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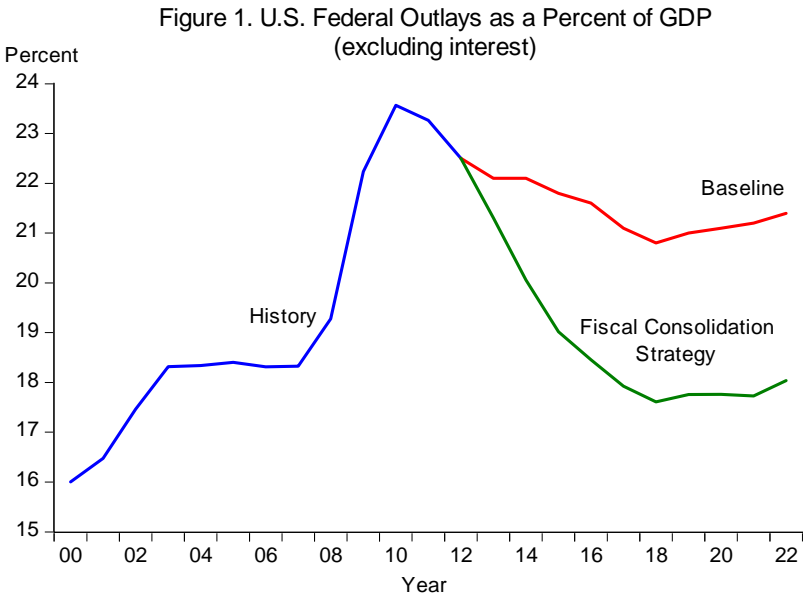
Abstract

In the aftermath of the global financial crisis and great recession, many countries face substantial deficits and growing debts. In the United States, federal government outlays as a ratio to GDP rose substantially from about 19.5 percent before the crisis to over 24 percent after the crisis. In this paper we consider a fiscal consolidation strategy that brings the budget to balance by gradually reducing this spending ratio over time to the level that prevailed prior to the crisis. A crucial issue is the impact of such a consolidation strategy on the economy. We use structural macroeconomic models to estimate this impact. We consider two types of dynamic stochastic general equilibrium models: a neoclassical growth model and more complicated models with price and wage rigidities and adjustment costs. We separate out the impact of reductions in government purchases and transfers, and we allow for a reduction in both distortionary taxes and government debt relative to the baseline of no consolidation. According to the initial model simulations GDP rises in the short run upon announcement and implementation of this fiscal consolidation strategy and remains higher than the baseline in the long run.

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As a consequence of the financial crisis and great recession government deficits have risen substantially creating the need for a fiscal consolidation strategy to reduce the deficits and stop the growing debt. This increase in budget deficits 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 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 summarizes the federal government spending situation in the United States. It shows U.S. federal government outlays—excluding interest payments—relative to GDP. Government outlays (or government spending) include both government *transfers* and government *purchases* of goods and services. The history line shows the rapid increase in spending during the crisis. The baseline shows that the high spending levels are projected to continue unless current federal spending policies are changed.¹ The interest payments on federal debt that is expected to be issued to finance this high level of spending, (not shown in the chart) will add increasingly larger amounts to total federal spending. Under the baseline assumptions, interest payments rise from 1.4 percent of GDP in 2012 to 3.7 percent in 2022.



¹ The details about the baseline and the consolidation strategy are presented below.

Implicit in this baseline is a long-run increase in tax rates needed to reduce the deficit and thereby prevent the national debt from growing to economically dangerous levels. However, higher tax rates themselves will distort private incentives for saving, investment and capital accumulation to the detriment of economic growth and welfare.

Figure 1 also shows the path of federal government spending under a fiscal consolidation strategy that gradually returns spending to the pre-financial crisis level as a share of GDP. Because the U.S. federal budget was close to balance before the crisis, (the federal deficit was only 1.3 percent of gdp in 2007) this strategy would mitigate the size of any tax rate increase. Hence, relative to the current policy baseline, long-run tax rates would be lower under this alternative strategy.

The purpose of this paper is to evaluate the impact of a fiscal consolidation plan on the U.S. economy, including quantifying its impact on GDP, consumption and investment. Of course, the size and sign of this impact is a crucial and widely debated policy question, which is at the heart of the current austerity debate. We use modern structural macroeconomic models to assess the impact.

To help establish the robustness of our results, we consider different types of models. First we consider a neoclassical growth model with flexible prices and forward-looking households. Such a model is helpful for clarifying some of the longer-run implications of changes in government spending and tax cuts. For example, in this model, a reduction in future government spending allows for a decrease in tax rates which will increase employment and GDP; if that decrease in taxes is anticipated, then consumption will increase in the short run.

Second, we consider forward looking models that include various price and wage rigidities and adjustment costs not present in the neoclassical growth model. Such models are needed to assess the short run impacts of a fiscal consolidation strategy. We focus on the

model of Coenen, McAdam and Straub (2008) and also consider the model of Cogan, Cwik, Taylor and Wieland (2010) (CCTW).

The model of Coenen et al (2008) accounts for a range of distortionary taxes. It covers the U.S. economy as well as the euro area economy as a whole, and was used by its European Central Bank authors to investigate the impact of a reduction in distortionary taxes in the euro area. It is sometimes called the New-Area-Wide Model (NAWM) since a version of the model has been estimated with euro zone data and has replaced the so-called Area-Wide-Model (AWM) in policy.² For the purpose of this study, we calibrate the parameters of the U.S. part of the model with references to empirically estimated models, including the CCTW model. The CCTW model is very similar to the well-known models of Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2007). We also use simulations of the CCTW model as a robustness check for the following two reasons. It is estimated by Bayesian methods on the same U.S. data as in Smets and Wouters (2007). Furthermore, this model includes not only 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. .

The paper is organized as follows. First, we present the neoclassical model, illustrate its properties with some simple examples, and explore the sensitivity of these properties to assumptions about the household utility function. Second, we present and illustrate the properties of the models with certain rigidities. Third, we present the fiscal consolidation strategy and compare it with the baseline assumption of what would happen if there were no consolidation. Finally, we examine the effect of the strategy on the economy using the models.

² We have made our implementations of the AWM, NAWM and CCTW models available online in a new macroeconomic model archive (see <http://macromodelbase.com>). The model comparison approach is presented in Taylor and Wieland (2012) and Wieland et al (2012).

