Fiscal Consolidation Strategies

INCOMPLETE DRAFT

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Abstract

In the aftermath of the global financial crisis and great recession, governments are faced with substantial deficits and debts. U.S. federal government outlays relative to GDP have risen substantially. We propose to stabilize government expenditures and return this ratio over time to the level that prevailed prior to the crisis. Of course, the response of GDP depends on the fiscal consolidation strategy that is pursued. Thus, we use structural macroeconomic models to investigate the endogenous response of the economy to fiscal reform. We start by exploring the impact of individual measures, such as reductions in purchases, transfers and distortionary taxes. We compare the effects in a simple neoclassical growth model with more complicated DSGE models that include various nominal and real rigidities and adjustment costs. Ultimately, we aim to put together and evaluate a reform proposal.

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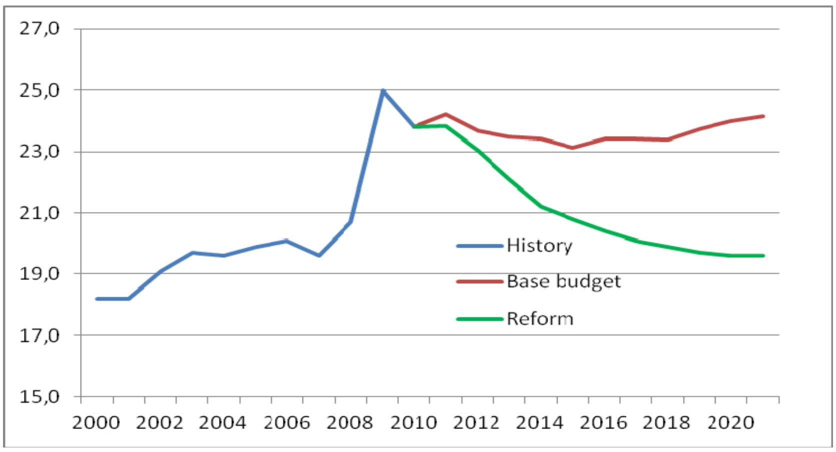
As a consequence of the financial crisis and great recession government deficits and government debt have risen substantially. This increase resulted partly from greater spending and transfers and partly from lower tax receipts during the recession. Looking forward, sustained spending increases are particularly worrisome, because they will ultimately require raising tax rates beyond pre-crisis levels, even after the economic recovery. Higher distortionary taxes may then dampen the economy's trend growth for a long time.

Figure 1 serves as an illustration. It depicts US federal government outlays relative to GDP. Future values are obtained from the 2011 forecast of the Congressional Budget Office (base budget, red line). The CBO's projection indicates that the magnitude of federal purchases and transfers relative to GDP are expected to remain at a much higher level over the complete horizon of the forecast. The difference to the pre-crisis level is over 5 percent of GDP.

Figure 1: U.S. Federal Outlays relative to GDP



If the ratio of outlays to GDP does not return to the pre-crisis level, tax rates will have to rise. Taxes will distort private incentives for saving, investment and capital accumulation to the detriment of economic growth and welfare. As an alternative proposal, **Figure 1** shows a fiscal reform (green line) that would imply a gradual return to the pre-crisis level of government expenditures to GDP. The question is what would be a good strategy for consolidating public finances in this manner.

Of course, the response of GDP, which is in the denominator of the ratio shown in **Figure 1**, depends itself on the fiscal consolidation strategy that is pursued. Thus, a structural macroeconomic model is needed to assess the endogenous response of the economy to the proposed fiscal reform. We begin by exploring the impact of individual measures such as reductions in federal purchases and transfers. As a starting point we consider a simple neoclassical growth model with flexible prices and perfect competition but a variety of distortionary taxes. Such a model is helpful for clarifying some of the longer-run implications of government spending and tax cuts.

Then we will compare the findings from the simple neoclassical growth model with modern dynamic stochastic general equilibrium (DSGE) models. These models include various nominal and real rigidities and adjustment costs not present in the simple growth model. We consider two DSGE models: the model of Cogan, Cwik, Taylor and Wieland (2010) (CCTW) and the model of Coenen, McAdam and Straub (2008).

The model of Cogan et al (2010) is very similar to the well-known medium-size DSGE models of Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2007). It is estimated by Bayesian methods on the same U.S. data as in Smets and Wouters (2007). There is one difference that is rather important to the analysis of fiscal policy. The version estimated in Cogan et al. includes not only optimizing, forward looking households but also households that choose to consume their current income. Due to the presence of these Keynesian or "rule-of-thumb" households the CCTW model does not exhibit Ricardian equivalence. Thus, the timing of taxes is not irrelevant anymore as in the Smets-Wouters model. Consequently, a reaction function for lump-sum taxes to government debt is included.

The model of Coenen et al (2008) accounts for a range of distortionary taxes and transfers that are not present in the CCTW model. It is a two-country model that is meant to cover the U.S. and euro area economies. Coenen et al used this model to evaluate the likely impact of a reduction in euro area taxes to U.S. levels. Unfortunately, the model parameters are calibrated rather than estimated. However, values of key parameters are taken from the model of Smets and Wouters (2003) that was estimated with euro area data. The model served as a blueprint for a single economy model estimated with euro area data that is used by ECB staff for policy purposes. At the ECB it is also called the New-Area-Wide Model (NAWM).

In the following we analyze the consequences of lasting reductions in government spending and transfers under a variety of responses of debt and distortionary taxes. Ultimately, we aim to put together a consolidation strategy that would help achieve a fiscal reform as suggested in **Figure 1** in an effective and efficient manner.

1. The impact of government expenditure reductions in a simple neoclassical model

1.1. The model

Our analysis builds on models studied by King, Plosser and Rebelo (1988) and Ljungvist and Sargent (2004). The government in our model purchases goods and finances its purchases with distortionary consumption, capital and labor taxes as well as non-distortionary lump-sum per-capita taxes. Government consumption is denoted by g_t and lump-sum (head) taxes by τ_{ht}. τ_{ct} is the consumption tax rate, τ_{kt} the capital tax rate and τ_{lt} the labor tax rate.

Households have preferences over consumption and leisure:

$$\sum_{t=0}^{\infty} \beta^t U(c_t, l_t), \quad \beta \in (0,1) \tag{1}$$

where c_t denotes private consumption and l_t hours worked. For the period utility function we use the following standard specification:

$$U(c_t, l_t) = \frac{c_t^{1-\sigma_1}}{1-\sigma_1} - \frac{l^{1+\sigma_2}}{1+\sigma_2}. \tag{2}$$

σ_1 denotes the intertemporal elasticity of substitution, while σ_2 refers to the inverse of the labor supply elasticity with respect to the real wage.[1] The labor supply elasticity plays an important role regarding the impact of changes in government spending on work hours and total output. We will discuss this issue in detail in subsection 1.4.

The household's budget constraint is given by

$$\sum_{t=0}^{\infty} \{p_t(1+\tau_{ct})c_t + p_t i_t\} \leq \sum_{t=0}^{\infty} \{r_t(1-\tau_{kt})k_t + w_t(1-\tau_{lt})l_t - p_t\tau_{ht}\}, \tag{3}$$

while the government has to satisfy

$$\sum_{t=0}^{\infty} p_t g_t \leq \sum_{t=0}^{\infty} \{\tau_{ct} p_t c_t + r_t \tau_{kt} k_t + w_t \tau_{lt} l_t + p_t \tau_{ht}\}. \tag{4}$$

Here, p_t denotes the time period 0 pre-tax price of one unit of investment, consumption or government spending. w_t refers to nominal pre-tax wages and r_t to the nominal pre-tax rental rate of capital. The consumption-, capital- and labor tax rates are set exogenously. Lump-sum taxes are a residual used to balance the government budget given the exogenously specified paths for government spending and distortionary tax rates ($g_t, \tau_{ct}, \tau_{kt}, \tau_{lt}$).

Output is produced with a standard Cobb-Douglas production technology:

$$y_t = F(k_t, l_t) = k_t^{\alpha} l_t^{(1-\alpha)}. \tag{5}$$

Capital is accumulated according to the following equation,

$$k_{t+1} = (1-\delta)k_t + i_t, \tag{6}$$

[1] Another popular utility specification is given by $U(c_t, l_t) = (1-\sigma_1)^{-1} c_t^{1-\sigma_1} + \nu(1-l)$. Our functional form includes the inverse of the labor supply elasticity directly as a parameter. It is more convenient for investigating the implications of different labor supply elasticities.

where k_t denotes the capital stock, i_t investment and δ the depreciation rate of capital. Market clearing requires that

$$y_t = c_t + i_t + g_t . \tag{7}$$

In equilibrium a representative household chooses $\{c_t, l_t, i_t\}_{t=0}^{\infty}$ to maximize utility defined by equations (1) and (2) subject to equations (3) and (6). A representative firm chooses $\{k_t, l_t\}_{t=0}^{\infty}$ to maximize profits, $\sum_{t=0}^{\infty}[p_t y_t - r_t k_t - w_t l_t]$, subject to the production function, equation (5). A feasible government policy is an expenditure and tax plan $\{g_t, \tau_{ct}, \tau_{kt}, \tau_{lt}, \tau_{ht}\}_{t=0}^{\infty}$ that satisfies its budget constraint, equation (4). A feasible allocation is a sequence $\{c_t, i_t, y_t\}_{t=0}^{\infty}$ that satisfies market clearing, i.e. equation (7).

