# Macroeconomic effects of fiscal consolidations in a DSGE model for the Euro Area: does composition matter?*

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## Abstract

We develop a new-Keynesian DSGE model with an extended fiscal policy block to assess the conditions for expansionary fiscal consolidations. In addition to several taxes, we consider public employment expenditures and government spending, which may have different degrees of productivity. We calibrate the model for the Euro Area and use it to simulate alternative fiscal consolidations with changes in the budget composition. Among the main conclusions we find that: (i) if conducted with a cut in weakly-productive spending and a symmetric increase in highly-productive spending, fiscal consolidations have expansionary effects on investment and output; (ii) if consolidation is pursued through a pure reduction in weakly-productive public employment, the effects on output decrease with the degree of labor market competition and turn out to be positive under perfect competition.

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# 1 Introduction

After the fiscal profligacy of the 1970s and early 1980s, several OECD governments undertook large fiscal consolidations, aiming at sustainably reducing public deficits and debt. Despite those efforts, further substantial fiscal adjustments cannot be avoided in most OECD countries in coming decades. In particular, the high levels of budget deficits and/or public debts, that resulted from the widespread fiscal stimulus against the 2007/08 financial crisis and the ensuing global depression, combined with the requirements of the Stability and Growth Pact (SGP), are currently requiring the consolidation of public finances in some European countries. Such need is further reinforced by the medium- and long-term spending pressures on public finances, related, *inter alia*, to population ageing.

Fiscal consolidations are usually expected to imply short-term contractionary effects on output, given the Keynesian positive fiscal spending multiplier. However, there is a long standing debate about the macroeconomic effects of fiscal policy, with yet no consensus on its impact on short-term output growth.[1]

At a theoretical level, the traditional Keynesian view of a larger than one fiscal multiplier, which was the conventional wisdom both in academic and in policy-making circles until then, has been challenged in the second half of the 1970s. On the one hand, new classical business cycle models, with wage and price flexibility and continuous market clearing, predict that fiscal policy can affect output only temporarily and if economic agents do not anticipate it. On the other hand, new Keynesian models, with intertemporal optimization and rational expectations, market imperfections and wage and price stickiness, raised the possibility of smaller or even negative fiscal multipliers (Cogan *et al.* (2010), Cwik and Wieland (2011)).

At a policy level, following the expansion of the modern welfare state during the 30 golden years, the usefulness of fiscal policy for stabilization has been challenged by the environment of high inflation and unemployment as budget deficits rose and there was a rapid accumulation of public debt. For the first time in decades there was a conflict between cyclical stabilization and the long-term sustainability of public finances.

At the empirical level, the extensive work on the output effects of fiscal consolidations since the early 1990s has failed to provide robust stylized facts on their short-run output effects. The literature may be summarized in three main groups, namely stud-

[1] For detailed surveys of the literature see, for example, European Commission (2003), Briotti (2005) and Hebous (2011).

ies comparing tax and spending multipliers, analyses of the transmission mechanism of fiscal policy, and studies of the dimension of the fiscal multiplier.

Regarding spending versus tax multipliers, the literature has typically estimated tax revenue multipliers relatively large and persistent, but smaller spending multipliers, lower than one on impact and decreasing thereafter (Blanchard and Perotti (2002), Mountford and Uhlig (2009), Alesina and Ardagna (2010)). More recently, Perotti (2005), Favero and Giavazzi (2007), Bilbiie *et al.* (2008) have found that the size of spending multipliers has fallen gradually after the 1980s.

Regarding the transmission of fiscal policy, while the results on the relation between fiscal policy and private consumption seem uncertain, although predominantly Keynesian (Perotti (1999), Giavazzi *et al.* (2000), Hogan (2004)), the evidence points to a large and persistent positive reaction of private investment to successful fiscal consolidations, which does not seem possible to justify only by simple textbook *crowding-in* effects (Blanchard and Perotti (2002), Burnside *et al.* (2004), Mountford and Uhlig (2009)).

Regarding the size of the fiscal multiplier, the evidence suggests that it is related to a set of critical conditions, namely the size and persistence of the fiscal consolidation, the initial state of public finances and, most especially, its composition in terms of fiscal instruments. With this respect, it is generally found that consolidations based on spending cuts lead to small or even negative fiscal multipliers (the so-called non-Keynesian effects), due to increases in private investment, especially in the case of cuts in government wage bills and welfare payments (Alesina and Ardagna (2010)). As they directly affect the labor market, spending cuts induce market adjustments that reduce unit labor costs, increase profits and increase investment growth, with the structure and institutions of the labor market playing an important role in these effects (Alesina and Perotti (1995), Alesina *et al.* (2002)).

Against this background, this paper asks whether it is possible to conduct fiscal consolidations without relatively high short-term output losses, or even, as some empirical evidence suggests, with some short-term output expansion. The paper contributes to the debate by developing a new-Keynesian DSGE model with a fiscal policy block that allows for alternative budget compositions, which is used for a thorough assessment of the investment and output effects of alternative fiscal consolidation strategies.

The paper is closely related to a recent generation of new-Keynesian general equilibrium models that include a more developed fiscal policy block (Coenen and Straub (2005), Galí *et al.* (2007), Coenen *et al.* (2008)). Following modern sticky-prices new Keynesian DSGE models, as firstly suggested by Smets and Wouters (2003) and Christiano *et al.* (2005), we develop a medium-scale general equilibrium model, with a thorough set of fiscal budget components. In particular, we introduce government spending and public employment expenditures as variables with a direct relation with total private factor productivity in the intermediate goods sector. Government spending is split into highly-productive, weakly- and non-productive spending and public employment expenditure into a strong and a weak productivity component. The productivities of each class of expenditure are calibrated in line with the evidence in related empirical literature.

Motivated by a growing consensus that the success of a fiscal consolidation depends on the "quality" of fiscal adjustments, *i.e.* on shifts in the budget decreasing less productive forms of expenditure (Romero-Ávila and Strauch (2008)), we simulate several experiments of fiscal consolidations with alternative changes in the budget composition.

Our main results may be summarized as follows: (i) The success – dimension and sustainability – of fiscal consolidations, either via public spending reductions or employment costs reduction, decreases with their degree of productivity; (ii) Consolidations through contractions of weakly-productive or, alternatively, non-productive public spending, generate short-run contractions of output; however, output falls twice as much in the case of weakly-productive spending consolidations, as investment falls, in contrast to what happens in the case of unproductive spending consolidations; (iii) If the consolidation is conducted with a structural change in the fiscal budget in favor of more productive spending – a cut in weakly- (or non-) productive spending together with a symmetric increase in highly-productive spending – the model predicts a positive short-run impact on output; there is a positive impact on output as long as highly-productive spending increases by 70 percent of the reduction in the weakly-productive spending (or 40 percent of the cut in non-productive spending); (iv) Consolidation through a reduction in weakly-productive public employment yields results that are similar to those of a reduction in weakly-productive public spending; however the negative effects on output decrease with the degree of labor market competition and can even turn out to be positive in a perfect competition scenario; (v) The less productive is the public expenditure that is cut, and the more competitive the labor market is, the more favorable is the reaction of private investment.