1. The Neoclassical Model

This model builds on the model in King, Plosser and Rebelo (1988) and the discussion in the Ljungvist and Sargent (2004) textbook. The government in this model buys goods and finances these purchases with distortionary taxes on consumption, capital and labor, as well as some non-distortionary lump-sum per-capita taxes. Government consumption is denoted by g_t and lump-sum 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:

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

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

$$U(c_t, l_t) = \frac{c_t^{1-\sigma_1}}{1-\sigma_1} - \frac{l_t^{1+\sigma_2}}{1+\sigma_2} \quad \text{for } 0 < \sigma_1 < 1 \text{ and } \sigma_1 > 1 \quad (2)$$

$$U(c_t, l_t) = \ln(c_t) - \frac{l_t^{1+\sigma_2}}{1+\sigma_2} \quad \text{for } \sigma_1 = 1.$$

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.³ The labor supply elasticity plays an important role regarding the impact of changes in government spending on work hours and total output, as we discuss in detail below.

The household's budget constraint is given by

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

while the government has to satisfy

³ Another popular utility specification is given by $U(c_t, l_t) = (1-\sigma_1)^{-1} c_t^{1-\sigma_1} + v(1-l_t)$. 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.

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

Here, p_t denotes the time period t 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:

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

Capital is accumulated according to the following equation,

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

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

$$y_t = c_t + i_t + g_t. \quad (7)$$

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,

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

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 :

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

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:

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

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

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

Other equations are not necessary to obtain a solution to the model, but 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 depreciation rate and the capital share are set to the same values as in Chapter 11 of Ljungvist and Sargent (2004):

$\beta = 0.95, \delta = 0.2, \alpha = 0.33$. Regarding the utility parameter we set the intertemporal elasticity of substitution $\sigma_1 = 1$ which corresponds to log utility. Log utility is compatible with a

balanced growth path (see King, Plosser and Rebelo, 1988).⁴ For the 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%.⁵ Other taxes or transfers are collected lump-sum.

For illustrative purposes we consider a lasting reduction in government spending of 1 percent of GDP that is phased in very gradually over five years. Thus, during the initial 20 quarters government spending is reduced by 0.05% per quarter. This policy is announced in the first period and anticipated by market participants from then onwards. **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.

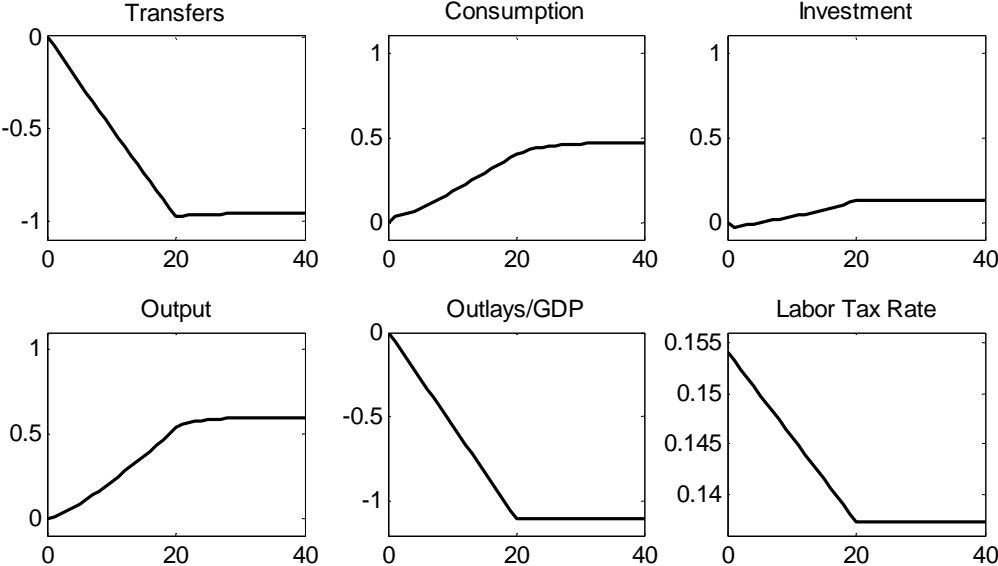
In this example simulation, the reduction in government spending is assumed to be due to a reduction in transfers. The funds from this reduction in transfers are used to reduce other taxes. Here, we use them to lower the labor income tax which distorts household decisions and induces adverse effects on the economy. Lowering such taxes may thus raise economic production and welfare. Tax rates in our parameterization reflect current U.S. tax

⁴ We have also run all simulations with an inter-temporal elasticity of substitution, $\sigma_1 = 2$. The results are very similar and the differences are quantitatively small. Therefore, we focus on the log utility case.

⁵ 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. They set the capital tax rate to the same value in both countries and determined by matching the investment/output ratio.

rates and are drawn from Coenen et al (2008).⁶ Labor tax rates shown in Figure 2 are net of social security contributions.

Figure 2: A reduction in transfers with savings applied to labor taxes
 -1% of GDP, phased-in over 5 years



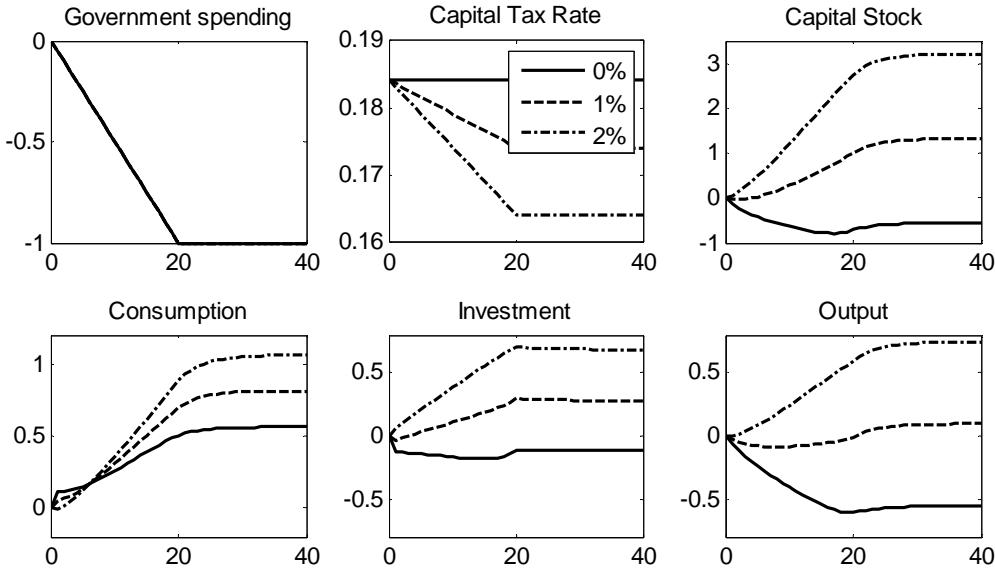
The reduction in transfers combined with a policy of using the budget savings to finance a lower distortionary labor income tax induces a substantial lasting positive effect on consumption, investment and total output. Households supply more labor. Higher investment leads to greater capital stock. Government purchases remain constant, but overall government outlays decline as a share of GDP by about 1 percentage point.