In our initial analysis we abstract from uncertainty. The equilibrium outcome can be characterized by the following conditions. First, consumption decisions must satisfy the standard Euler equation,

$$c_t^{-\sigma_1} = \beta c_{t+1}^{-\sigma_1} R_{t+1} , \tag{8}$$

where R_t is the after-tax one-period gross interest rate between t and t + 1 measured in units of consumption goods at t + 1 per consumption good at t:

$$R_t = \frac{(1+\tau_{ct})}{(1+\tau_{ct+1})}\left[(1-\delta) + (1-\tau_{kt+1})\alpha\left(\frac{k_{t+1}}{l_{t+1}}\right)^{\alpha-1}\right]. \tag{9}$$

Secondly, the consumption-leisure choice is determined by equating the marginal rate of substitution with the real after-tax wage adjusted for consumption tax payments. In the resulting equation (11), we have replaced the real wage by the marginal product of labor:

$$\frac{l_t^{\sigma_2}}{c_t^{-\sigma_1}} = \frac{(1-\tau_{lt})}{(1+\tau_{ct})}(1-\alpha)\left(\frac{k_t}{l_t}\right)^{\alpha}. \tag{10}$$

Thirdly, capital evolves according to the following law of motion:

$$k_{t+1} = k_t^{\alpha} l_t^{1-\alpha} + (1-\delta)k_t - c_t - g_t \tag{11}$$

Other equations are not necessary to obtain a solution to the model. However, they are used to determine the paths of other variables. Output can be obtained from equation (5) and investment from equation (6). The real pre-tax rental rate of capital is given by the marginal product of capital. The real pre-tax wage corresponds to the marginal product of labor.

The parameter values for the discount factor, the intertemporal elasticity of substitution, the depreciation rate and the capital share are set to the same values as in Ljungvist and Sargent (2004) (chapter 11): $\beta = 0.95, \sigma_1 = 2, \delta = 0.2, \alpha = 0.33$. Regarding the utility parameter governing the labor-leisure decision, we use Smets and Wouters (2003, 2007) prior estimate of $\sigma_2 = 2$. This value implies a Frisch labor supply elasticity of $1/\sigma_2 = 0.5$, which is consistent with microeconomic estimates (see Chetty et al (2010)).

We calibrate the tax rates so that they match current U.S. tax rates. Specifically, we use the U.S. values from the model of Coenen et al. (2008). Thus, the consumption tax rate is 7.7%, the labour tax rate is 22.5% and the capital tax rate is 18.41%.[2] Other taxes or transfers are collected lump-sum.

1.2. A standardized benchmark simulation.

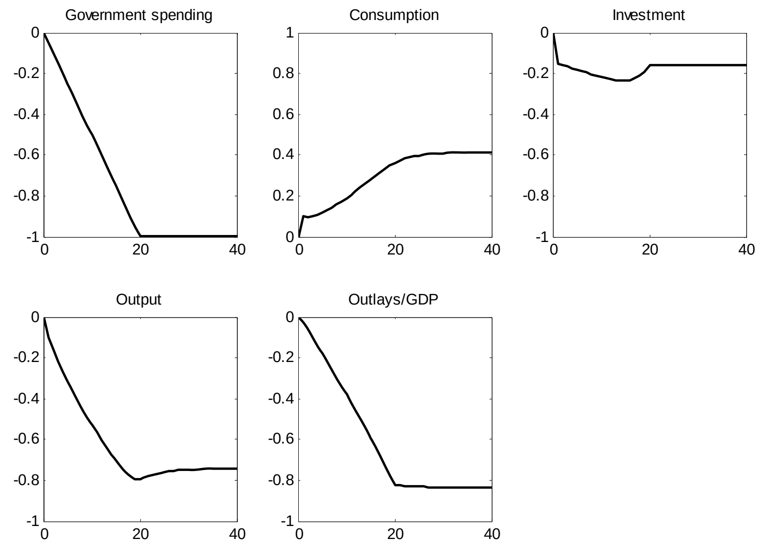
For illustrative purposes we consider a lasting reduction in government purchases of 1 percent of GDP that is phased in very gradually over five years. Thus, during the initial 20

[2] Coenen et al match the consumption tax, labor tax and social security contributions to data on U.S. tax rates and euro area tax rates. The capital tax rate is set to the same value in both countries and determined by matching the investment / output ratio.

quarters government purchases is reduced by 0.05% per quarter. This policy is announced in the first period and anticipated by market participants from then onwards.[3]

Figure 2 shows the impact on government spending, consumption, investment and total output. Percentage changes in government spending, consumption and investment are weighted by the shares of the respective variables in initial steady-state GDP. Thus, their values sum up to the percentage change in total output relative to the initial steady-state. Distortionary tax rates are held constant. Thus, the decrease in government consumption induces a reduction in per-capita lump-sum taxes. The resulting boost to households' life-time income has two different effects on household behaviour. Households desire to increase consumption but they also want to enjoy more leisure by reducing hours worked. This positive income effect on leisure was emphasized by Aiyagari et al. (1992). The reduction in labor input causes a decline in total output.

Figure 2: A permanent reduction in government purchases
-1% of GDP, phased-in over 5 years



[3] In addition, we consider a scenario with an announcement 1 / 2? year(s) ahead of the policy change (Not shown yet). In this case, the anticipation of future policy yields adjustments in consumption and investment even before the change in policy takes place.

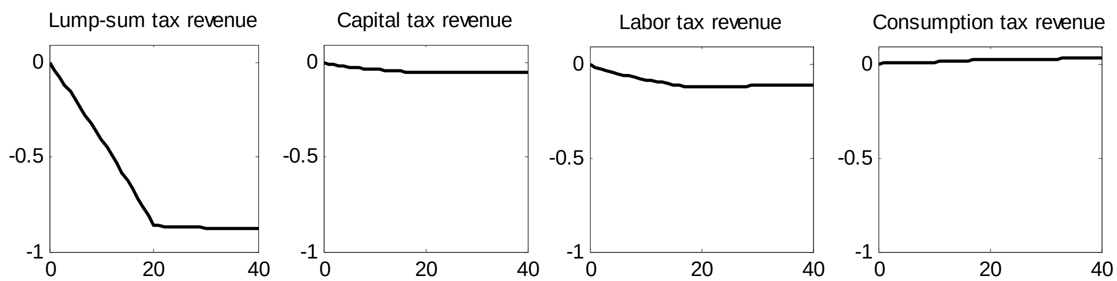
In terms of relative magnitudes, households in our model appear to give greater weight to leisure. Total output declines by about 3/4 percent in the long run, while goods consumption increases by just about 0.4 percent. Investment demand also declines, because less capital is needed in the production of output. Investment drops a bit more during the phase-in period than in the long-run. The steady-state reduction in investment is about -0.15 percent.[4] The relative magnitude of the consumption and leisure effects depends crucially on the parameter in the utility function that determines the labor supply elasticity. We will return to this question further below, in subsection 1.4.

The ratio of government outlays to GDP declines by about 80 basis points (2nd panel in the bottom row). Thus, with a greater cut in government spending a reduction in the share of outlays to GDP similar to the reform path in **Figure 1** could be achieved. However, GDP would also be lowered.

Since the spending cuts reduce the governments need for tax finance, it is worth exploring the resulting adjustments in revenues from the different taxes. **Figure 3** reports the implied changes in tax revenues, measured in terms of initial steady-state GDP.

Figure 3: Tax revenues following a reduction in government purchases

-1% of GDP, phased-in over 5 years



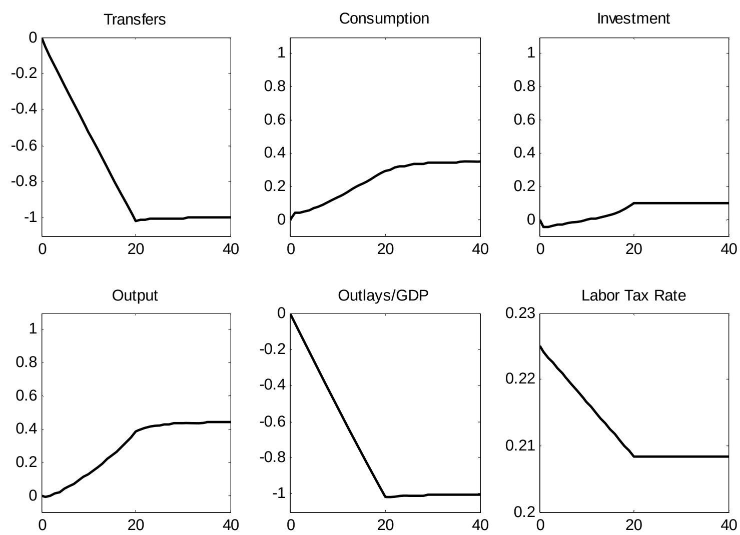
[4] The investment response to a temporary decrease in government spending is very different. In this case, investment and consumption increase as shown by Aiyagari et al. (1992) using a neoclassical growth model. Recently, Cwik and Wieland (2011) found that temporary spending cuts may even raise output and cause a temporary boom in announced and anticipated in advance of the policy change. They obtained these results in state-of-the-art estimated DSGE models of the euro area. These models include characteristics that are central to short-run macroeconomic analysis such as imperfect competition, price and wage rigidities, investment and capital utilization adjustment costs and habit formation.