This paper is organized as follows. Section 2 discusses the composition and productivity of public expenditures, including the review of the estimates that are used to calibrate our model. Section 3 develops our new-Keynesian DSGE model. Section 4, firstly, analyzes the impact on debt of shocks to each of the different fiscal spending components, in order to verify which may lead to a sizable and sustained fiscal consolidation; then, it presents and discusses the general equilibrium effects of the fiscal shocks that have been identified as achieving a fiscal consolidation. Section 5 concludes.

# 2 Composition of Public Expenditure and Macroeconomic Productivity

The main distinctive feature of our analysis of fiscal consolidations is considering changes to the budget composition that impact on overall productivity, in a general equilibrium framework. To motivate our approach, in this section we briefly review the literature on the productivity of public expenditure.[2]

Much of the literature focusing on the effects of fiscal policy considers government spending as consisting entirely of unproductive expenditure on goods, overlooking the productive and employment components of public spending. However, "*In practice, government expenditure is on a variety of goods, some of which are intended to enhance the productive capacity in the economy*" (Turnovsky (2000), p.255)

Macroeconomists have known for a long time that public spending is an important input in the production of total output, but only recently has this feature of public spending been explicitly modeled. To the best of our knowledge, Ratner (1983) has been the first to suggest an empirical model explicitly adding public spending to the neoclassical production function and to present econometric evidence consistent with that hypothesis. Barro (1990) has introduced government expenditure as an argument in the production function of a theoretical endogenous growth model.

This strand of literature received an important impulse with Aschauer's (1989a, 1989b, 1990) empirical assessment of the effects of public inputs on output and productivity. Testing the hypothesis that the decrease in productive government services had been crucial for the productivity slowdown of the early 1970s in the United States, Aschauer (1989a) used a production function approach and found a strong positive relation between the stock of non-military public structures and equipment and total output, estimating an elasticity of 0.39 for 1949-1985. Such a figure has been considered surprisingly high by several authors, as it implies that public inputs seem more pro-

[2] For comprehensive surveys on this empirical literature see, among others, Gramlich (1994), Romp and de Haan (2007) and Pereira and Andraz (2010).

ductive than private capital. Aschauer's controversial results stimulated a large body of empirical research testing their robustness, which has yielded mixed results.

The criticism to Aschauer's analysis has focused essentially on possible econometric problems such as non-stationarities, omitted variables and reverse causation.[3] Subsequently, alternative approaches based on the estimation of cost and profit functions and on VAR models were not able to settle the issue, with some supporting Aschauer's hypothesis, but others concluding against it.

Overall, it can be argued that public inputs are relevant in the production process − either by directly providing intermediate services to private sector firms, or by complementing private inputs in production − and thus raise the marginal productivity of private capital and labor. The controversy lays on the magnitude of the contribution.

The literature suggests that different types of public expenditure have different impacts on the private factors productivity. Public capital stock, and especially non-military "core" infrastructures (highways, airports, electric and gas facilities, water systems, sewers, mass transit), directly raise the productive capacity of private firms, and are the most productive government expenditures. In fact, at a national level (either for the US or for some European countries), several studies found elasticities in line with Aschauer's (1989a); for example, Fernald (1999), Everaert and Heylen (2004) and Abdih and Joutz (2008), estimated an output elasticity of, respectively, 0.35, 0.31 and 0.39. However, other studies found smaller output elasticities, in the range $0.15 - 0.25$, as for example, Finn (1993), Kamps (2005) and Heintz (2010) (0.16, 0.22 and 0.21, respectively).

Recently, using a meta-analysis of all relevant studies until 2005, Ligthart and Suárez (2011) concluded that for national level studies the weighted average estimate of the impact of public capital on total factor productivity is an elasticity of 0.20 (with a confidence interval that goes from a lower bound of 0.177 to a upper bound of 0.224).

Other types of government spending, generally seen as comprising less productive capital expenditures (for instance, public buildings and football stadiums) or a set of non capital expenditures (including, among others, basic education, health care, entertainment, culture, national defense and environment) provide a lower contribution to private production. While Aschauer's estimates for these elasticities are insignificant, Garcia-Milà and McGuire (1992) and Evans and Karras (1994) found a positive corre-

[3] When output growth is high, incomes are rising rapidly and then the government can provide more public goods and services; *i.e.*, the correlation can reflect a demand-side rather then a supply-side causal relationship.

lation between these types of government spending, especially in education, and total output, estimating an elasticity in the range of 0.04 to 0.16, and Cutanda and Parício (1992) found an output elasticity of 0.11 with respect to social capital.

The main conclusion of this section is that governments should be able to achieve productivity gains by altering the composition of government spending from weakly- to highly-productive expenses. Then, a criterious selection of the type of public expenditure cut in fiscal consolidations may minimize the possible negative output impact of these cuts and may even generate a positive impact, as fiscal consolidation could be reconciled with an increase in global productivity. In the next sections we assess this conjecture. Our analysis will be based on model simulations developed within a new-Keynesian DSGE model overall calibrated for the Euro Area.

# 3 The Model

Sticky-prices new-Keynesian DSGE models developed along the lines of Smets and Wouters (2003) and Christiano *et al.* (2005) are presently the most-favoured framework for policy analysis. In spite of their extensive use for monetary policy analysis, new-Keynesian DSGE models have been far less used for fiscal policy analysis, which explains the typical extreme simplicity of their fiscal policy block. We develop a version of the state-of-the art new-Keynesian DSGE model that features a further detailed fiscal policy block.

The structure of the model (agents, preferences, sources of inertia and market structures) is essentially similar to Smets and Wouters (2003). There are mainly two differences. First, we consider, in addition to the standard monopolistic competition structure, a perfectly competitive labor market (Galí *et al.* (2007)), for the sake of comparison. Second, our fiscal policy block is particularly developed.

The government purchases final goods from the private sector and finances its spending requirements with lump-sum taxes and with three different types of distortionary taxes, over consumption, labor income and capital income. As usual, a fiscal rule guarantees that the debt dynamics is non-explosive.

Public spending comprises three types of productive public expenditures: (i) highly-productive spending; (ii) weakly-productive spending; and (iii) public employment. Expenditures of type (i) should be thought of as those associated with public capital; expenditures of type (ii) broadly correspond to items of current public spending that may also somewhat increase private factors productivity, like basic education, security and justice, and basic health care.

The introduction of government spending in the production function of the private sector follows the seminal work by Aschauer (1989a). The implied productivity effect of public spending on private factors has also been outlined by Finn (1998), among others, and is one channel through which the government can influence the economic activity.