There are alternative tax and spending assumptions to go along with this illustrative scenario. If government purchases are reduced rather than transfers the positive impact of on GDP is smaller. If lower funding needs for purchases are channeled to reduce lump sum rather than labor taxes, total GDP even falls in this model. This occurs because there is no

⁶See Coenen et al (2008) for an evaluation of the effects of a reduction of Euro area tax rates to U.S. levels. All tax rates reflect current US taxes except for the capital tax rate. The capital tax rate is determined by the calibration steady state ratios of the model. 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.

reduction in distortions and because the positive private sector wealth increase (due to the decline in government spending) induces a decline in labor supply. Alternatively capital tax rates can be reduced. **Figure 3** shows the impact of a decline in the capital tax rate phased-in over five years along with the decline in government spending, which, in this case, takes the form of a decline in purchases rather than transfers. We consider reductions of 1 and 2 percentage points, respectively, down from an initial rate of 18.4%. As the savings from government spending cuts are used to lower capital taxation, we observe an increase in 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. A decrease of the capital tax rate of 2 percentage points leads to an increase in output.

Figure 3: 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



Implications of a weaker labor supply elasticity

Note in the lower right hand graph in Figure 3 that output actually declines when the budget savings are used to reduce lump sum taxes, instead of the distortionary capital tax rate. This result occurs because, with government purchases not in the utility function, household

are wealthier when government purchases decline and transfer payment rise. Thus they reduce their labor supply due to an income effect.

In the benchmark calibration we have set σ_2 equal to 2, which implies a labor supply elasticity of 0.5. While this is a widely-used value in models (see e.g. Smets and Wouters (2007) used to study macroeconomic fluctuations,⁷ it might be too high to capture labor supply responses over coming years when the economy may require substantial shifts in sectoral labor allocation following the financial crisis and the great recession. Jobholders may be less willing to reduce hours or quit their job compared to earlier decades, and 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.

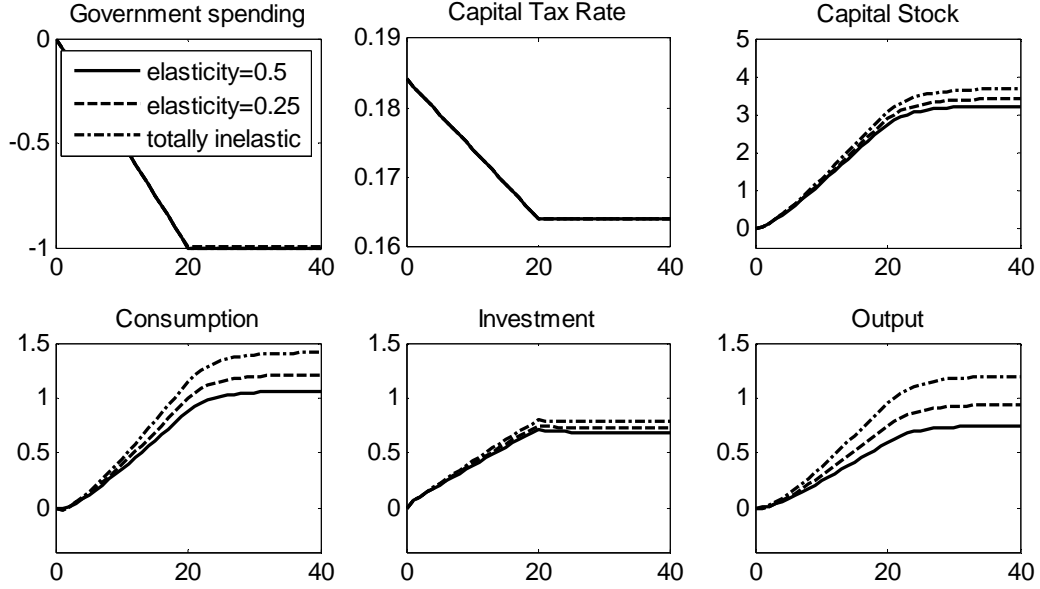
To illustrate the implications of different assumptions about labor supply elasticity we simulated versions of the model with inflexible labor supply, totally elastic labor supply and intermediate cases of labor market responses. Thus, we compare values of $\sigma_2 = 2$, $\sigma_2 = 4$ (low elasticity of $1/\sigma_2 = 0.25$) and $\sigma_2 \rightarrow \infty$ (totally inelastic, $1/\sigma_2 \rightarrow 0$).

Figure 4 shows the simulation results of a decline in government purchases with two cases of a less elastic labor supply. A comparison with Figure 3 shows that consumption and output increase by a larger amount when labor supply is less elastic.⁸

⁷ 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 $\frac{3}{4}$ 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 close to zero.

⁸The resulting tax revenues are shown in the Appendix.

Figure 4: Lower labor supply elasticity
g reduced by 1% of GDP, capital tax by 2 percentage points, phased-in over 5 years



Implications of adding government consumption to household utility

The model can also be expanded to let household utility depend positively on government consumption. If households derive utility from government consumption such as infrastructure, police, fire protection, national defence, education they may respond to a government spending cut with more private consumption to make up for it. We extend the simple neoclassical model by introducing a new utility function which comprises a bundle of private and public consumption \tilde{c}_t ⁹:

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

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.

Specifically, we can 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:

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

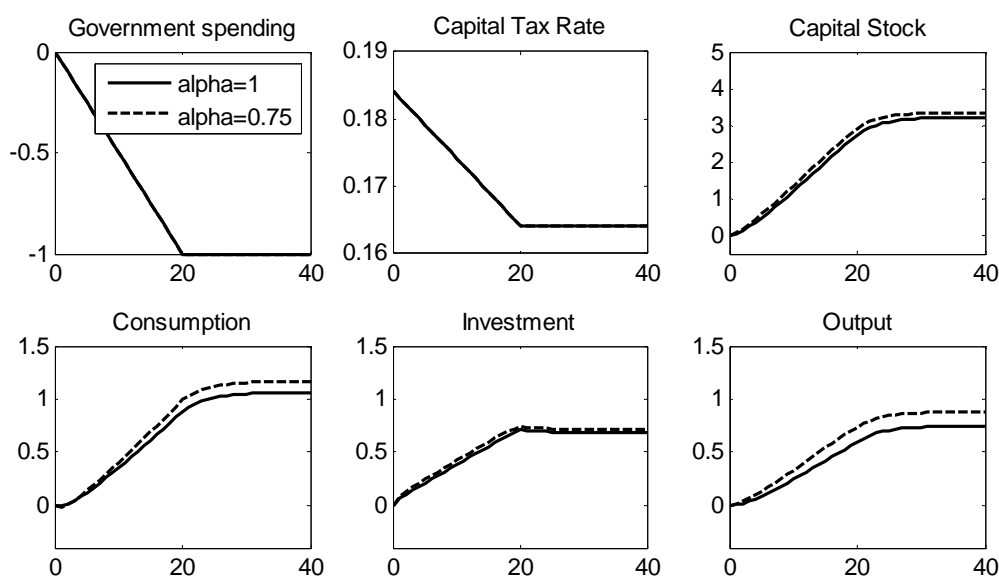
α denotes the relative weight of private to public consumption. γ determines the intra-temporal elasticity of substitution $\zeta \equiv 1/(1 - \gamma) > 0$ between private and public consumption. $\gamma = 1$ implies perfect substitutes.¹⁰ With $\alpha \rightarrow 1$ government consumption drops out 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 5 shows the effects of a joint reduction of government purchases and the capital tax rate in the case where $\alpha = 0.75$. The labor supply elasticity is set to 0.5 as in the benchmark simulation. The simulation indicates that consumption and investment rise by a larger amount when households derive utility from government consumption.¹¹ The steady-state capital stock and output also increase.