Not surprisingly, the revenue from the consumption tax rises, while the reduction in output implies smaller revenues due to lower usage of the factors of production, capital and labor. Interestingly, however, these changes are rather small. Most of the reduction in tax revenue results from lower lump-sum taxes. The reason is that lump-sum taxes are the residual terms that offset deficits, $\tau_{ht} = g_t - (\tau_{ct} c_t + r_t / p_t \tau_{kt} k_t + w_t / p_t \tau_{lt} l_t)$, and ensure budget balance. Lump-sum tax revenue declines by about 0.9 percent of GDP. Thus, almost all of the savings achieved by the change in government policy are applied to a cut in the non-distortionary lump-sum tax.

The lump-sum tax in our simple neoclassical model is the inverse of lump-sum transfers. A reduction in these transfers constitutes an alternative to the cut in purchases. It is equivalent to an increase in lump-sum taxes. The savings from this reduction in transfers can then be applied to reduce other taxes. Here, we use them to lower the labor income tax.

Figure 4: A reduction in transfers with savings applied to labor taxes

-1% of GDP, phased-in over 5 years



Taxes that are not raised lump-sum such as the labor income tax distort household expenditure decisions and induce adverse effects on the economy. Lowering such taxes may thus raise economic production and welfare. Tax rates in our parameterization reflect current U.S. tax rates and are drawn from Coenen et al (2008). [5]

The reduction in transfers with savings applied to lower the distortionary labor income tax induces a substantial lasting positive effect on consumption, investment and total output. Households supply more labor. Investment leads to greater capital stock. Government purchases remain constant, but overall government outlays decline as a share of GDP by a bit more than 1 percentage point. Thus, the reduction of transfers is more effective in reducing overall outlays relative to GDP than cuts in purchases, because it causes GDP to increase.

1.3. Applying government savings to lower capital taxation

Figure 5 shows the impact of a gradual decline in the capital tax rate phased-in over five years along with the decline in government spending. We consider reductions of 1 and 2 percentage points, respectively, down from an initial rate of 18.41%. As the savings from government spending cuts are applied to lower capital taxation, we observe an increase rather than a decrease of the capital stock. The depreciation rate is constant and thus in the new steady state more investment is needed to keep the capital stock at the new, higher level. Consumption increases more than in the case with changes of lump-sum taxes only. A decrease of the capital tax rate of 2 percentage points leads to an increase in output.

[5] See Coenen et al (2008) for an evaluation of the effects of a reduction of Euro area tax rates to U.S. levels. Furthermore, a recent paper by Uhlig and Drautzburg (2010) investigates the negative impact from (future) increases in distortionary taxes needed finance fiscal stimulus packages such as the ARRA legislation from 2009.

Figure 5: Reducing government purchases and capital taxation

g reduced by 1% of GDP, capital tax by 1 and
2 percentage points respectively, phased-in over 5 years

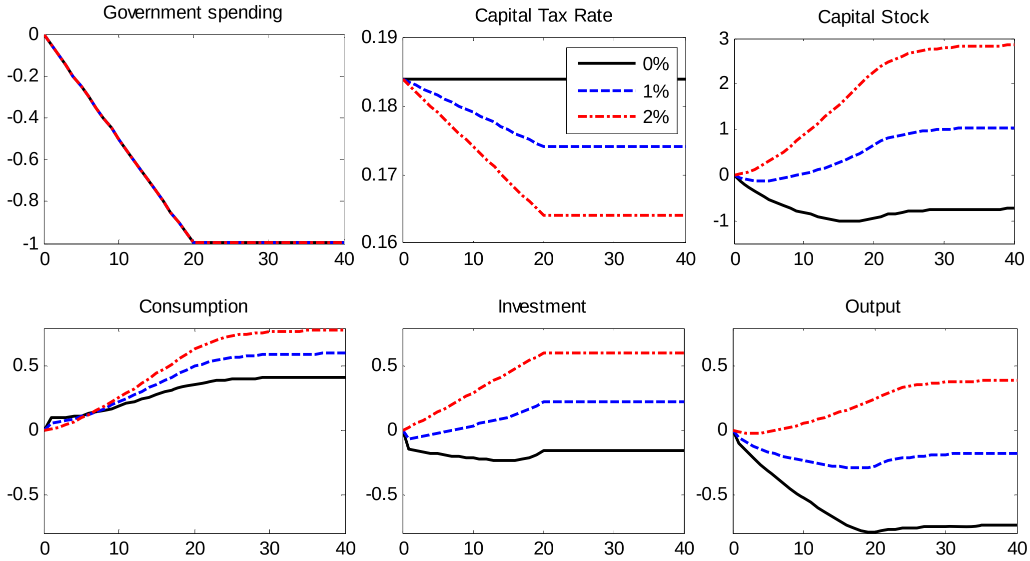
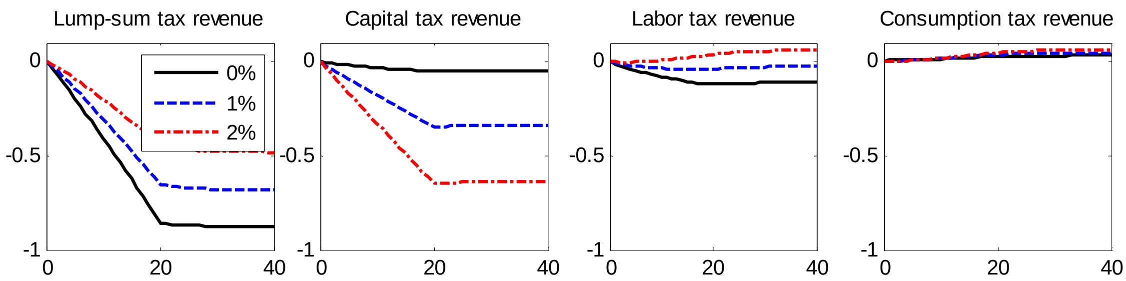


Figure 6 reports the resulting tax revenues. With a reduction of the capital income tax rate by 2 percentage points, the reduction in revenues is split more evenly between lump-sum taxes and capital taxes. The revenues from labor income and consumption income increase by a small amount.

Figure 6: Tax revenues following government purchases and capital tax cuts

g reduced by 1% of GDP, capital tax by 1 and
2 percentage points respectively, phased-in over 5 years



We have also simulated a decrease of the tax rate on labor income. The results are shown in figures A1 and A2 in the appendix. The increase of consumption is of the same size as for a capital tax reduction, but the increase in investment is much lower. The income tax cut stimulates output less than the capital tax cut.

In sum, the neoclassical model would suggest that applying government savings to a reduction in capital taxes is most effective in achieving a lower government expenditure to GDP ratio.

1.4. Implications of a weaker elasticity of labor supply

To study and understand the increase in consumption and the decrease in hours and output in more detail we simulate versions of the model with inflexible labor supply, totally elastic labor supply and intermediate cases. The Frisch labour supply elasticity is defined as the elasticity of labor with respect to real wages for a given level of consumption, i.e. for holding marginal utility of consumption constant.

In the benchmark calibration we have set σ_2 equal to 2, which implies a labor supply elasticity of 0.5. This is a widely-used value in state-of-the art DSGE models (see e.g. Smets & Wouters, 2007) that are employed to study macroeconomic fluctuations over the last three to four decades.[6] However, this value might be too high to capture labor market responses over coming years. The U.S. economy may well require substantial shifts in sectoral labor allocation following the disruptions of the financial crisis and great recessions. On the one side, job owners may be less willing to reduce hours or quit their job compared to earlier decades. On the other side, there may be larger inflow of new entrants that will render total work hours rather inelastic relative to a reduction in the size of government.