The literature is very scarce as regards the inclusion of government expenditures in the production function within new-Keynesian DSGE models.[4] To the best of our knowledge, the only exception is Pappa (2009) who has incorporated both productive government spending and public employment in a new-Keynesian DSGE model. Yet, our exercise differs from hers in several respects: first, our model is more complete in what regards nominal and real frictions and is thus more likely to be data-consistent; second, we do not limit productive public spending to correspond to public investment; finally, we aim at studying the effects and transmission mechanisms of fiscal consolidations.

## 3.1 Households

Households maximize an intertemporal utility function, separable in consumption ($C$) and labor ($l$), over an infinite life horizon. The function is given by:

$$\mathrm{E}_t \sum_{t=0}^{\infty} \beta^t U_t^{\theta} \left( C_t^{\theta}, l_t^{\theta} \right) \tag{1}$$

where the index $\theta$ represents a continuum of households that differ in that they supply a differentiated type of labor, $\beta$ is the discount factor and $U_t^{\theta}$ is the following instantaneous utility function:

$$U_t^{\theta} = e^{\varepsilon_t^b} \left[ \frac{1}{1-\sigma_c} (C_t^{\theta} - H_t)^{1-\sigma_c} - \frac{e^{\varepsilon_t^N}}{1+\sigma_N} (l_t^{\theta})^{1+\sigma_N} \right]. \tag{2}$$

Utility depends negatively on labor supply, $l_t^{\theta}$, and positively on consumption, $C_t^{\theta}$, relative to a time-varying external habit variable, $H_t$, that is assumed to be proportional to aggregate past consumption (habit formation in consumption):

[4] Finn (1998) and Cavallo (2005) explicitly incorporate productive public spending and public employment but in a purely neoclassical DSGE model.

$$H_t = hC_{t-1}. \tag{3}$$

In equation (2) the parameters $\sigma_c$ and $\sigma_N$ represent, respectively, the coefficient of relative risk aversion of households or the inverse of the intertemporal elasticity of substitution, and the inverse of the elasticity of work effort with respect to the real wage. $\varepsilon_t^b$ and $\varepsilon_t^N$ are two preference shocks that affect the intertemporal substitution of households and the labor supply, which are assumed to follow a first-order autoregressive process with i.i.d.-normal error terms:

$$\varepsilon_t^b = \rho_b \varepsilon_{t-1}^b + \eta_t^b; \tag{4}$$

$$\varepsilon_t^N = \rho_N \varepsilon_{t-1}^N + \eta_t^N. \tag{5}$$

Households face an intertemporal budget constraint given by:

$$Y_t^\theta + \frac{B_t^\theta - b_t B_{t+1}^\theta}{P_t} = (1 + \tau_t^c) C_t^\theta + I_t^\theta. \tag{6}$$

This constraint means that current real disposable income, $Y_t^\theta$, and real financial wealth, which is hold in the form of government bonds $B_t^\theta$, can be used for consumption, $C_t^\theta$, (including consumption taxes $\tau_t^c$), and investment in physical capital, $I_t^\theta$. Government bonds are one-period securities with price $b_t$, and $b_t B_{t+1}^\theta$ is the current value of future holdings of government bonds[5].

Current disposable income, $Y_t^\theta$, consists of the sum of labor income with the return on the real capital stock and the dividends paid by the imperfect competitive intermediate firms, $Div_t^\theta$, deducted from the lump-sum taxes, $T_t^\theta$ and distortionary labor and capital income taxes, $\tau_t^n$ and $\tau_t^k$:

$$Y_t^\theta = (1 - \tau_t^n) w_t^\theta l_t^\theta + (1 - \tau_t^k) r_t^k K_t^\theta + \delta \tau_t^k K_t^\theta + Div_t^\theta - T_t^\theta \tag{7}$$

where $w_t^\theta$ is the real wage, $r_t^k$ the real rental price of capital services and $\delta$ is the depreciation rate.

**Consumption and savings behavior**

Households maximize their objective function, given by equations (1) and (2), sub-

[5] As $b_t = \frac{1}{R_t}$, where $R_t$ is the nominal interest rate on bonds, $b_t B_{t+1}^\theta = \frac{B_{t+1}^\theta}{R_t}$.

ject to the intertemporal budget constraint, given by equations (6) and (7):

$$\text{MAX E}_t\sum_{t=0}^{\infty}\beta^t\left\{e^{\varepsilon_t^b}\left[\frac{1}{1-\sigma_c}(C_t^\theta - H_t)^{1-\sigma_c} - \frac{e^{\varepsilon_t^N}}{1+\sigma_N}(l_t^\theta)^{1+\sigma_N}\right]\right\} \tag{8}$$

subject to,

$$(1-\tau_t^n)w_t^\theta l_t^\theta + (1-\tau_t^k)r_t^k K_t^\theta + \delta\tau_t^k K_t^\theta + Div_t^\theta - T_t^\theta + \frac{B_t^\theta - b_t B_{t+1}^\theta}{P_t} = (1+\tau_t^c)C_t^\theta + I_t^\theta. \tag{9}$$

Maximization with respect to consumption and bonds holdings yields the following first-order conditions:

$$\lambda_t = \frac{e^{\varepsilon_t^b}(C_t - H_t)^{-\sigma_c}}{1+\tau_t^c}; \tag{10}$$

$$\text{E}_t\left[-\lambda_t\frac{b_t}{P_t} + \beta\lambda_{t+1}\frac{1}{P_{t+1}}\right] = 0 \Longrightarrow \text{E}_t\left[\beta\frac{\lambda_{t+1}}{\lambda_t}\frac{R_t P_t}{P_{t+1}}\right] = 1 \tag{11}$$

where $R_t = 1/b_t$ is the gross nominal rate of return on bonds and $\lambda_t$ is the marginal utility of consumption.

Aggregating equations (10) and (11), and using equation (3) we obtain:

$$\text{E}_t\left[\beta\frac{e^{\varepsilon_{t+1}^b}\frac{(C_{t+1}-hC_t)^{-\sigma_c}}{1+\tau_{t+1}^c}}{e^{\varepsilon_t^b}\frac{(C_t-hC_{t-1})^{-\sigma_c}}{1+\tau_t^c}}\frac{R_t P_t}{P_{t+1}}\right] = 1. \tag{12}$$

**Investment and capital accumulation**

Households own the capital stock which they rent out to firms at a given rental rate of $r_t^k$. They decide how much capital to accumulate in each period given the depreciation rate ($\delta$) and the costs ($S(\cdot)$) of adjusting the capital stock, which are a positive function of changes in investment,[6]

$$K_t = K_{t-1}(1-\delta) + \left[1 - S\left(\frac{e^{\varepsilon_{t-1}^I}I_{t-1}}{I_{t-2}}\right)\right]I_{t-1} \tag{13}$$

where $\varepsilon_t^I$ represents a shock to the investment cost function, which is assumed to follow a first-order autoregressive process with an i.i.d.-normal error term:

[6]It is assumed that, in the steady-state, $S(\cdot)$ equals zero, and the first derivative, $S'(\cdot)$, also equals zero around the equilibrium.

$$\varepsilon_t^I = \rho_I \varepsilon_{t-1}^I + \eta_t^I. \tag{14}$$

Households choose the capital stock and investment in order to maximize their intertemporal objective function subject to the intertemporal budget constraint, as described by (8) and (9), as well as subject to the capital accumulation equation (13).