¹⁰Amano 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.

¹¹Public and private consumption are substitutes (compare also appendix 2) and thus a decrease of utility due to a decrease in public consumption can be compensated through an increase in private consumption. For 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 reduction in lump-sum tax revenues is smaller the larger the value of α .

Figure 5: 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



2. Models with Rigidities

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 are not appropriate for assessing the short run impacts. Thus, we consider models that include various price or wage rigidities and adjustment costs.

The NAWM model of Coenen et al (2008) accounts for a range of distortionary taxes. As with the neoclassical model, households maximize utility over time. But only some households have access to financial markets; they can accumulate capital and hold money. The other type of households can smooth consumption only by adjusting their money holdings. Still, these households are more sophisticated than the rule-of-thumb households in the CCTW model. The utility function also allows for slow adjustment of consumption due to habits in which consumption at different periods of time affects current utility.

Households supply differentiated labor services and have some market power in wage setting. Wages are determined in staggered contracts setting of the Calvo (1983) variety in which some workers have an opportunity to change their wage while others have their wages indexed to a geometric average of past changes in the prices. 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 goods, financial investment in international markets and capital utilization are subject to specific proportional adjustment 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. Like wages, price setting is subject to staggered price contracts of the Calvo (1983) variety. Some firms get to adjust their price each period, while 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 review the government budget constraint:

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

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. As in the neoclassical model there are various assumptions that can be made about what happens to lump sum taxes, T_t .¹²

Some of the parameters of the model are chosen by setting steady state ratios to match actual U.S. and Euro area ratios. Others are calibrated along the lines of Smets and Wouters (2003). The labor supply elasticity equals 0.5 as in the 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 without access to financial markets is 25%. While the price stickiness for goods sold in the domestic market is higher than for exports. The substitution elasticities between home and foreign goods are set to 1.5. Adjustment costs associated with changing the import share in investment is a relative high 2.5. With these parameters consumption and investment respond with low sensitivity to changes in the terms of trade. We

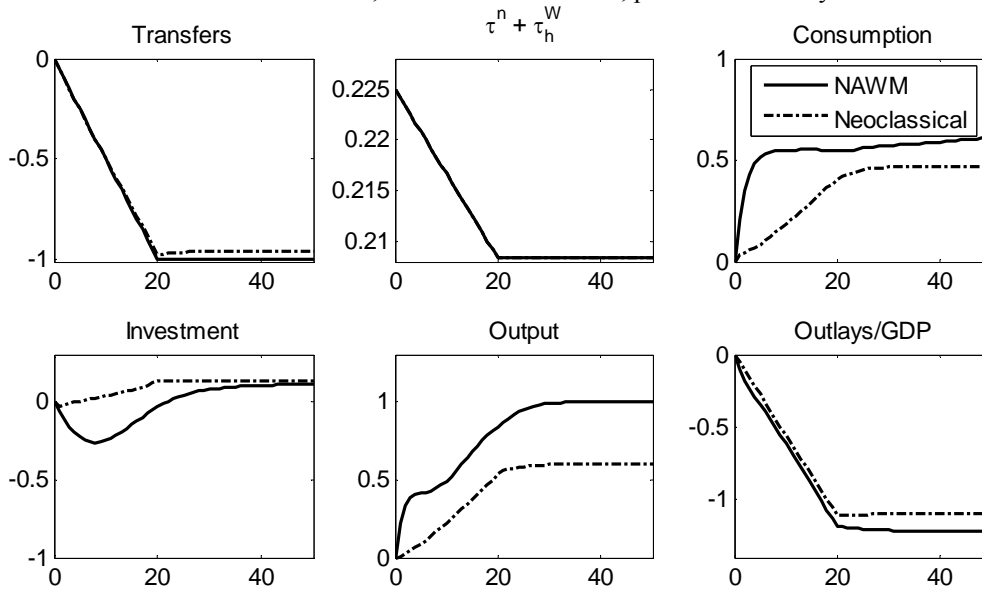
¹² In the neoclassical model lump-sum taxes serve to balance the budget. The NAWM model also contains government debt and lump-sum taxes are related to deviations of the debt to GDP ratio from a target rate. In both models, the path of lump-sum taxes can be influenced by modifying other distortionary taxes.

deviate with respect to the calibration of the intertemporal elasticity of substitution from Coenen et al (2008). Instead of a value of 2 we use a value of unity which implies log utility and is consistent with a balanced-growth path. The multiplicative utility function in the CCTW is already consistent with balanced growth.

Tax rates are calibrated as in Coenen et al (2008). Their values for consumption, income and social security taxes are 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 as in Coenen et al (2008). 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 .

We consider the same illustrative simulation as in the neoclassical model: a reduction in transfer payments. In the NAWM model, transfers affect the two types of households in different ways. **Figure 6** shows the outcome of a reduction in transfers in the NAWM model. In this simulation we let the government savings be applied to a reduction in labor taxes. The reduction in government transfers causes total consumption to rise substantially. Investment and net exports increase somewhat. Output increases substantially. A fiscal consolidation results in an increase in total output.

Figure 6: A reduction in transfers and labor income taxes
 Transfers -1% of GDP, income tax rate -1.6%, phased-in over 5 years



Finally, we consider the CCTW model, which is estimated with U.S. data using Bayesian methods, as an empirical benchmark for comparison with the calibrated NAWM and neoclassical model. With regard to short-run effects, it is of interest that the CCTW model includes about 28 percent of “rule-of-thumb” households which do not smooth consumption. Because the CCTW model does not incorporate the incentive effects of changes in tax rates we confine these comparisons to simulations of reductions in government purchases where the funds saved were paid out in lump sums, such as the simulations in Figure 3 without a change in the tax rate on capital (solid line). The long-run impact on GDP and government outlays relative to GDP is very similar in all three models. With regard to the short-run impact, the CCTW model lies in between the NAWM and neoclassical model. .