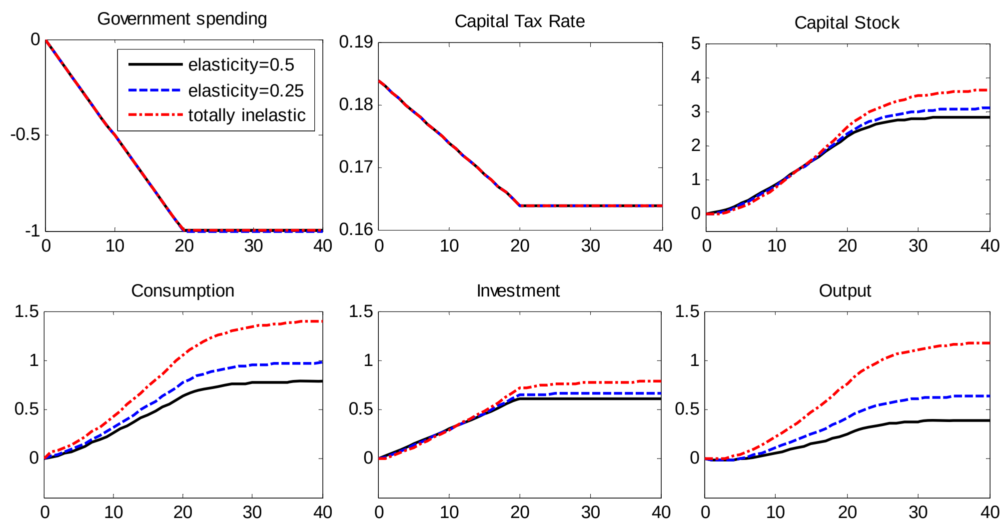
[6] In the real-business cycle literature the labor supply elasticity is often calibrated to much high values in analysis of short-run output fluctuations in models without nominal rigidities. For example, King and Rebelo (1999) set the labor supply elasticity to 4 and Cho and Cooley (1994) to 2.61. Chetty et al. (2011 a,b) review the micro and macro evidence of labor supply elasticities. The micro evidence points to much lower numbers, around 0.5 at the intensive margin and 0.25 at the extensive margin which add up to ¾ for aggregate hours. Heterogeneity of elasticities between different groups of workers lead to the divergence of micro and macro estimates. Extensive margin elasticities of prime-age men are even close to zero.

To account for the possibility that hours worked will be less responsive than in the benchmark parameterization, we explore the impact of a smaller elasticity of 0.25% and of an inelastic[7] labor supply on our simulation of a government spending cut of 1 percent of GDP together with a 1 percentage point reduction of the capital income tax. Thus, we compare values of $\sigma_2 = 2$, $\sigma_2 = 4$ (low elasticity of $1/\sigma_2 = 0.25$) and $\sigma_2 \to \infty$ (totally inelastic, $1/\sigma_2 \to 0$).

Figure 7 shows the simulation results. With less elastic labor supply, additional income is available for consumption. If the capital tax rate would be held constant, the additional wealth due to the reduction of lump-sum taxes would be fully used for additional consumption purchases. In the long-run, it would imply a one-to-one increase in consumption, while steady-state hours, the capital stock, investment and output would remain the same. The one percentage point decrease in the capital tax rate, however, causes additional investment to build up the capital stock. Thus, output increases, and private consumption even more.[8]

Figure 7: Lower labor supply elasticity

g reduced by 1% of GDP, capital tax by 2 percentage points, phased-in over 5 years



[7] Government spending in a model with totally inelastic labor supply has been investigated by Hall (1980).
[8] The resulting tax revenues are shown in Figure A5 in Appendix 1.

1.5. Government consumption and household utility

So far we have considered a model where government consumption does not generate household utility. This assumption is common in DSGE models used to study short-run fluctuations. Even so, it is a fair argument that certain categories of government spending like spending on infrastructure, police, fire protection, national defence, education etc. provide utility to households. If households derive utility from government consumption, they may respond to a government spending cut with more private consumption to make up for it. Thus, we want to investigate the magnitude of such effects for our simulations of spending and tax cuts.

We extend our simple neoclassical model by introducing a new utility function which comprises a bundle of private and public consumption $\widetilde{c}_t$ [9]:

$$\sum_{t=0}^{\infty} \beta^t U(\widetilde{c}_t, l_t), \quad \beta \in (0,1) \tag{12}$$

Specifically, we follow Ni (1995), Amano and Wirjanto (1998) and Linnemann and Schabert (2004) and use a linearly homogenous consumption bundle of the CES form that allows private and public consumption to be perfect or imperfect substitutes:

$$\widetilde{c}_t = \widetilde{c}_t(c_t, g_t) = \left[\alpha c_t^{\gamma} + (1-\alpha) g_t^{\gamma}\right]^{1/\gamma}, \quad \gamma \in (-\infty,1), \ \alpha \in (0,1) \ . \tag{13}$$

α denotes the relative weight of private to public consumption. γ determines the intratemporal elasticity of substitution $\zeta \equiv 1/(1-\gamma) > 0$ between private and public

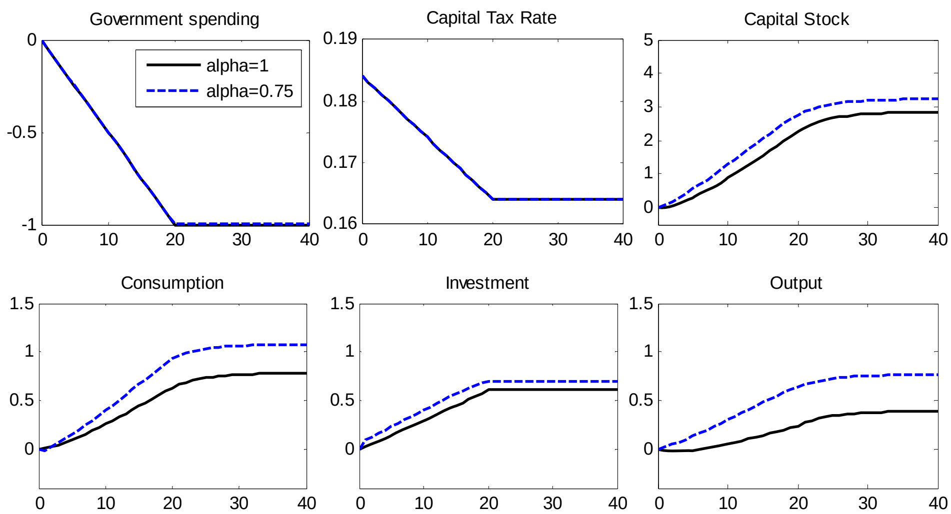
[9] Earlier research considering government consumption in household utility includes Barro (1981), Barro (1990), Christiano and Eichenbaum (1992), Baxter and King (1993), Ambler and Paquet (1996) and Finn (1998). These studies treat government consumptions as perfect substitutes. Public spending categories like free school lunches are close substitutes to private spending, while others like spending on transportation are probably complements (see Karras, 1994). Kormendi (1983) and Aschauer (1995) find evidence for a substantial amount of substitutability of private and public consumption for the US and Ahmed (1986) for the UK. Karras (1994) examines evidence from a number of countries and finds that private and government consumption are best described as complementary or unrelated goods. Ni (1995) finds evidence for complementarity between private and public consumption. Amano and Wirjanto (1998) find that additive separability, i.e. public and private consumption are unrelated, cannot be rejected.

consumption. $\gamma = 1$ implies perfect substitutes.[10] With $\alpha \to 1$ government consumption drops out of the consumption bundle and utility simplifies to the standard case with private consumption and leisure only. In terms of parameterization, we follow Amano and Wirjanto (1998) and use their estimate of $\gamma = 0.36$. We then conduct a sensitivity study for different weights α of private relative to public consumption in the utility function.

Figure 8 compares the outcomes of a joint reduction of government purchases (1% of GDP) and the capital tax rate (2 percentage points) in the benchmark case to a value of α =0.75 . The labor supply elasticity is set to 0.5 as in the benchmark simulation.

Figure 8: Government purchases and tax cuts when households derive utility from government purchases

g reduced by 1% of GDP, capital tax by 2 percentage points, phased-in over 5 years



The simulation indicates that the private consumption and investment rise more in response to spending cuts when households derive utility from government consumption.[11] The steady-state capital stock and output also increase.

[10] Amano and Wirjanto (1998) show that the sign of the partial cross-derivative $U_{cg,t} = \partial[\partial U(c_t, g_t)/\partial c_t]/\partial g_t$ is determined by the relative magnitude of the intertemporal and intraperiod elasticities of substitution: if $1/\sigma_1 > \zeta$ then private and public goods are complements, i.e. $U_{cg,t} > 0$, if $1/\sigma_1 < \zeta$, i.e. $U_{cg,t} < 0$, then the two goods are substitutes and if $1/\sigma_1 = \zeta$, i.e. $U_{cg,t} = 0$, then the goods are unrelated.

[11] Public and private consumption are substitutes (compare with footnotes 3 and 4) and thus a decrease of utility due to a decrease in public consumption can be compensated through an increase in private consumption. For

2. The impact of government expenditure reductions: State-of-the-art DSGE models

While the simple neoclassical growth model used in the preceding section is helpful for illustrating some of the long-run consequences of changes in the fiscal policy regime, the assumptions of perfect markets and flexible prices render it inappropriate for the analysis of short- to medium-run fluctuations. Thus, we consider two state-of-the art medium size DSGE models taken from Cogan et al (2010) and Coenen et al (2008). These models include various nominal and real rigidities and adjustment costs that help understand economic fluctuations and transition paths towards a new fiscal regime. Furthermore, the Coenen et al (2008) contains a more detailed fiscal sector than the neoclassical model we have used so far. Thus, it may also shed new light on the long-run consequences of changes in the fiscal regime.