The resulting first-order conditions are the following equations for the real current value of capital stock ($q_t$) and investment:

$$q_t = \mathrm{E}_t \left[ \beta \frac{\lambda_{t+1}}{\lambda_t} \left[ q_{t+1}(1-\delta) + (1-\tau_{t+1}^k) r_{t+1}^k + \delta \tau_{t+1}^k \right] \right]; \tag{15}$$

$$\begin{aligned} q_t \left[ 1 - S\left( \frac{e^{\varepsilon_t^I} I_t}{I_{t-1}} \right) \right] &= \qquad\qquad (16) \\ = \quad q_t S' \left( \frac{e^{\varepsilon_t^I} I_t}{I_{t-1}} \right) \frac{e^{\varepsilon_t^I} I_t}{I_{t-1}} &- \mathrm{E}_t \left[ \beta \frac{\lambda_{t+1}}{\lambda_t} q_{t+1} S' \left( \frac{e^{\varepsilon_{t+1}^I} I_{t+1}}{I_t} \right) \frac{e^{\varepsilon_{t+1}^I} I_{t+1}}{I_t} \frac{I_{t+1}}{I_t} \right] + 1. \end{aligned}$$

**Labor supply and wage setting**

Each household provides differentiated labor inputs, and wages are set according to the Calvo model: households are allowed to optimally adjust their wage to $\widetilde{w}_t^\theta$ each period with a constant probability equal to $1-\xi_w$ (Calvo (1983)). The fraction of wages not reoptimized in a given period is partially indexed to past inflation:

$$W_t^\theta = \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_w} W_{t-1}^\theta \tag{17}$$

where $\gamma_w$ is the degree of wage indexation. When $\gamma_w = 0$ there is no indexation, and the wages that cannot be reoptimized remain constant; when $\gamma_w = 1$ there is perfect indexation to past inflation.

Households set nominal wages to maximize their intertemporal objective function subject to the intertemporal budget constraint, as described by (8) and (9), as well as subject to the demand for labor, which is:

$$l_t^\theta = \left( \frac{W_t^\theta}{W_t} \right)^{-(1+\lambda_{w,t})/\lambda_{w,t}} N_t \tag{18}$$

where $\lambda_{w,t}$ is a stochastic parameter that determines the time-varying wage markup. It is assumed that $\lambda_{w,t} = \lambda_w + \eta_t^w$, with $\eta_t^w$ i.i.d.-normal. The aggregate labor demand, $N_t$, and the aggregate nominal wage, $W_t$, are given by the usual Dixit-Stiglitz aggregator functions:

$$N_t = \left[ \int_0^1 (l_t^\theta)^{1/(1+\lambda_{w,t})} d\theta \right]^{(1+\lambda_{w,t})}; \quad (19)$$

$$W_t = \left[ \int_0^1 (W_t^\theta)^{-1/\lambda_{w,t}} d\theta \right]^{-\lambda_{w,t}}. \quad (20)$$

This maximization problem results in the following markup equation for the reoptimized wage:

$$\mathrm{E}_t \sum_{i=0}^{\infty} \beta^i \xi_w^i N_{t+i}^\theta \left[ \frac{\widetilde{w}_t}{P_t} \left( \frac{\left(\frac{P_{t-1+i}}{P_{t-1}}\right)^{\gamma_w}}{\frac{P_{t+i}}{P_t}} \frac{U_{t+i}^C}{(1+\tau_{t+i}^c)} \right) - (1+\lambda_{w,t+i}) \frac{U_{t+i}^l}{(1-\tau_{t+i}^n)} \right] = 0 \quad (21)$$

where $U_{t+i}^C$ and $U_{t+i}^l$ are, respectively, the marginal utility of consumption and the marginal disutility of labor.

Following the Calvo model, and given equations (17) and (20), the law of motion of the aggregate wage index is given by:

$$(W_t)^{-1/\lambda_{w,t}} = \xi_w \left[ W_{t-1} \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_w} \right]^{-1/\lambda_{w,t}} + (1-\xi_w)(\widetilde{w}_t)^{-1/\lambda_{w,t}}. \quad (22)$$

**Perfectly competitive labor market**

As seen in section 1, some literature on the short-term effects of fiscal consolidations suggests that under increased labor market efficiency and competitiveness, consolidations may generate a surge in private investment, that can lead to small or even negative fiscal multipliers. Motivated by this evidence, and given the purposes of our analysis, we will conduct our simulations not only under the standard monopolistic competition but also under a perfectly competitive labor market.

Each household chooses the quantity of hours supplied given the market wage, *i.e.* maximizes, with respect to labor supply, the intertemporal objective function (8) subject to the intertemporal budget constraint (9). The first-order condition is the following equation for the real wage:

$$\lambda_t (1-\tau_t^n) w_t = e^{\varepsilon_t^N} e^{\varepsilon_t^b} N_t^{\sigma_N}. \quad (23)$$

Using (10) and rearranging, we obtain

$$(C_t - hC_{t-1})^{-\sigma_c}(1-\tau_t^n)w_t = e^{\varepsilon_t^N} N_t^{\sigma_N}(1+\tau_t^c). \tag{24}$$

## 3.2 Firms

There is a single final good, used for consumption and investment, and a continuum of intermediate goods indexed by $j$, with $j$ distributed over the unit interval $[0,1]$. The final-good sector is perfectly competitive while there is monopolistic competition in the markets for intermediate goods.

### Final-good sector

The final good is assumed to be produced using the intermediate goods with the following constant returns technology:

$$Y_t = \left[\int_0^1 (y_t^j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}} \tag{25}$$

where $y_t^j$ denotes quantity of intermediate good of type $j$ at date t and $\varepsilon$ is the constant elasticity of substitution.

At each period, the competitive final good producer maximizes its profit:

$$\text{MAX} \left[P_t Y_t - \int_0^1 p_t^j y_t^j dj\right] \tag{26}$$

where $P_t$ is the overall price index of the final good and $p_t^j$ are the prices of the intermediate inputs. From (25) and (26), the demand for each intermediate input and the price index can be shown to be:

$$y_t^j = \left(\frac{p_t^j}{P_t}\right)^{-\varepsilon} Y_t; \tag{27}$$

$$P_t = \left[\int_0^1 (p_t^j)^{1-\varepsilon} dj\right]^{\frac{1}{1-\varepsilon}}. \tag{28}$$

### Intermediate goods sector

Each intermediate good $j$ is produced by a firm $j$ with the following technology:

$$y_t^j = e^{\varepsilon_t^a} K_{j,t}^{\alpha} \left(N_{j,t}^p\right)^{(1-\alpha)} \left(G_t^{lp}\right)^{\gamma} \left(G_t^{hp}\right)^{\eta} \left(N_t^g\right)^{\nu}. \tag{29}$$

The production function (29) features constant returns to scale with respect to private inputs.[7] It differs from the standard production function in that public spending has three components, $G^{lp}$, $G^{hp}$ and $N^g$, respectively, low productivity (or unproductive) spending, high productivity spending and public employment. The three types of public expenditures are incorporated in the production function as a part of the technologic constraint that enhances the productivity of private factors. We assume that these public inputs are freely made available by the government at the beginning of each period.

