.79	1.06	2.28	3.25
GOV.DEBT(%GDP)	0.29	1.42	2.49	3.44	4.28	7.42	8.20
GOV.BALANCE(%GDP)	-0.92	-1.08	-1.05	-0.96	-0.87	-0.45	-0.05
CURRENT.ACC(%GDP)	0.04	0.05	0.04	0.04	0.03	0.02	0.01
PRIV.INV(%GDP)	-0.26	-0.32	-0.31	-0.29	-0.26	-0.16	-0.09
SAVINGS(%GDP)	0.70	0.80	0.78	0.71	0.64	0.31	-0.03

Government investment

	1	2	3	4	5	10	20
GDP	0.84	0.54	0.40	0.38	0.41	0.82	1.54
EMPLOYMENT	0.70	0.34	0.04	-0.11	-0.17	-0.30	-0.18
CONSUMPTION	-0.01	-0.26	-0.45	-0.53	-0.55	-0.32	0.49
.CLC	0.34	0.27	-0.09	-0.42	-0.66	-1.00	-0.17
.CCC	0.54	0.17	-0.33	-0.67	-0.88	-1.13	-0.19
.CNLC	-0.46	-0.75	-0.70	-0.54	-0.35	0.43	1.16
INVESTMENT	-0.95	-1.75	-1.87	-1.67	-1.37	0.15	1.49
INVESTMENT.HOUSE	-0.84	-1.48	-1.56	-1.38	-1.13	0.07	0.93
.INVESTMENT.H.CC	-0.69	-1.37	-1.71	-1.85	-1.89	-1.54	-0.35
.INVESTMENT.H.NLC	-0.88	-1.51	-1.52	-1.28	-0.96	0.43	1.22
EXPORTS	1.48	0.80	0.57	0.48	0.48	0.81	1.51
IMPORTS	1.35	0.66	0.52	0.51	0.55	0.93	1.56
REAL WAGES	0.38	0.72	0.75	0.74	0.77	1.21	1.71
NET REAL CONS WAGES	0.37	0.53	0.23	-0.11	-0.36	-0.61	0.48
TERMS OF TRADE	-0.02	-0.02	-0.01	0.01	0.02	0.04	0.02
NOM.INT.RATE	0.33	0.47	0.46	0.39	0.33	0.14	0.00
REAL.INT.RATE	-0.13	0.16	0.21	0.20	0.17	0.09	0.05
INFL	0.55	0.34	0.26	0.21	0.17	0.05	-0.05
TAX LAB.	0.00	0.12	0.32	0.53	0.70	1.12	0.76
GOV.DEBT(%GDP)	-0.26	0.43	1.19	1.82	2.30	2.88	0.63
GOV.BALANCE(%GDP)	-0.59	-0.83	-0.84	-0.74	-0.59	-0.02	0.24
CURRENT.ACC(%GDP)	0.01	0.02	0.01	-0.00	-0.00	-0.01	-0.01
PRIV.INV(%GDP)	-0.34	-0.43	-0.42	-0.38	-0.33	-0.14	-0.03
SAVINGS(%GDP)	0.26	0.42	0.43	0.36	0.26	-0.13	-0.28

Government transfers

	1	2	3	4	5	10	20
GDP	0.22	-0.04	-0.22	-0.34	-0.43	-0.84	-1.21
EMPLOYMENT	0.19	-0.06	-0.25	-0.38	-0.47	-0.90	-1.26
CONSUMPTION	0.47	0.18	-0.06	-0.25	-0.40	-1.07	-1.66
.CLC	1.78	1.54	1.12	0.73	0.38	-1.08	-2.22
.CCC	1.50	1.49	1.11	0.73	0.38	-1.13	-2.29
.CNLC	-0.72	-1.17	-1.25	-1.22	-1.18	-1.05	-1.07
INVESTMENT	-0.59	-1.11	-1.29	-1.31	-1.29	-1.17	-1.15
INVESTMENT.HOUSE	-0.50	-0.80	-0.82	-0.76	-0.69	-0.45	-0.39
.INVESTMENT.H.CC	0.63	1.00	0.90	0.67	0.41	-0.79	-1.59
.INVESTMENT.H.NLC	-0.76	-1.21	-1.21	-1.09	-0.95	-0.38	-0.12
EXPORTS	0.63	0.24	0.01	-0.15	-0.28	-0.76	-1.14
IMPORTS	0.26	-0.17	-0.33	-0.42	-0.48	-0.75	-0.99
REAL WAGES	0.14	0.22	0.20	0.16	0.14	0.17	0.18
NET REAL CONS WAGES	0.13	-0.06	-0.54	-1.02	-1.44	-3.21	-4.60
TERMS OF TRADE	-0.07	-0.07	-0.06	-0.05	-0.03	0.02	0.08
NOM.INT.RATE	0.13	0.19	0.19	0.16	0.14	0.07	0.00
REAL.INT.RATE	-0.06	0.04	0.06	0.05	0.04	0.00	-0.01
INFL	0.23	0.16	0.13	0.12	0.11	0.07	0.02
TAX LAB.	0.00	0.17	0.46	0.73	0.98	2.11	2.99
GOV.DEBT(%GDP)	0.34	1.35	2.34	3.24	4.02	6.92	7.58
GOV.BALANCE(%GDP)	-0.86	-1.00	-0.99	-0.91	-0.82	-0.41	-0.04
CURRENT.ACC(%GDP)	0.04	0.04	0.04	0.03	0.03	0.01	0.01
PRIV.INV(%GDP)	-0.17	-0.21	-0.21	-0.19	-0.16	-0.06	0.00
SAVINGS(%GDP)	0.73	0.83	0.82	0.76	0.69	0.36	0.05