2.1. The Cogan, Cwik, Taylor, Wieland (2010) model

The model of Cogan et al (2010) is very similar to the well-known medium-size DSGE models of Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2007). It is estimated by Bayesian methods on the same U.S. data as in Smets and Wouters (2007). There is one difference that is rather important to the analysis of fiscal policy. The version estimated in Cogan et al. includes not only optimizing, forward looking households but also households that choose to consume their current income. Due to the presence of these Keynesian or "rule-of-thumb" households the CCTW model does not exhibit Ricardian equivalence. Thus, the timing of taxes is not irrelevant anymore as in the Smets-Wouters model. Consequently, a reaction function for lump-sum taxes to government debt is included.

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private consumption to increase sufficiently, produced output must not fall too much or even increase. This leads to an increase in the capital stock and investment. Figure A4 in the appendix shows that the decrease of lump-sum taxes decreases with α.

2.2. The Coenen, McAdam, Straub (2008) (NAWM) model

The model of Coenen et al (2008) accounts for a range of distortionary taxes and transfers that are not present in the CCTW model. It is a two-country model covering the U.S. and euro area economies. The model parameters are calibrated and not estimated. The model served as a blueprint for a single economy model estimated with euro area data that is used by ECB staff for policy purposes, the so-called New-Area-Wide Model (NAWM). Thus, we also use this term here.

The two economies in the NAWM model are largely symmetric. They only differ with respect to size, extent of home-bias in the final goods technology, investment adjustment cost and capital utilisation parameters, and most importantly for our purposes, with regard to the calibration of the fiscal sector. The tax rates and the government spending to GDP ratio are calibrated to match observable fiscal policy parameters in the US and the Euro area.

In each economy, only part of the households (households *I*) have access to domestic and international financial markets, accumulates capital and holds money. The remaining households (household *J*) can smooth consumption only via adjusting their money holdings. Both types of households maximize a lifetime utility function. Thus, the households constrained to money markets are still much more sophisticated than the rule-of-thumb households in the CCTW model. The utility function includes consumption habits.

Households supply differentiated labor services and have monopoly power in wage setting. Wages are determined in a Calvo (1983) fashion. Households that have an opportunity to re-optimize their wage choose the same optimal wage while the other wages are indexed to a geometric average of past changes in the price of the consumption good. Households' gross income is subject to a variety of taxes. Households pay taxes on consumption purchases, on wage income and on capital income. Furthermore, they pay social security contributions, a lump-sum tax and receive transfers. Purchases of consumption, financial investment in international markets and capital utilization are subject to specific proportional costs.

Firms produce tradable or non-tradable goods. Intermediate goods firms produce a single, tradable differentiated good using an increasing-returns-to-scale Cobb-Douglas technology with capital services and labor as inputs. These goods are sold in domestic and foreign market under monopolistic competition. Price setting is subject to staggered price contracts a la Calvo (1983). Firms that get to adjust their price pick the same optimal value, while the other firms prices are indexed to a geometric average of past changes in the aggregate price indexes. The final goods firms produce three non-tradable final goods: private consumption goods, investment goods and public consumption goods. Final non-tradable private consumption and private investment goods are modelled in the same manner. These final goods are assembled with CES technology, combining intermediate domestic and imported foreign goods. Varying the use of imported intermediate goods in the production process is subject to adjustment costs. These final goods are sold taking the price as given. The public consumption good is a composite of only domestically produced intermediate goods.

Demand for imported goods is equal to the sum of the respective demands for intermediate goods for private consumption and investment. These intermediate goods are sold in the home market by the foreign intermediate-good producer. Domestic and export prices for the same intermediate good might differ as producers use local currency pricing, i.e. set different prices for the domestic and the export market.

To better understand the structure of the fiscal sector in the NAWM model, it is useful to the review the government budget constraint:

$$\begin{aligned} & P_{G,t}G_t + TR_t + B_t + M_{t-1} = \\ & \tau_t^C P_{C,t}C_t + \tau_t^N (W_{I,t}N_t^I + W_{J,t}N_t^J) + \tau_t^{W_h} (W_{I,t}N_t^I + W_{J,t}N_t^J) + \tau_t^{W_f} W_t N_t + \\ & \tau_t^K (R_{K,t}u_t - (\Gamma_u(u_t) + \delta)P_{I,t})K_t + T_t + R_t^{-1}B_{t+1} + M_t \end{aligned} \tag{14}$$

The left hand side denotes expenditures while the right hand side denotes revenues.

G_t, TR_t, τ_t^C, τ_t^N, $\tau_t^{W_h}$ and $\tau_t^{W_f}$ refer to government consumption, transfers, consumption tax rate, labor tax rate, employee and employers' social security contributions and are set exogenously. B_t and M_t are government bonds and money supply. Demands for these assets are determined by the household's first order conditions.

Lump-sum taxes T_t are set according to the following feedback rule:

$$\frac{T_t}{P_{y,t}Y_t} = \phi_{B_Y}\left(\frac{B_t}{P_{y,t}Y_t} - B_{Y,t}\right) \tag{15}$$

where T_t is zero in the initial steady state and $B_{Y,t}$ is the target for the debt to GDP ratio, which is set exogenously.

Parameterization

Steady state ratios are calibrated to match the accordant US and Euro area data ratios. The remaining parameters are calibrated along the lines of Smets and Wouters (2003). The labor supply elasticity equals 0.5 as in our simple neoclassical model of the preceding section and in the CCTW model. This is a key parameter for the effects of changes in fiscal policy and we will examine – as in the simulations with the neoclassical growth model – the sensitivity of the simulation results to variations in the labor supply elasticity. The share of households J is 25% in both countries. While the price stickiness for goods sold in the domestic market is high, the Calvo parameter is 0.9 and indexation is 0.5, price-setting for exports is subject to a Calvo parameter of 0.3 only, so that these prices adjust much more quickly. The substitution elasticities between home and foreign goods are set to 1.5. Adjustment costs associated with changing the import share in investment is 2.5, which is a high value. These two parameters ensure that consumption and investment respond with low sensitivity to changes in the terms of trade.

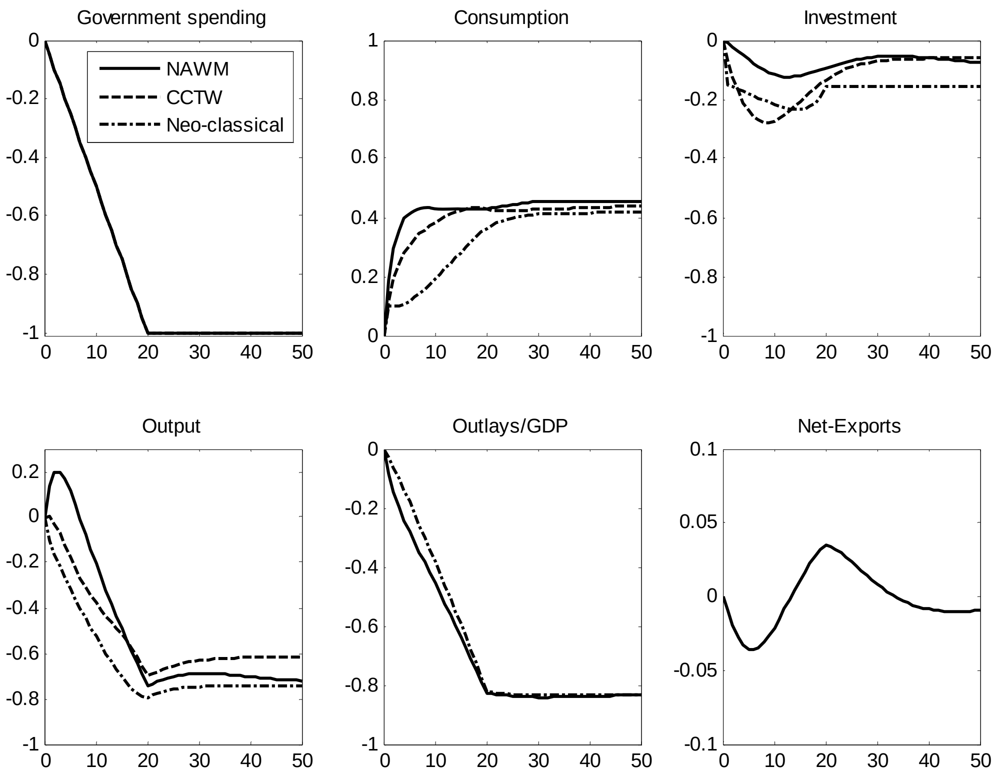
Tax rates are calibrated based on observable data for the US and the Euro area. The consumption tax rates is set to 7.7% for the US and 18.3% for the Euro area, the income tax to 15.4% and 12.2%, respectively, the social security contributions of employees to 7.1% and 11.8%, respectively and the social security contribution of employers to 7.1% and 21.9% respectively. The capital tax ratio is calibrated to 18.41% in both countries to match the observed investment-to-output expenditure ratio. The government consumption to GDP ratio is calibrated to 16% for the US and 18% for the Euro area. The target for the debt-to-GDP ratio is calibrated in both countries to 60% of annual GDP (240% of quarterly GDP). Transfers in per capita terms are unevenly distributed between households *J* and households *I* in the proportion 3 to 1. Lump-sum taxes in per capita terms are collected in the proportion of 1 to 3 from households *J* and households *I*.