3. Fiscal Consolidation Strategy

Having explained the models and illustrated some of their basic properties we can now consider a budget consolidation reform and estimate its impacts. The Fiscal Consolidation Strategy is designed to approximate a realistic budget plan that might be employed to reduce

federal spending, and thereby, bring the U.S. federal budget deficit down from its current level of 9 percent of GDP. This prototypical plan contains reductions in both government purchases and transfer payments from their current trajectory, or baseline. The impact of the Fiscal Consolidation Strategy is measured against a realistic budget baseline through the year 2022. Thereafter, we assume that the Strategy's annual expenditure reduction relative to the baseline remains fixed at its 2022 level.

The 2012-2022 budget expenditure baseline is derived from the Congressional Budget Office's (CBO) Alternative Fiscal Scenario.¹³ This CBO baseline assumes that current federal expenditure policies will remain in place for the next decade. During this period, according to CBO, discretionary programs grow at a rate approximated by the rate of inflation. Mandatory programs, which are driven by three large entitlements; Social Security, Medicare and Medicaid, grow faster than GDP over the period 2013-2022, mainly as a result of an increase in the number of workers reaching retirement age and a continuation of rapidly rising health care costs. Under this baseline, non-interest federal spending gradually declines by one percent of GDP between 2013 and 2022.

The fiscal consolidation path used in our analysis is modelled on the 2013 Budget Resolution passed earlier this year by the U.S. House of Representatives.¹⁴ The plan calls for sizeable reductions in expenditures in both discretionary and mandatory program expenditures relative to the budget baseline between 2013 and 2022. Under the plan, non-interest federal spending is projected to decline to 17.3 of GDP in 2022; a full 2.6 percentage points of GDP below the CBO baseline in that year.

To estimate the impact of the Consolidated Fiscal Strategy with structural macroeconomic models, the baseline and House Budget Resolution estimates, both of which are presented on a unified federal budget basis, must be first converted to a National Income

¹³ Congressional Budget Office, The 2012 Long-Term Budget Outlook, June 2012

¹⁴ House Concurrent Resolution, 112th Congress, 2nd Session, House Report No. 112, March 2012.

and Products Account (NIPA) basis. Unfortunately, the publicly available data on the CBO baseline and the Resolution does not contain sufficient detail to permit a precise conversion to be made. Nevertheless, a reasonably accurate conversion may be obtained by making a few simple assumptions.

Our NIPA-based expenditure projections are obtained by converting three large categories of non-interest federal spending into federal purchases and transfer payments. The first category consists of four main federal entitlements: Social Security, Medicare, Medicaid, and health insurance subsidies under the Affordable Care Act. These expenditures, which account for nearly one-half of all federal spending are treated as transfers.¹⁵ The second category consists of defense expenditures.¹⁶ All of the spending in this category, which accounts for 20 percent of federal spending, is classified as purchases. The third category consists of all other non-interest expenditures. These expenditures are allocated to purchases and transfers according to their share in 2011, the latest year for which we have a detailed conversion of federal budget expenditures into NIPA expenditures.

A final step is to convert the annual budget data series to quarterly data. This step was accomplished by linearly interpolating the deviations of purchases and transfers from the budget baseline, measured as a share of GDP. That is, each value in the annual series was assigned to the last quarterly observation of the associated annual series. Then intermediate points were placed on straight lines connecting these points.

Purchases and Transfer Payments under the Fiscal Consolidation Strategy

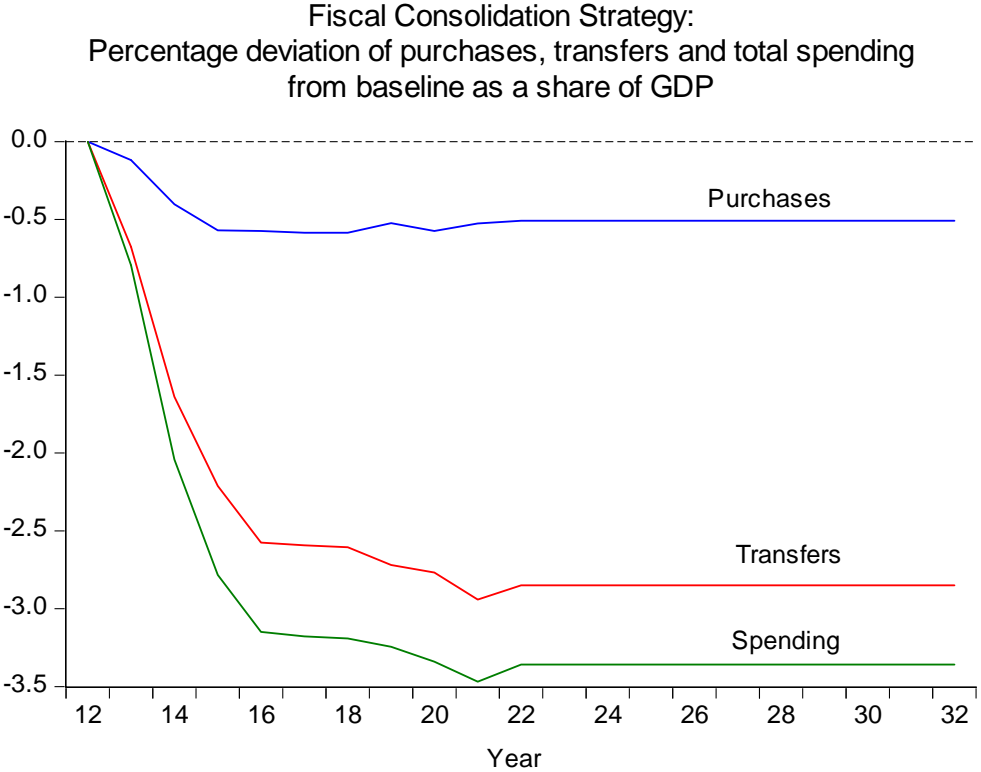
The budgetary impact of the Fiscal Consolidation Strategy, shown earlier in Figure 1, is substantial. By 2022, federal expenditures relative to GDP are reduced relative to the

¹⁵ Medicare expenditures are gross of Medicare receipts, mainly premium payments by enrollees. Under NIPA accounting, these receipts are recorded as revenues.

¹⁶ Defense spending is measured by discretionary spending.

baseline by 3.4 percentage points. **Figure 7** shows how this reduction is distributed between federal government purchases and federal government transfer payments.