The output elasticities of each of the components of public spending, $\gamma$, $\eta$ and $\nu$, determine the interaction between public and private inputs in production. Depending on their value, an increase in government spending or employment has large, small or null effects on output.

$\varepsilon_t^a$ is a productivity shock, assumed to follow a first-order autoregressive process with an i.i.d.-normal error term,

$$\varepsilon_t^a = \rho_a \varepsilon_{t-1}^a + \eta_t^a. \tag{30}$$

Labor demand by private firms is derived from the firms' cost minimization for a given installed capital stock and a given stock of public inputs:

$$\frac{w_t N_{j,t}^p}{r_t^k K_{j,t}} = \frac{1-\alpha}{\alpha} \Longleftrightarrow N_{j,t}^p = \frac{(1-\alpha)\, r_t^k K_{j,t}}{\alpha w_t}. \tag{31}$$

which implies that the capital-labor ratio will be identical across all intermediate good producers and equal to the aggregate capital-labor ratio.

The production function implies that the firms' marginal costs ($MC_t$) are given by,

$$MC_t = \frac{1}{e^{\varepsilon_t^a}} w_t^{(1-\alpha)} r_t^{k\alpha} \left(G_t^{lp}\right)^{-\gamma} \left(G_t^{hp}\right)^{-\eta} \left(N_t^g\right)^{-\nu} \left[\alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}\right]. \tag{32}$$

[7] In the empirical literature there is no clear preference between constant returns to scale in all inputs or only in the two private inputs. Turnovsky and Fisher (1995, p.753) argue that "*(...) our assumption of linear homogeneity in the two private factors views infrastructure as providing economies of scale in production. An alternative assumption discussed by Aschauer (1989) is to assume that the production function is linearly homogeneous in all three factors of production. It turns out that the choice between these two alternative formulations makes little difference, as long as one assumes $F_{KL}>0$ in this alternative specification.*"

which implies that the marginal costs are also independent of the intermediate good produced. Real profits of firm $j$ are then given by:

$$profit_t^j = \left(\frac{p_t^j}{P_t} - MC_t\right) y_t^j = \left(\frac{p_t^j}{P_t} - MC_t\right)\left(\frac{p_t^j}{P_t}\right)^{-\varepsilon} Y_t. \tag{33}$$

**Price setting**

Each firm produces a differentiated intermediate good and prices are set according to the Calvo model, *i.e.*, firms are allowed to optimally adjust their prices each period with a constant probability equal to $1-\xi_p$. In setting the new price, $\widetilde{p}_t^j$, the reoptimizing firms take into account the probability that it will not reoptimize in the near future. Prices that are not reoptimized in a given period are partially indexed to past inflation:

$$p_t^j = \left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma_p} p_{t-1}^j \tag{34}$$

where $\gamma_p$ is the degree of price indexation.

A firm resetting its price in period t will seek to maximize the discounted sum of future real profits, using the relevant stochastic discount factor $\Lambda_{t,t+i}$,

$$\text{MAX}_{\widetilde{p}_t^j}\ \text{E}_t \sum_{i=0}^{\infty} \left\{ \xi_p^i \Lambda_{t,t+i} \left[ \left( \frac{\widetilde{p}_t^j}{P_{t+i}} - MC_{t+i} \right) y_{t+i}^j \right] \right\}. \tag{35}$$

Given (34), profit maximization by the producers that reoptimize their prices at time $t$ results in the following first-order condition:

$$\text{E}_t \sum_{i=0}^{\infty} \left\{ \xi_p^i \Lambda_{t,t+i} y_{t+i}^j \left[ \frac{\widetilde{p}_t^j}{P_t} \left( \frac{\left(\frac{P_{t-1+i}}{P_{t-1}}\right)^{\gamma_p}}{\frac{P_{t+i}}{P_t}} \right) - \mu\ MC_{t+i} \right] \right\} = 0 \tag{36}$$

which shows that prices are set as a function of current and expected real marginal costs, with a markup $\mu$ over these weighted marginal costs. The gross "frictionless" price markup is,

$$\mu = \frac{\varepsilon}{\varepsilon - 1}. \tag{37}$$

Given equations (28) and (34) and the Calvo price-setting, the law of motion of the aggregate price index is given by:

$$P_t^{(1-\varepsilon)} = \xi_p \left[ P_{t-1} \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\gamma_p} \right]^{(1-\varepsilon)} + (1-\xi_p)(\widetilde{p}_t^j)^{(1-\varepsilon)}. \tag{38}$$

## 3.3 Policy and Market Clearing

**Monetary policy**

The monetary authority sets the nominal interest rate according to a Taylor-type rule which includes a reaction to deviations of inflation from the target and inertia in the form of interest rate smoothing:

$$R_t = R_{t-1}^{\rho} \left[ \left( \frac{P_t}{P_{t-1}} \right)^{\Phi_\pi} \right]^{1-\rho} \tag{39}$$

with $\Phi_\pi > 1$, guaranteeing satisfaction of the Taylor principle, which is, in the absence of non-Ricardian consumers, a necessary and sufficient condition to guarantee the uniqueness of equilibrium in this class of models (Galí *et al.* (2007), Bilbiie *et al.* (2008)).

We model monetary policy as a strict inflation targeting, placing a zero coefficient on the output gap, for two main reasons. First, as we intend to isolate possible "purely fiscal" effects of a fiscal consolidation, we purposely assume the simplest possible monetary framework; in fact, including output in the interest rate rule induces lower Keynesian effects because of the interest rate response to the decrease in output. Second, as we are calibrating the model to the Euro Area, our policy rule seems in line with the legal mandate of the European Central Bank (ECB) and is supported by empirical evidence on the preferences of the ECB (Aguiar and Martins (2005)).

**Fiscal policy**

The fiscal authority purchases final goods that are employed in two classes of expenditure with different impact on productivity ($G_t^{lp}$ and $G_t^{hp}$), and hires labor ($N_t^g$). It finances its spending with lump-sum taxes ($T_t$) and distortionary taxes − over consumption ($\tau_t^c$), labor income ($\tau_t^n$) and capital income ($\tau_t^k$). It issues debt ($B_{t+1}$), which consists of one-period nominal discounted bonds, paying 1 unit at the beginning of next period.