Labour taxes

	1	2	3	4	5	10	20
GDP	0.48	0.38	0.31	0.26	0.21	0.01	-0.14
EMPLOYMENT	0.49	0.47	0.40	0.34	0.29	0.05	-0.14
CONSUMPTION	0.81	0.69	0.58	0.49	0.42	0.06	-0.21
.CLC	1.74	1.56	1.30	1.08	0.89	0.04	-0.58
.CCC	1.83	1.62	1.34	1.12	0.92	0.02	-0.61
.CNLC	-0.15	-0.21	-0.17	-0.11	-0.07	0.09	0.17
INVESTMENT	-0.31	-0.49	-0.49	-0.44	-0.39	-0.21	-0.08
INVESTMENT.HOUSE	-0.01	-0.08	-0.10	-0.09	-0.07	0.05	0.11
.INVESTMENT.H.CC	0.88	1.11	0.94	0.74	0.56	-0.22	-0.67
.INVESTMENT.H.NLC	-0.22	-0.35	-0.33	-0.28	-0.21	0.12	0.28
EXPORTS	0.82	0.52	0.41	0.32	0.25	-0.01	-0.18
IMPORTS	0.59	0.23	0.17	0.14	0.12	0.01	-0.10
REAL WAGES	-0.08	-0.11	-0.12	-0.12	-0.11	-0.03	0.01
NET REAL CONS WAGES	2.35	2.11	1.78	1.49	1.24	0.17	-0.63
TERMS OF TRADE	-0.05	-0.06	-0.05	-0.04	-0.03	-0.00	0.02
NOM.INT.RATE	0.08	0.09	0.08	0.07	0.06	0.04	-0.00
REAL.INT.RATE	0.04	0.08	0.06	0.05	0.03	0.01	0.00
INFL	0.08	0.01	0.01	0.02	0.02	0.02	-0.00
TAX LAB.	-1.52	-1.39	-1.20	-1.01	-0.85	-0.12	0.40
GOV.DEBT(%GDP)	0.11	0.82	1.48	2.05	2.56	4.38	4.65
GOV.BALANCE(%GDP)	-0.66	-0.67	-0.62	-0.56	-0.50	-0.24	-0.00
CURRENT.ACC(%GDP)	0.02	0.03	0.03	0.02	0.02	0.00	-0.00
PRIV.INV(%GDP)	-0.13	-0.14	-0.13	-0.11	-0.09	-0.03	0.02
SAVINGS(%GDP)	0.55	0.56	0.52	0.47	0.43	0.22	0.03

Consumption taxes

	1	2	3	4	5	10	20
GDP	0.37	0.22	0.10	0.02	-0.05	-0.36	-0.61
EMPLOYMENT	0.37	0.28	0.15	0.05	-0.02	-0.36	-0.63
CONSUMPTION	0.68	0.53	0.36	0.23	0.11	-0.41	-0.84
.CLC	1.44	1.23	0.88	0.56	0.28	-0.91	-1.80
.CCC	1.50	1.20	0.81	0.48	0.19	-1.04	-1.94
.CNLC	-0.11	-0.16	-0.12	-0.07	-0.02	0.15	0.19
INVESTMENT	-0.44	-0.79	-0.88	-0.86	-0.82	-0.64	-0.54
INVESTMENT.HOUSE	-0.07	-0.18	-0.20	-0.18	-0.15	0.01	0.05
.INVESTMENT.H.CC	0.48	0.44	0.16	-0.12	-0.36	-1.36	-1.95
.INVESTMENT.H.NLC	-0.20	-0.32	-0.29	-0.20	-0.10	0.32	0.51
EXPORTS	0.74	0.44	0.28	0.16	0.06	-0.31	-0.58
IMPORTS	0.44	0.10	-0.00	-0.06	-0.10	-0.29	-0.46
REAL WAGES	0.00	0.02	0.00	-0.01	-0.01	0.06	0.09
NET REAL CONS WAGES	1.43	1.19	0.76	0.37	0.02	-1.46	-2.58
TERMS OF TRADE	-0.06	-0.06	-0.05	-0.04	-0.03	0.02	0.05
NOM.INT.RATE	0.10	0.14	0.13	0.12	0.10	0.06	0.00
REAL.INT.RATE	-0.01	0.06	0.06	0.05	0.04	0.01	-0.00
INFL	0.15	0.08	0.07	0.06	0.06	0.04	0.00
TAX LAB.	0.00	0.16	0.41	0.64	0.86	1.82	2.52
GOV.DEBT(%GDP)	0.26	1.14	2.00	2.76	3.42	5.84	6.26
GOV.BALANCE(%GDP)	-0.83	-0.87	-0.83	-0.76	-0.68	-0.33	-0.01
CURRENT.ACC(%GDP)	0.03	0.04	0.03	0.03	0.02	0.01	0.00
PRIV.INV(%GDP)	-0.13	-0.16	-0.15	-0.13	-0.11	-0.02	0.04
SAVINGS(%GDP)	0.73	0.75	0.72	0.66	0.60	0.32	0.06

Note: Top half of each table percentage difference from baseline, bottom half percentage point difference from baseline