2.2. Expenditure reductions: Simple neoclassical model versus DSGE models

We start by considering the benchmark simulation with a permanent reduction in government consumption by 1 percent of GDP phased-in gradually over five years. Interestingly, the long-run impact on consumption, investment and output is very similar in the three models as shown in **Figure 9**. Thus, our presumption that the simple neoclassical model would be helpful in pinpointing the long-run impact of expenditure cuts turns out to be correct in this case. In the DSGE models the reduction in government spending also raises permanent income of households, who then decide to consume more and to enjoy more leisure. The resulting reduction in work hours is causing a decline in output that is smaller than the decline in government consumption, but still substantial. Of course, given that the preference parameter on leisure is key in the neoclassical model and of identical value, lowering it in the DSGE models may similarly reduce the negative impact of a cut in government purchases on hours worked and total output. We will return to this issue further below.

Figure 9: A reduction in government purchases: Neo-classical versus DSGE models

g reduced by 1% of GDP, phased-in over 5 years

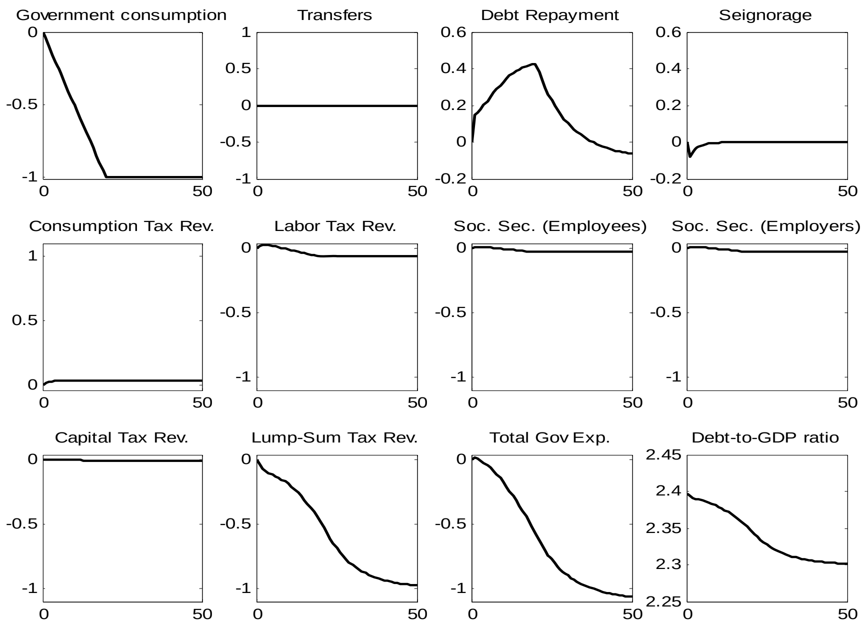


The DSGE models differ from the neoclassical model in the short-run. Specifically, consumption increases much more quickly in the DSGE models. The NAWM model even indicates a temporary boost to total output in the initial periods as a result. The consumption response in the estimated CCTW model is relatively close to the consumption response in the calibrated NAWM model. However, investment in the CCTW model declines more quickly. The NAWM model also indicates a response of net exports that is initially negative and then positive for a while. The ratio of government outlays to GDP declines by about 0.8 percent. This decline happens more quickly in the NAWM model relative to the simple neoclassical model.

Given the extensive detail on the government sector in the NAWM model, it is of interest to review the consequences of a government purchases cut on other fiscal variables and tax revenues. **Figure 10** reports the behaviour of different components of the government budget constraint in NAWM. The government savings from a reduction in purchases are mostly applied to a reduction of lump-sum tax revenue (2nd panel in the 3rd row). The other taxes and social security contributions only vary a little bit. During the transition to the new steady-state some of the government savings are used to reduce the outstanding government debt (3rd panel in the 1st row). The ratio of total debt to quarterly GDP declines from 2.4 to about 2.3, i.e. in percentages of annual GDP from 60 percent to 57.5 percent.

Figure 10: Tax revenues following the government spending cuts.

g reduced by 1% of GDP, phased-in over 5 years



Another possibility to reduce government expenditure is to lower transfers instead of government purchases. Note, contrary to the neo-classical model and the CCTW model where lump-sum transfers and lump-sum taxes apply to all households in the same manner, lump-sum taxes and transfers in the NAWM model apply differently to households of type I and J. **Figure 11** shows the outcome of a reduction in transfers in the NAWM model. In this simulation we let the government savings be applied to lump-sum taxes. The reduction in government transfers causes total consumption to rise substantially. Investment and net exports increase somewhat. Output increases substantially by almost 0.6 percent. The government outlays to GDP ratio decreases by about 1,1 percent. Again, in contrast to the reduction in government purchases, fiscal consolidation goes hand in hand with an increase in total output.

Figure 11: A reduction in transfers: NAWM model
-1% of GDP, phased-in over 5 years

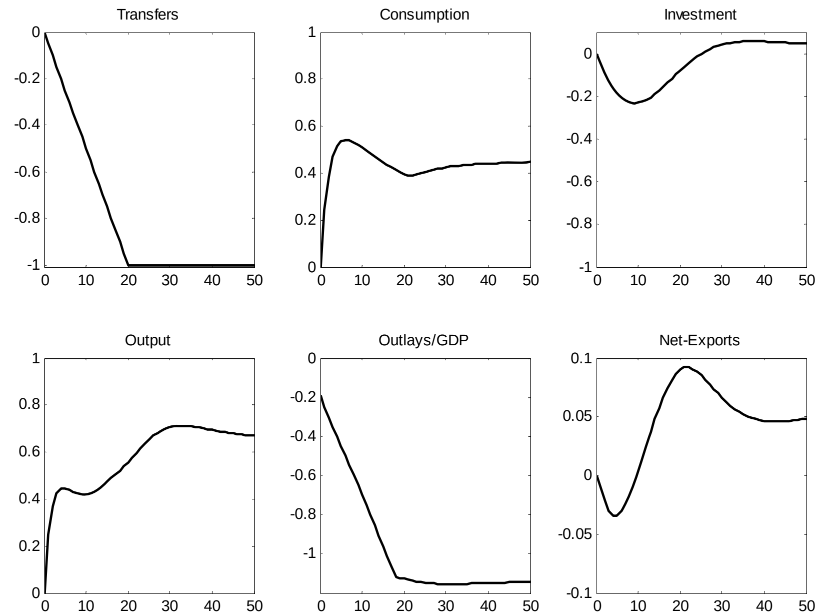
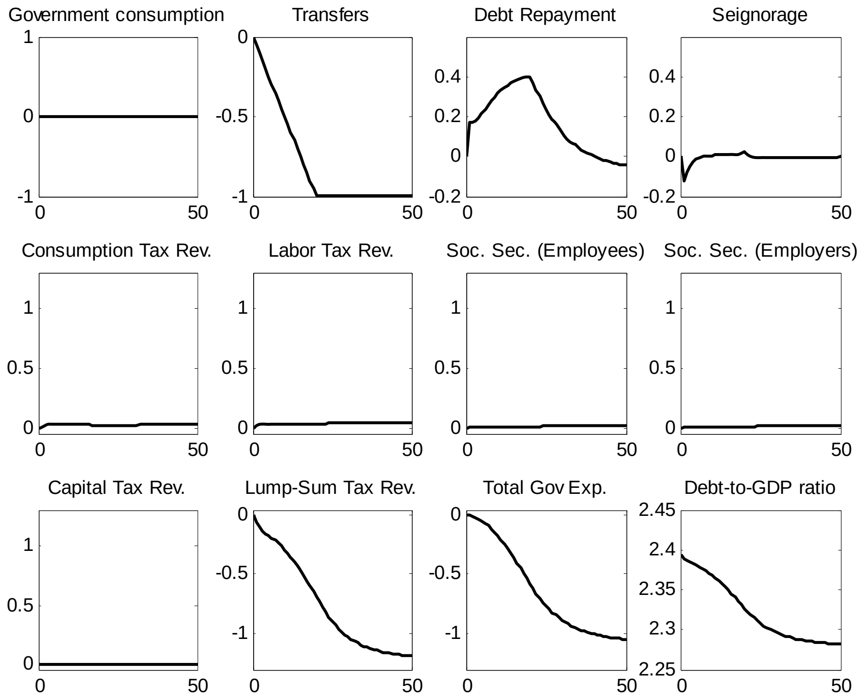


Figure 12 reports the behaviour of different components of the government budget constraint in NAWM following the reduction in transfers. As noted previously, government savings are used for a reduction in lump-sum taxes. During the transition some of the savings are used to repay government debt. The debt to GDP ratio declines.