The government budget constraint is given by,

$$G_t^{lp} + G_t^{hp} + w_t N_t^g + \frac{B_t}{P_t} = T_t + \frac{B_{t+1}}{P_t} b_t + \tau_t^n w_t N_t + \tau_t^k r_t^k K_t - \delta \tau_t^k K_t + \tau_t^c C_t. \tag{40}$$

where wages ($w_t$) are equal to private sector's wages, as we assume that (i) working hours can be moved costlessly across the two sectors, and (ii) the private and public labor supply are perfect substitutes, as working for private firms or for the government brings households exactly the same marginal disutility.[8]

All government spending variables and all tax rates are assumed to evolve exogenously according to a first order autoregressive process with i.i.d.-normal errors,[9]

$$\widehat{G}_t^{lp} = \varepsilon_t^{g^{lp}} = \rho_{g^{lp}} \varepsilon_{t-1}^{g^{lp}} + \eta_t^{g^{lp}}, \tag{41}$$

$$\widehat{G}_t^{hp} = \varepsilon_t^{g^{hp}} = \rho_{g^{hp}} \varepsilon_{t-1}^{g^{hp}} + \eta_t^{g^{hp}}, \tag{42}$$

$$\widehat{N}_t^g = \varepsilon_t^{N^g} = \rho_{N^g} \varepsilon_{t-1}^{N^g} + \eta_t^{N^g}. \tag{43}$$

$$\widehat{\tau}_t^c = \rho_{\tau^c} \widehat{\tau}_{t-1}^c + \eta_t^{\tau^c}, \tag{44}$$

$$\widehat{\tau}_t^n = \rho_{\tau^n} \widehat{\tau}_{t-1}^n + \eta_t^{\tau^n}, \tag{45}$$

$$\widehat{\tau}_t^k = \rho_{\tau^k} \widehat{\tau}_{t-1}^k + \eta_t^{\tau^k}. \tag{46}$$

Following Bilbiie and Straub (2004) and Galí *et al.* (2007), we assume a fiscal policy rule of the form,

$$\widehat{T}_t = \phi_b \widehat{B}_t + \phi_g \widehat{G}_t \tag{47}$$

where $\phi_b$ and $\phi_g$ are positive constants representing the elasticities of lump-sum taxes with respect to government debt and government spending, respectively. Under

[8] There is evidence indeed of a significant positive correlation between private and public sector wages (Afonso and Gomes (2008), Lamo *et al.* (2008)).

[9] In what follows a variable with a hat denotes its log deviation from its steady-state value, which is denoted by a "$-$" above a variable.

this rule, a necessary and sufficient condition for non-explosive debt dynamics is given by,[10]

$$\beta^{-1}(1-\phi_b) < 1. \tag{48}$$

**Market clearing**

The model is closed with two aggregate constraints. First, labor supply must equate labor employed by the private firms and by the public sector,

$$N_t = N_t^p + N_t^g. \tag{49}$$

Second, aggregate production must equal the demand for goods by the private and public sector,

$$Y_t = C_t + I_t + G_t^{lp} + G_t^{hp}. \tag{50}$$

The capital rental market is in equilibrium when the demand for capital by the intermediate goods producers equals the supply by the households. The capital market equilibrium means that the government debt is held by domestic investors at the market interest rate $R_t$.

## 3.4 Calibration

After its log-linearization around the nonstochastic steady state (the full set of linear rational expectations equations are presented in appendix) the model has thirteen equations and thirteen endogenous variables: consumption, interest rate, inflation, investment, real current value of capital stock, rental rate of capital, capital stock, real wage, labor demand, private labor demand, output, government bonds and lump-sum taxes. The stochastic behavior of the model is driven by fourteen exogenous shocks: four associated to technology and preferences ($\varepsilon^b$, $\varepsilon^I$, $\varepsilon^a$and $\varepsilon^N$ ), three "cost-push" shocks ($\eta^q$, $\eta^p$ and $\eta^w$), a monetary policy shock ($\eta^R$) and six fiscal policy shocks ($\widehat{G}_t^{lp}$,$\widehat{G}_t^{hp}$, $\widehat{N}_t^g$, $\widehat{\tau}_t^c$, $\widehat{\tau}_t^n$ and $\widehat{\tau}_t^k$).

To calibrate the model, we assume that each period corresponds to a quarter, and use, as a rule, the Euro Area estimates of Smets and Wouters (2003).

Table 1 presents the calibration and the source for each parameter. In the text

[10]For more details see Galí *et al.* (2007).

that follows, we focus on the coefficients in which we diverge from Smets and Wouters (2003), namely the steady-state values, and the parameters associated to fiscal policy.

**Table 1 - Calibration**

| Parameter | Value | Source | Parameter | Value | Source |
|---|---|---|---|---|---|
| Discount factor - $\beta$ | 0.99 | standard | Consumption habit - h | 0.7 | SW |
| Inverse elasticity of substitution - $\sigma_c$ | 1.0 | SW | Inverse elasticity of work effort - $\sigma_N$ | 2.0 | SW |
| Investment adjustment costs - $\varphi$ | 4.0 | SW | Depreciation rate - $\delta$ | 0.025 | standard |
| Degre of price indexation - $\gamma_p$ | 0.75 | SW | Calvo's parameter on prices - $\xi_p$ | 0.75 | SW |
| Degre of real wage indexation - $\gamma_w$ | 0.75 | SW | Calvo's parameter on wages - $\xi_w$ | 0.75 | SW |
| Share of capital input - $\alpha$ | 0.3 | standard | Wages markup - $\lambda_w$ | 0.3 | BLP/J |
| Steady-state I/Y - $\gamma_i = \delta\gamma_k$ | 0.2 | ECB data | Steady-state $G^{hp}/Y$ - $\gamma_g^{hp}$ | 0.03 | F/P |
| Steady-state $G^{lp}/Y$ - $\gamma_g^{lp}$ | 0.07 | F/P | Steady-state $(wN^g)/Y$ - $\gamma_{wn}^g$ | 0.1 | F/P |
| Steady-state C/Y - $\gamma_c$ | 0.6 | ECB data | Steady-state (B/P)/Y - $\gamma_b$ | 2.4 | ECB data |
| Degree of interest rate smoothing - $\rho$ | 0.8 | SW | Taylor rule inflation - $\phi_\pi$ | 1.5 | GSV |
| Elasticity of taxes to spending - $\phi_g$ | 0.1 | CS | Elasticity of taxes to debt - $\phi_b$ | 0.1 | CS |
| Capital income tax rate - $\tau^k$ | 0.2 | CMS/C | Consumption tax rate - $\tau^c$ | 0.2 | CMS |
| Labor income tax rate - $\tau^n$ | 0.2 | CMS | Productivity of $G^{hp}$ - $\eta$ | 0.15 | Section 2 |
| Productivity of $G^{lp}$ - $\gamma$ | 0 or 0.05 | Section 2 | Productivity of $N^g$ - $\nu$ | 0.05 or 0.15 | P |
| Steady-state $N^p/N$ - $\vartheta_n^p$ | 0.84 | C/A | Steady-state $N^g/N$ - $\vartheta_n^g$ | 0.16 | C/A |
| AR parameter of fiscal policy shocks | 0.9 | standard | AR parameter of other shocks | 0.85 | standard |