Figure 7



As the chart shows, the plan’s major budgetary impact is achieved through a reduction in transfer payments. The plan reduces transfers relative to the budget baseline by 2.5 percentage points. Most of this reduction occurs relatively early in the ten year period; by 2015. The plan’s impact on federal purchases is, in contrast, relatively modest. Government purchases decline relative to GDP by only .6 percentage points. As was the case with transfers, most of the decline in purchases occurs early; by 2015.

Debt and Tax Rates under the Fiscal Consolidation Strategy

Because the reform spending path is lower than the baseline spending path, it allows for lower tax rates and/or lower levels of government debt. We assume a mixture. Under the Fiscal Consolidation Strategy, the funds released from reduced federal spending are used to

reduce the labor tax rate by about 5 percentage points with the remaining funds used to reduce the debt to GDP ratio as implied by the budget constraint and the model of the economy.

4. Estimating the Impact of the Fiscal Consolidation Strategy

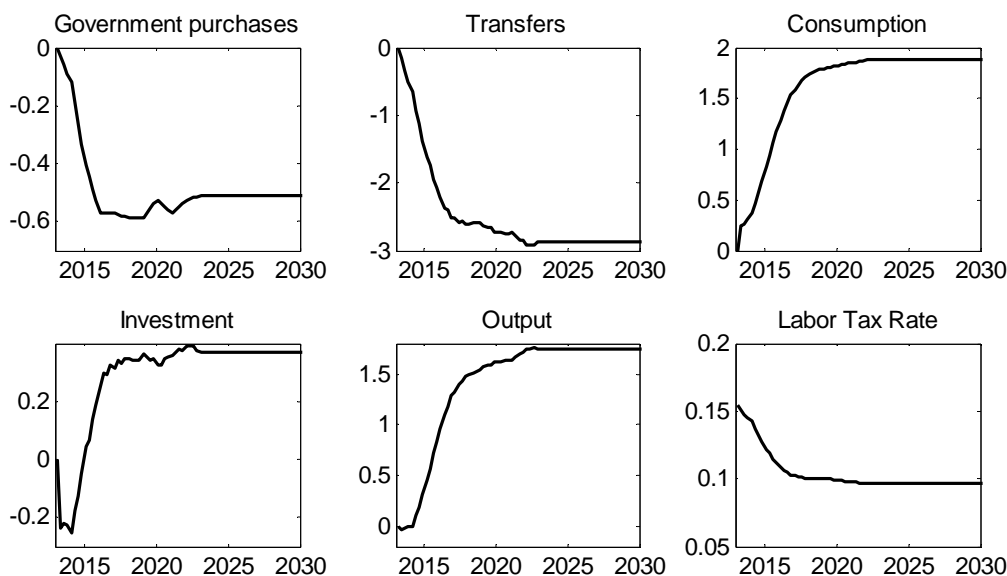
We consider the impacts of the budget reform on the economy by simulating it in the neoclassical model¹⁷ and in the NAWM model. In both cases, we assume that the strategy is announced and immediately implemented starting in the first quarter of 2013. The households and firms in the model are assumed to expect immediately that the plan will be carried out as announced from 2013 onward as illustrated in Figure 1. With the rational expectations assumption of the model, they take the reduced tax rates and increased after-tax income into account as they make their consumption decisions. Figure 8 shows the result for the neoclassical model and Figure 9 shows the result for the NAWM model.

Estimated Impact in the Neoclassical Model

First note that the two charts in the upper left of Figure 8 show the change in government purchases and transfers and correspond exactly to Figure 7. The chart on the lower right shows the proposed decline in the tax rate on labor. The neoclassical model assumes that the government's budget is balanced every period by lump-sum taxes and does not incur debt. The timing of labor tax rate changes is chosen to avoid large fluctuations in lump-sum taxes. We evaluate debt in the NAWM model.

¹⁷ For the simulations reported here we use the version of the neoclassical model in which government purchases appear in the household utility function. In our ongoing research we are examining alternative assumptions, and testing for robustness of the simulations, which, for this reason, we still consider preliminary

Figure 8: Fiscal Consolidation Strategy in the Neoclassical Model



The middle chart in the lower part of the diagram shows that output rises in both the short run and in the long run. Hence, there is no negative effect of this plan on GDP even though the budget cuts begin immediately. To the extent that employment moves along with GDP there is no negative effect on employment either. Because people are forward looking they see that their incomes will be higher and they begin to increase consumption. The increase in consumption is more than the decline in government purchases. Moreover people increase the quantity of their labor supplied as tax rates decline. The permanent impact on the long run is that GDP rises by two percentage points compared with the baseline assumptions. Note that consumption also rises in the long run. While there is small decline in investment in the short run due to a temporary increase in the real interest rate, the overall effect is positive. Thus, the capital stock rises to a higher long-run level. The initial drop depends on the speed of the government spending cuts relative to the labor tax reductions. If the tax reduction were to be

accelerated, investment would increase right away. Hours worked increase from the start of the simulation.

Estimated Impact in the Model with Rigidities

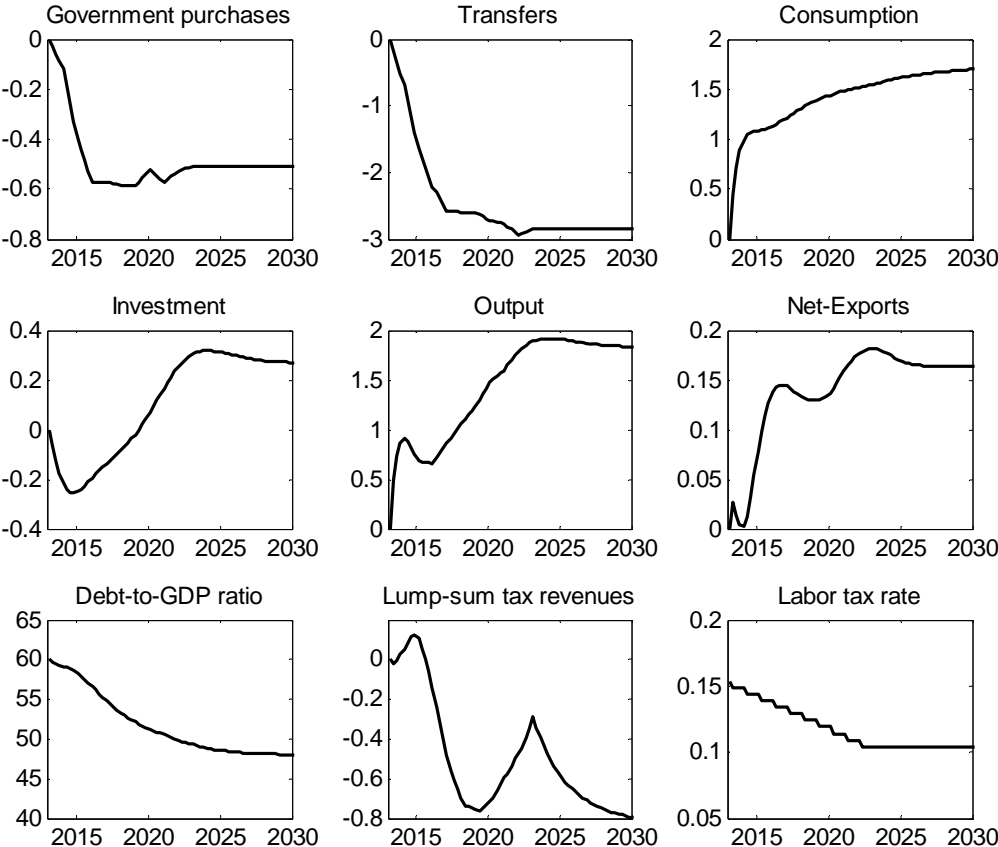
Again we can see, now in the upper left of Figure 9, the decline in government purchases and transfers, and the decline in the tax rate. Note also in the lower left the decline in the debt as a ratio to GDP.