Figure 12: Tax revenues following the reduction in transfers: NAWM model
tr reduced by 1% of GDP, phased-in over 5 years



Of course, the positive impact on GDP may even be greater of government savings are used to reduce distortionary rather than lump-sum taxes. Thus, we consider the case of a reduction in the labor income tax as previously in section 1.2 with the neoclassical findings. The findings are summarized in Figures 13 and 14.

Figure 13: A reduction in transfers and labor income taxes
Transfers -1% of GDP, income tax rate -1.6%, phased-in over 5 years

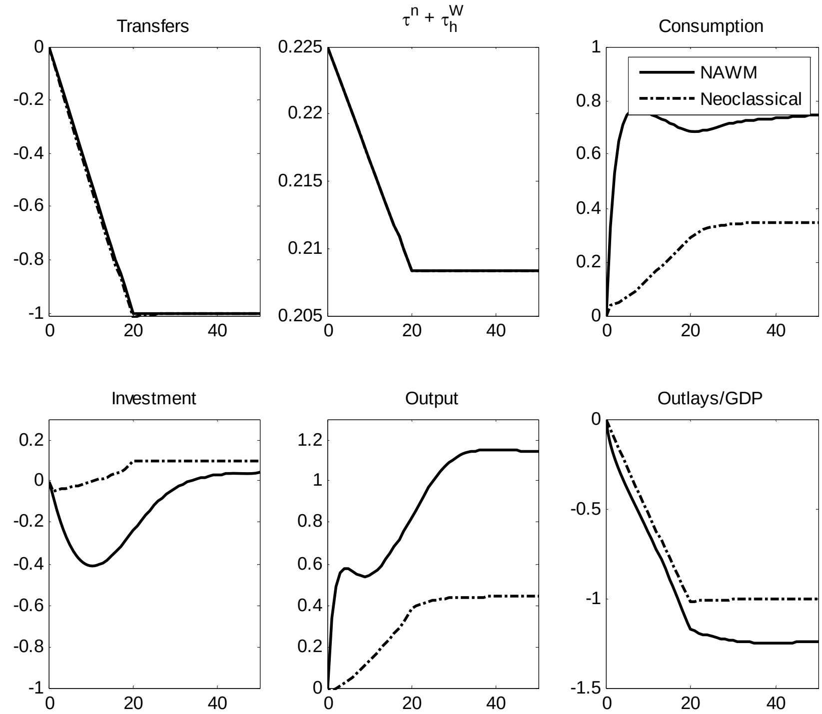
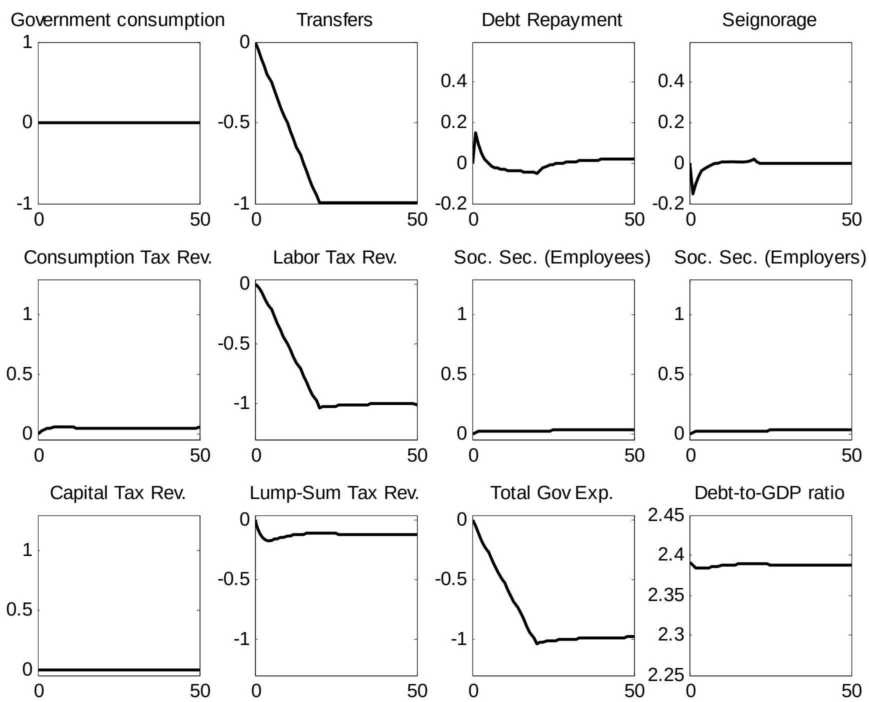


Figure 14: Tax revenues following the reduction in transfers: NAWM model
Transfers -1% of GDP, income tax rate -1.6%, phased-in over 5 years



3. Conclusion: A proposal for fiscal reform (to be added)

References

Aiyagar, S. Rao, Lawrence J. Christiano, and Martin Eichenbaum (1992), "The output, employment, and interest rate effects of government consumption." *Journal of Monetary Economics*, 30:73-86.

Amano, Robert A. and Tony S. Wirjanto (1998). "Government expenditures and the permanent-income model." *Review of Economic Dyn*amics, 1: 719-730.

Barro, Robert J. (1990). "Government spending in a simple model of endogeneous growth." *Journal of Political Economy*, 98(S5): 103-125.

Baxter, Marianne and Robert G. King (1993), "Fiscal Policy in General Equilibrium", *The American Economic Review*, 83(3): 315-334.

Chetty, Ray, Adam Guren, Day Manoli and Andrea Weber (2011a), "Are micro and macro labor supply elasticities consistent? A review of evidence on the intensive and extensive margins", *The American Economic Review Papers and Proceedings*, 101(3): 471-475.

Chetty, Ray, Adam Guren, Day Manoli and Andrea Weber (2011b), "Does indivisible labor explain the difference between micro and macro elasticities?", NBER Working Paper No. 16729.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans (2005), "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 113(1): 1-45.

Coenen, Günter, Peter McAdam and Roland Straub (2008), "Tax reform and labour-market performance in the euro area: A simulation-based analysis using the New Area-Wide Model", *Journal of Economic Dynamcis & Control*, 32: 2543-2583.

Coenen, Guenter and Roland Straub (2005), "Does Government Spending Crowd in Private Consumption? Theory and Empirical Evidence for the Euro Area," *International Finance*, 8(3): 435-470.

Ljungqvist, Lars and Thomas J. Sargent (2004). Recursive Macroeconomic Theory, MIT Press, 2nd edition.

Hall, Robert E. (1980), "Labor supply and aggregate fluctuations," In *On the State of Macroeconomics, Carnegie Rochester Conference on Public Policy*, XII, Amsterdam, North Holland.

King, Robert G., Plosser, Charles I. and Rebelo, Sergio T. (1988). "Production, growth and business cycles : I. The basic neoclassical model," *Journal of Monetary Economics*, 21(2-3): 195-232.

Linnemann, Ludger and Schabert, Andreas (2004). "Can fiscal spending stimulate private consumption?," *Economics Letters*, 82(2): 173-179.

Smets, Frank and Raf Wouters (2007), "Shocks and Frictions in U.S. Business Cycles: A Bayesian DSGE Approach." *American Economic Review* 97, 3: 506–606.

Taylor, John B. (1993), *Macroeconomic Policy in a World Economy: From Econometric Design to Practical Operation,* WW Norton, New York.

Taylor, John B. (2009), "The Lack of an Empirical Rationale for a Revival of Discretionary Fiscal Policy," *American Economic Review, Papers and Proceedings*, (May) Vol. 99, No. 2.

Taylor, John B. and Volker Wieland (forthcoming), "Surprising Comparative Properties of Monetary Models," *The Review of Economics and Statistics*.

Uhlig, Harald and Thorsten Drautzburg (2011), "Fiscal Stimulus and Distortionary Taxation, NBER Working Paper 17111.

Wieland, Volker, Tobias Cwik, Gernot Mueller, Sebastian Schmidt and Maik Wolters (forthcoming), "A New Comparative Approach to Macroeconomic Modelling and Policy Analysis" *Journal of Economic Behavior and Organisation*.

Appendix 1

Figure A1: Responses to a joint reduction of government spending and the labor tax rate.