***Notes***: SW – Smets and Wouters (2003); BLP – Bayoumi *et al.* (2004); J – Jonsson (2007); F – Finn (1998); P – Pappa (2009); GSV – Gali *et al.* (2007) ; CS – Coenen and Straub (2005); C – Cavallo (2005); CMS – Coenen *et al.* (2007); A – Ardagna (2007); Section 2 – Literature review of section 2

Smets and Wouters (2003) set the steady-state values of the wage markup ($\lambda_w$) and of the price markup ($\mu$) to 1.5, based on estimates for the United States. We set those at, respectively, 1.3 and 1.35, following Bayoumi *et al.* (2004) and Jonsson (2007), who use estimates for the Euro Area. In what regards the steady-state values of the ratios of private consumption and private investment relative to GDP, we set them equal to, respectively, 0.6 and 0.2, which broadly corresponds to their average value in the Euro Area over the period 1981Q1:2005Q4[11]. Following Cavallo (2005) and Ardagna (2007), we calibrate the steady-state ratios of private and public employment to total employment as, respectively, 0.84 and 0.16. Following Finn (1998) and Pappa (2009), the steady-state ratios of the low productivity government spending, high productivity government spending and public wage bill to output ($\gamma_{g^{lp}}$, $\gamma_{g^{hp}}$ and $\gamma_{wn^g}$) are calibrated as, respectively, 0.07, 0.03 and 0.1. The latter is also in accordance with the statistic of

[11] European Central Bank's Area-wide Model database, update 6 (September 2006), which has been originally published in Fagan *et al.* (2005).

the European Commission for the European Union in 2007 (Afonso and Gomes (2008)).

Regarding fiscal policy, we calibrate the parameters of the policy rule ($\phi_g$ and $\phi_b$) both to 0.1, following Coenen and Straub (2005). The autoregressive parameters of all fiscal policy shocks are set to 0.9. The quarterly value of the ratio of real government debt relative to GDP is set to 2.4, which is in accordance to the Stability and Growth Pact reference of a annual debt ratio of 60%. As to distortionary taxation, we follow the average values for the Euro Area calculated by Coenen *et al.* (2007), setting the steady-state values of the consumption tax rate ($\tau^c$) and the labor income tax rate ($\tau^n$) to 0.2.[12] As for capital income tax rate ($\tau^k$), given the wide range of values in the literature (going from 0 (Coenen *et al.* (2007)) to 40% (Cavallo (2005))), we set its steady-state value to 20%.

The crucial parameters for our paper are those associated to the impact of government spending and employment on overall productivity. For those parameters, we base our calibrations on the empirical evidence reported in section 2. Given the evidence in that section, a value between 0.15 and 0.2 for the output elasticity of the highly-productive components of government spending seems warranted but we choose to be conservative and so calibrate parameter $\eta$ at 0.15. As regards the low productivity spending we calibrate parameter $\gamma$ with two alternative values, 0.05 and 0, which we use subsequently for robustness check. The motivation for the null elasticity is that, at an aggregate level, the productive effects of these inputs may be offset by the absorption of resources by the related unproductive government spending, like the regulatory and bureaucratic processes. Regarding the public employment parameter ($\nu$), following Pappa (2009), we consider two alternative calibrations, 0.15 and 0.05 (Pappa's calibration has a wider range, going from 0 to 0.25). These alternative calibrations are also important to test the model's sensitivity to these central parameters.

# 4 Fiscal Consolidations With Changes in the Budget Composition

In this section we set out to identify changes in the budget composition that achieve a fiscal consolidation with a short term favorable impact on output. Fiscal consolidation

[12] Coenen *et al.* (2007) found, for Euro Area, average values for consumption and labor income tax rates of, respectively, 18.3% and 24%. The labor income tax rate includes social security contributions by employees.

is defined as a gradual and highly persistent fall in the debt to GDP ratio to a level significantly below its initial steady state. The analysis evolves in steps. First, we find which fiscal shocks, among those in our model, do generate a fiscal consolidation; then, we assess their general equilibrium effects; finally, we search for critical conditions for expansionary fiscal consolidations.

## 4.1 Fiscal Consolidations

There is a growing consensus in the literature that the success of a fiscal consolidation depends on the "quality" of fiscal adjustments (von Hagen *et al.* (2002), Guichard *et al.* (2007)). "Good quality" fiscal adjustments are typically defined as those based on government spending cuts rather than on raising taxes; and, among expenditure, particularly those based on the reduction of current expenditures (public consumption and social transfers) and politically sensitive items of the budget, such as public employment and public sector wages.

Cuts in politically sensitive expenditures have a higher probability of successfully consolidating public finances because they signal a stronger commitment to their sustainability. In our model there are no comparable credibility effects, but a structure of several classes of expenditure that have different roles in the production of intermediate goods and income.

Given the above mentioned facts about "good quality" consolidations, we do not assess tax based strategies, but only consolidations based on spending cuts.

Since our model's fiscal policy shocks are modelled with high persistence, as AR processes with a root of 0.9, negative spending shocks may induce a gradual and persistent fall of the public debt ratio, and so impulse response functions may be used to check their potential for fiscal consolidation.

In figure 1 we show the dynamic path of the deviation of the public debt from its initial steady state value ($\widehat{B}_t$) as a result of a unitary shock to government spending, both non-productive and weakly-productive. In figure 2 we show the path of $\widehat{B}_t$ as a response to a unitary shock to both highly and weakly-productive public employment. Both figures include the results under the baseline monopolistically competitive labor market and the alternative perfectly competitive market.

The results are in the line with the literature: (i) cuts in non-productive government spending and weakly-productive public employment generate fiscal consolidations; (ii) cuts in productive public spending generate a rather limited and not sustained response of debt;[13] (iii) cuts in highly-productive public employment also generate a timid response of debt and may even induce a long- term increase in debt.

Figures 1 and 2 highlight an interesting result regarding the labor market: provided that the consolidation is based on cuts in a class of spending with some non-null productivity, the more competitive is the labor market, the larger is the consolidation.

The figures further show that fiscal consolidations take between 40 and 60 quarters to fully develop in the case of the most effective shocks. Hence, in the next subsections we show impulse response functions for such horizon.

## 4.2 Government Spending Shocks

In this subsection we discuss the general equilibrium effects of the fiscal shocks that have been identified in the previous subsection as achieving a fiscal consolidation.

**Non-productive government spending shock ($\gamma = 0$)**

Figure 3 shows the results from a non-productive government spending negative shock. While there is a small increase in private consumption and a marked crowding-in effect on private investment, they are insufficient to offset the direct negative impact of the spending cut on output, and so a moderate fall in output occurs.

The decrease in non-productive government spending generates a wealth effect caused by the decrease in the present value of future taxes, which leads households to increase consumption and leisure, thus reducing labor supply. Given the environment of monopolistic competition and sticky prices, there is also a labor demand effect: in response to the decline of aggregate demand, only a few firms are able to lower prices, and the others lower production and labor demand. The combination of reductions in supply and demand, as well as the real wage stickiness, lead to no visible change in the real wage.