Despite the wage and price rigidities in this model, there is also an increase in output in the short run. The reasons are similar to the neoclassical model: the expectations of higher incomes in the future increase consumption. The long run and the short run effects on output and consumption are also quite similar in the two models. 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 models with rigidities 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.

Consumption and output increase on impact with another increase after 5 to 10 years. Investment decreases temporarily, but also increases in the medium run. The NAWM model shows that these positive effects are bolstered by an increase in net exports, stimulated by a real depreciation of the dollar. Of course the effect on net exports in the other “country” in

this two country model (i.e. Europe) is the opposite sign, though the overall impacts on euro area consumption and GDP are small but positive as shown in the appendix.¹⁸

Figure 9: Fiscal Consolidation Strategy in the NAWM Model



The fluctuations in the lump sum taxes reflect the difficulty of finding a path which gives both a smooth reduction in the debt to GDP ratio and the tax rate. Fortunately these ups and downs have little effect because the lump sum taxes are not distortionary and people are forward looking. In any case the different simulations make clear that the proposed fiscal consolidation path can be accompanied by sizable tax rate cuts relative to the baseline which

¹⁸ For recent evaluations of the impact of government spending cuts in Europe see Roeger and int’Veld (2010) and Cwik and Wieland (2011). In future work, it would be of interested to investigate the impact of the fiscal consolidation strategy in the euro area part of the model and quantify the implications of joint U.S. and euro area consolidation.

to increase economic growth in the medium to long run. The anticipation of tax cuts leads also to growth of consumption and output on impact and avoids any decrease in economic activity.

4. Conclusion

In this paper we estimated the macroeconomic impacts of a fiscal consolidation strategy in which the government gradually reduces spending over time in order to reduce the deficit and the growth of the debt. For concreteness the starting point for assessing the strategy is the current budget situation in the United States where federal spending increased sharply as a share of GDP during the recent financial crisis and great recession, and spending is expected to remain high into the future under the baseline projection of the Congressional Budget Office (CBO).

The fiscal consolidation strategy considered here brings federal spending below this CBO baseline with spending as a share of GDP returning to the percentage observed prior to the crisis. While the decrease in spending is gradual, it starts in the first quarter of the new strategy. Both transfer payments and government purchases of goods and services are reduced relative to the baseline, though transfers are reduced by a larger amount. The strategy uses the funds saved both to reduce tax rates and the debt relative to the baseline.

A big question is whether the reduction in government spending reduces GDP in the short run, a concern that has been raised by many economists and policy makers. We examine this question and others by simulating the strategy in two types of modern economic models calibrated to the U.S. economy: (1) models without price and wage rigidities designed to examine long run issues and (2) and models with such rigidities which are aimed at more

explicitly capturing short run effects as well. In both types of models households are forward looking and they adjust their behavior in response to expectations of future tax and spending policy.

According to the initial model simulations, the strategy increases GDP in both the short run and the long run relative to the baseline. There appear to be three sources of this positive effect. First, lower levels of government spending in the future, compared to the baseline, imply lower tax rates which provide incentives and stimulate employment. Second, the expectation of reduced government spending in the future lowers interest rates, which stimulates demand today offsetting the decline in government spending in the short run. And third, the lower interest rate reduces the exchange rate thereby increasing net exports which also offset the decline in government spending. More generally, the gradual and credible decline in government spending allows the private sector to adjust smoothly to the decline in spending without negative disruptions.

While the fiscal consolidation strategy focusses on current circumstances in the United States, the methodology can easily be applied to consolidation plans in other countries or to joint consolidation plans in several countries.

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Appendix

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

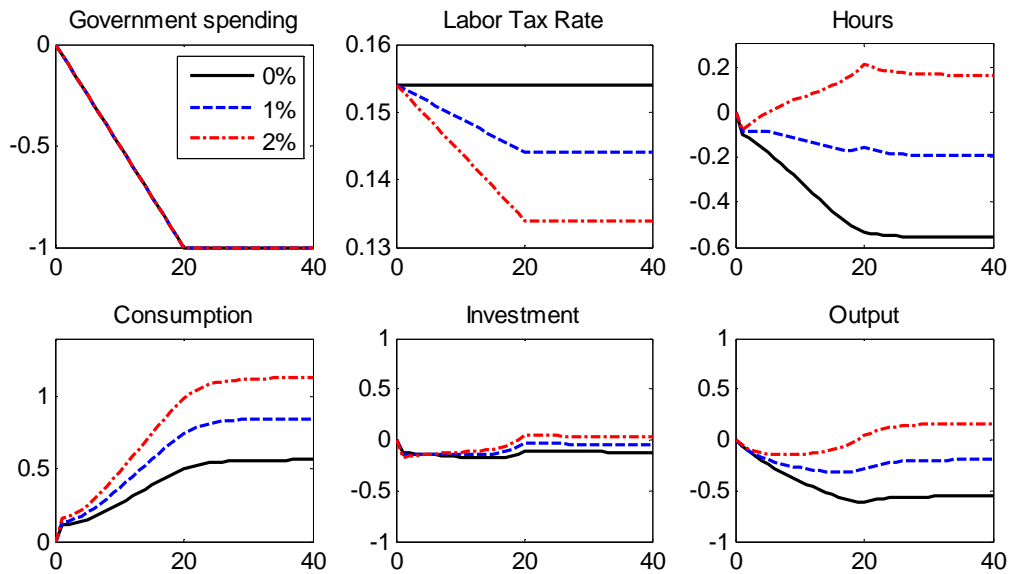


Figure A2: Tax revenues in the case of a labor tax rate reduction.