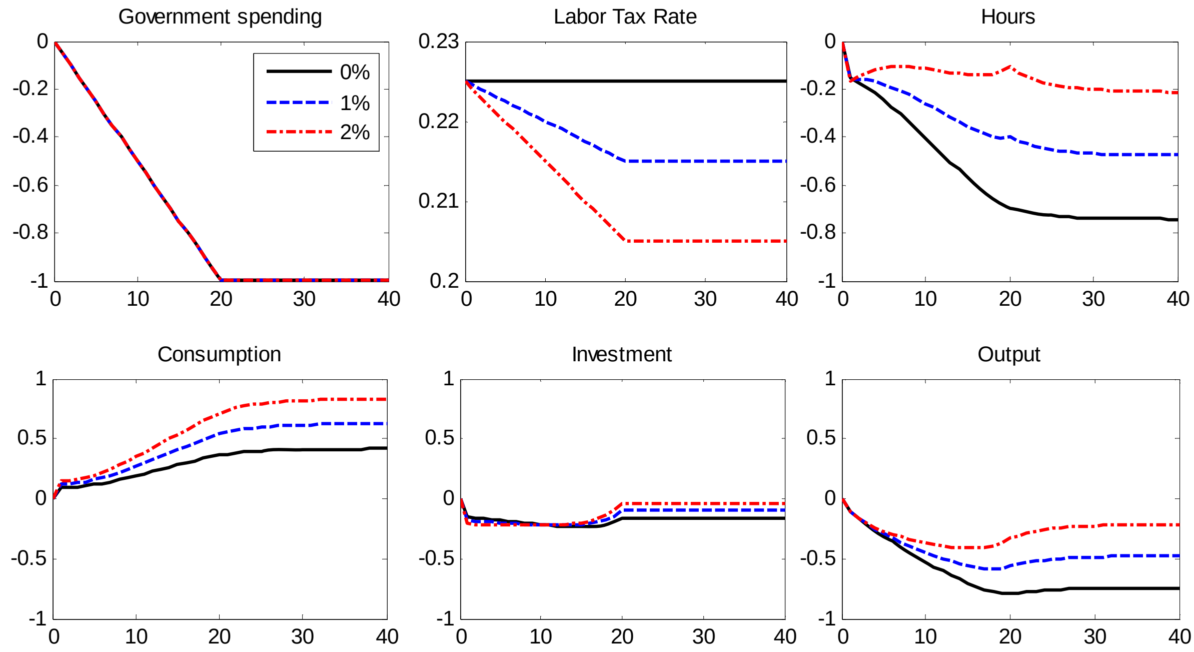


Figure A2: Tax revenues in the case of a labor tax rate reduction.

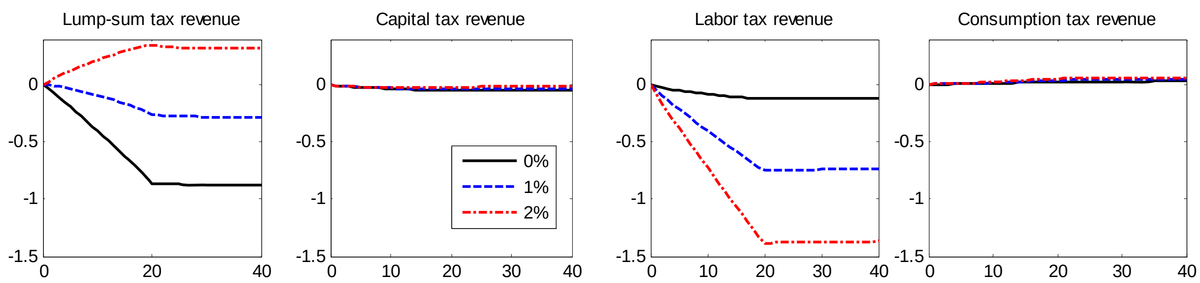


Figure A3: Tax revenues in the case of different labor supply elasticities and a joint government spending and capital tax reduction.

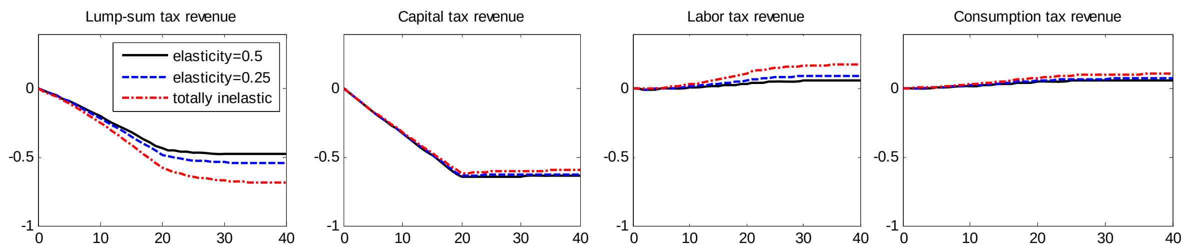
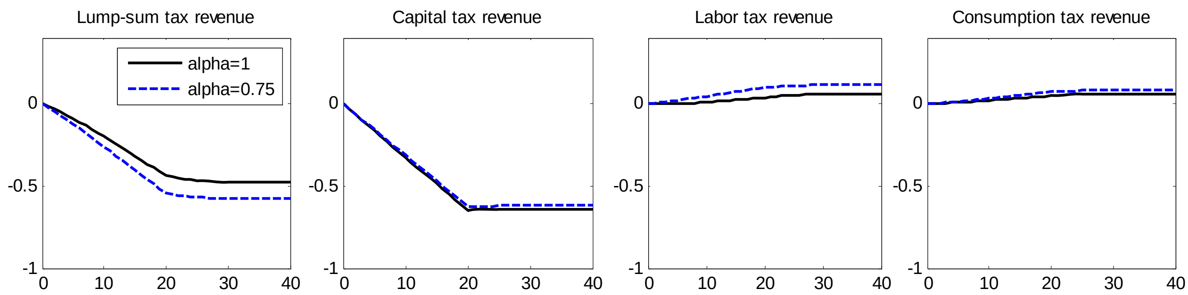


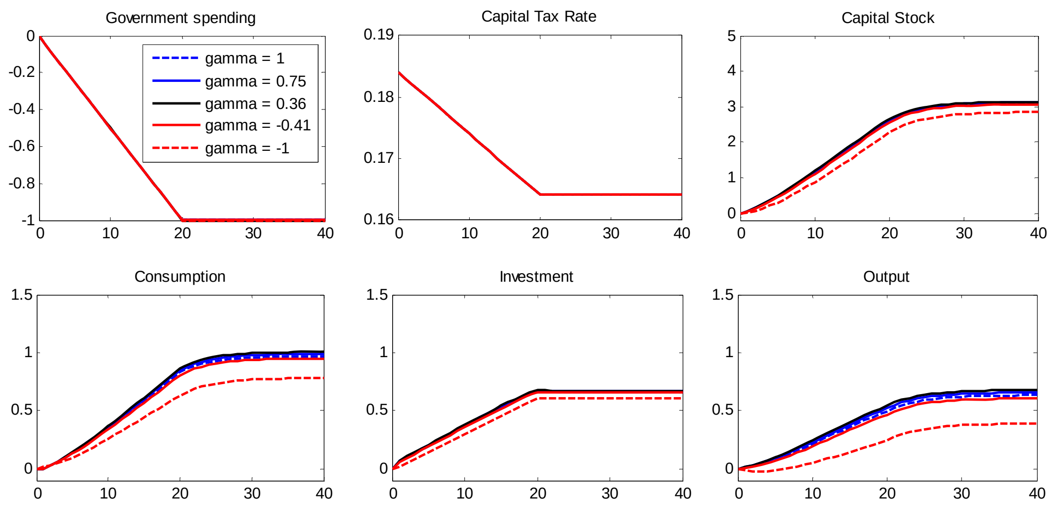
Figure A4: Tax revenues and utility of public consumption



Appendix 2: Substitutability of private and public consumption

The effects of government consumption in the utility function depend on the degree of substitutability of private and public consumption as we will show in the following analysis. Intuitively, if private and public consumption are substitutes, a decrease in public consumption will lead to an increase in private consumption. If they are complements, a decrease in public consumption leads to a decrease in private consumption. Figure 8 shows this. We calibrate the weight of private to public consumption in the utility function to and vary the degree of substitutability. We include the value estimated by Amano and Wirjanto (1998) and the mean of the estimates by Ni (1995) of . Estimates of other authors use different and less general functional forms of the utility function and are, thus, not comparable. We include, however, also other values to cover a large range of substitutability degrees. The results show the non-monotonic effect of decreasing of γ, i.e. the substitutability of private and public consumption as described above. For highly negative values of γ one can even generate a comovement of government spending and consumption (not shown). These values are, however, totally off the estimated value of $\gamma = 0.36$ by Amano and Wirjanto (1998).[12][13]

Figure A5: The role of substitutability of private and public consumption



[12] Gamma=0,36 is consistent with an estimate of the intratemporal elasticity of substitution between private and public consumption of about 1.56.

[13] Note that in our setting $1/\sigma_1 = 0.5 < \xi = 1/(1-\gamma) = 1.56$ and thus private and public consumption are substitutes. Amano and Wirjanto (1998) estimate $1/\sigma_1 = 1.56 = \xi = 1/(1-\gamma) = 1.56$, so that private and public consumption are unrelated. However, their estimate σ_1 is very low, so that we proceed with the usual value of 2.