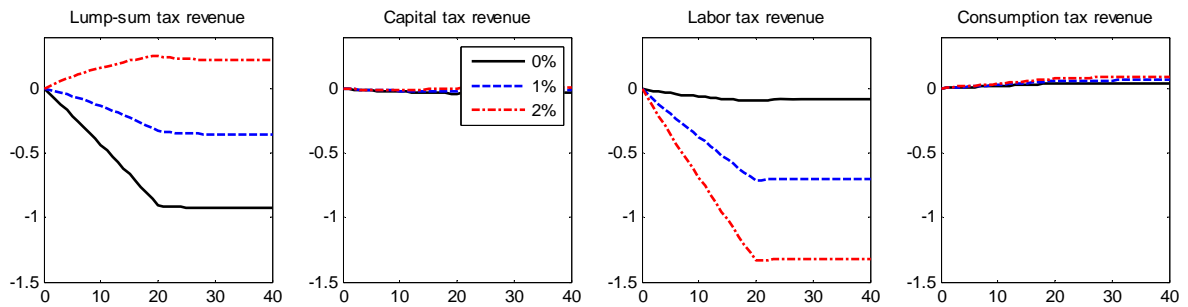


Figure A3: Tax revenues in the case of different labor supply elasticities and a joint government spending and capital tax reduction.

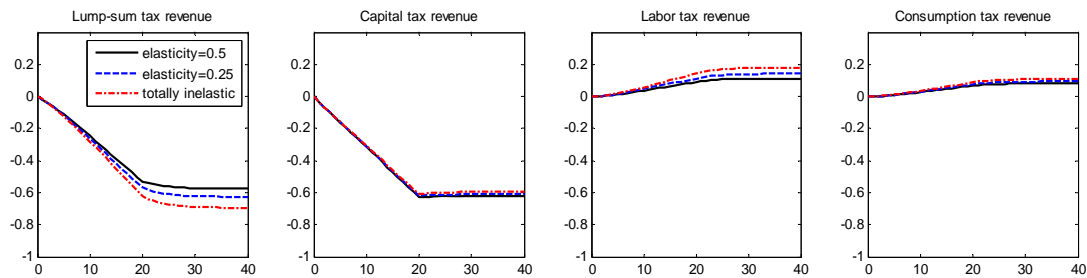


Figure A4: Tax revenues and utility of public consumption

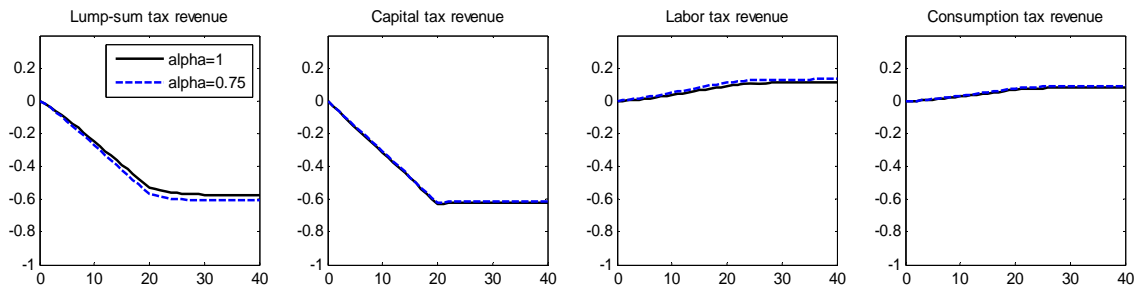
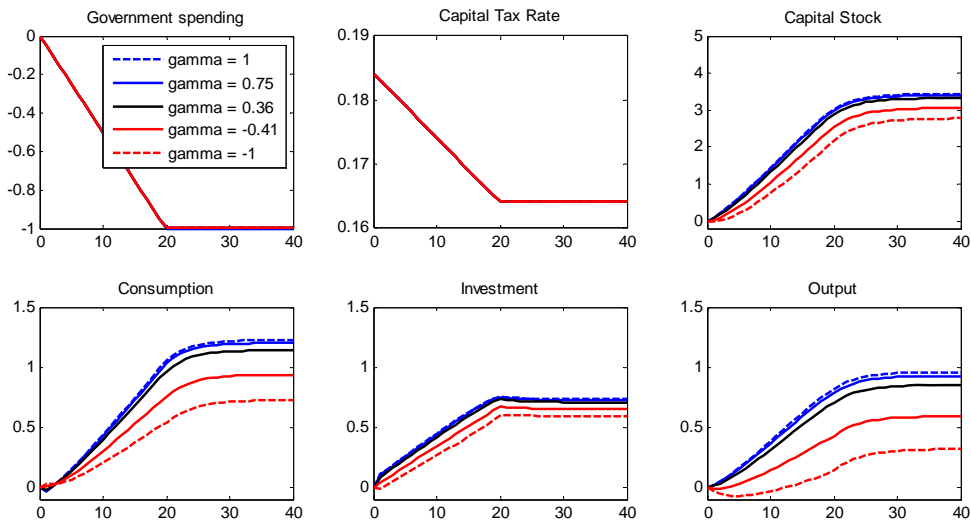


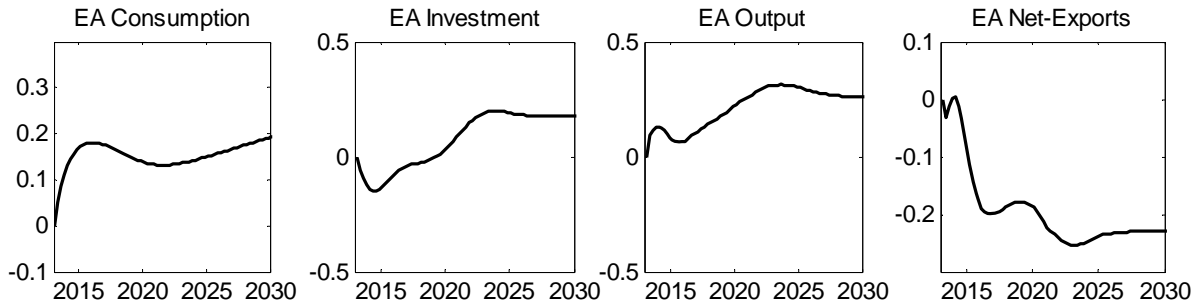
Figure A5: The role of substitutability of private and public consumption



Substitutability: 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 A5 shows this. We calibrate the weight of private to public consumption in the utility function to $\alpha = 0.8$ 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 $\gamma = -0.41$. 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).^{19,20}

¹⁹ Gamma=0.36 is consistent with an estimate of the intratemporal elasticity of substitution between private and public consumption of about 1.56.

Figure A5: Impact of U.S. Fiscal Consolidation Strategy on the Euro Area



²⁰ 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.