Moreover, there is an intertemporal substitution effect, as the monetary policy reaction to the decrease in inflation causes a fall in the real interest rate, leading households to anticipate consumption. In addition, private investment increases, not only because of the fall in the interest rate but also because there is a decrease in the rental price of capital.

[13] We did not consider a fiscal consolidation entirely based on cuts in the highly-productive government spending for two reasons. On the one hand, it seems economically unsustainable, from a long-term output growth point of view; on the other hand, they would not consolidate the fiscal position in the medium- to long-run.

As expected, these results are generally in line with those obtained for fiscal shocks in models with standard (non-productive) public expenditure (*e.g.*, Smets and Wouters (2003)). Yet, in those models there is a strong crowding-in effect not only on investment but also on consumption. These consumption effects may be explained by differences in the policy framework that involve both transmission mechanisms (wealth and substitution): (i) our model includes a fiscal policy rule that generates a decrease in current lump-sum taxes in response to a lower government spending, which induces a lower wealth effect, and thus a lower increase in private consumption; (ii) our interest rate rule attaches a zero coefficient to the output gap, which reduces the intertemporal substitution effect.

In the case of a perfectly competitive labor market, the response of private consumption would be identical, but the crowding-in effect on investment would be slightly higher and, thus, the overall impact on output would be slightly lower.[14] Under perfect competition, the fall in labor demand resulting from the spending cut increases the probability of unemployment and moderates wage claims by the households in the unified labor market. The resulting fall in marginal costs and increase in firms' profits stimulates investment. This is a result already documented in the theoretical literature on short-term effects of fiscal consolidations (Alesina and Perotti (1995), Alesina and Perotti (1997), Alesina *et al.* (2002), Ardagna (2007).).

**Weakly-productive government spending shock ($\gamma = 0.05$)**

The general equilibrium effects of a weakly-productive government spending shock are quite different (figure 4): although the reaction of private consumption remains muted, investment is crowded-out and, as a result, there is a stronger negative impact on output.

The differences to the case of a shock to non-productive public spending are caused by the negative impact of the government spending cut on the productivity of private factors, which generates a negative wealth effect that offsets the standard positive wealth effect arising from the fall in the present value of taxes. The combination of labor demand and capital demand reductions is associated to some fall in the real wage and a marked fall in the real rental price of capital.

In the alternative labor market scenario (perfect competition, figures not reported), there would be a smaller negative impact on investment and, hence, a lower contraction

[14] Results not shown, for the sake of space conservation and given their similarity with figure 3, but available on request.

of output. Again, the explanation lies on the higher decline of the (now flexible) real wage, which induces a fall in firms' marginal costs and, hence, an increase in profits, generating an upward pressure on investment that partially compensates the dominant fall in capital demand.

Overall, in this subsection, we show that a fiscal consolidation based on cutting productive public spending leads to a twice as large output contraction, compared to a consolidation based on non-productive spending. The difference arrises from a contraction in private investment, due to the dominance of productivity effects over the other indirect general equilibrium effects, as well as to the smaller dimension of the wealth effect coming from a weaker consolidation.

## 4.3 Switching Government Spending Productivity

It is well known that, in an environment of limited public resources and binding fiscal constraints, fiscal policy makers may redirect spending towards more productive activities. In this subsection we simulate fiscal consolidations with a switching from non- or weakly-productive to highly-productive public spending. Such simulations captures realistic features of fiscal consolidations in the real world, as policy makers try to minimize the social costs of consolidations and to strengthen their probability of success promoting long-term economic growth.

Our aim throughout these simulations is to uncover thresholds for combinations of shocks that may, in our model, generate expansionary effects driven by private investment and yet achieve a fiscal consolidation.

Firstly we have performed four different experiments of switching from low productivity spending to high productivity spending, in which the decrease in the low productivity spending equals the increase in the high productivity spending, *i.e.* $\widehat{G}_t^{hp} = -\widehat{G}_t^{lp}$. In the first two simulations we cut non-productive spending, while in the third and fourth we replace weakly-productive spending by highly-productive spending (for all, both a monopolistically and a perfectly competitive labor market are analyzed). In summary: (i) $\gamma = 0$ with monopolistic competition in labor market (figure 5); (ii) $\gamma = 0$ within a perfectly competitive labor market (figure 6); (iii) $\gamma = 0.05$ with monopolistic competition in labor market (figure 7); and, (iv) $\gamma = 0.05$ within a perfectly competitive labor market (figure 8).

Overall, replacing less productive with more productive public spending reconciles a fiscal consolidation with positive short-term effects on output that are driven by a strong increase in private investment. Note that in these simulations so far, there is no overall reduction of public expenditures, and the fiscal deficit improves simply because of the increase in taxes generated by higher output.

We have further analyzed whether short-term expansionary effects could arise if the increase in the highly-productive government spending was smaller than the decrease in the weakly-productive spending. Such combinations would improve the budget balance more rapidly and thus enhance the fiscal consolidation credibility. In particular, we searched for the threshold for the percentage of the low productivity spending cut that needs to be compensated by an high productivity spending increase in order to generate a consolidation with expansionary effects. Four experiments have been made, and their results are summarized in table 2 below.

**Table 2 - Thresholds for spending switching**

| | | Switching from: | |
|---|---|---|---|
| | | **non-productive spending** | **weakly-productive spending** |
| **highly-productive spending threshold** | **perfect competition** | 0.40 | 0.70 |
| | **monopolistic competition** | 0.35 | 0.65 |

The results show that, with our model and calibration, short-term expansionary effects appear if the highly-productive spending is increased by about 40% of the reduction in the non-productive spending and 70% of the reduction in the weakly-productive spending. Hence, if the government reduces the non-productive (weakly-productive) spending by 10% of its steady-state level, it should increase the highly-productive spending by about 4% (7%) of its steady-state level. These values are rather similar in the two analyzed scenarios (perfectly competitive and monopolistically competitive labor market).[15]

## 4.4 Public Employment Shocks

In this subsection, we simulate fiscal consolidations based on negative shocks to public employment (a reduction in the number of public employees and/or in public wages). Given the results in subsection 4.1, we focus on the case of a consolidation via a reduction of the weakly-productive public employment. Differently from the previous subsection, we do not change the composition of the fiscal budget, as we want to high-

[15]The thresholds presented allow for visible short-term expansionary effects. Some inferior values may also allow for medium-term expnsionary effects, but with a negative short-run impact on output.

light the effect of the labor market structure on the short-term output effects of the consolidation.

A negative shock to weakly-productive public employment achieves a consolidation with a short run fall in output, as expected, if the labor market has a monopolistically competitive structure. The results are, thus, qualitatively similar to those obtained with a pure cut in weakly-productive government spending (figure 9 *vs* figure 4). The reduction in public employment generates two contradictory wealth effects: on the one hand, the decrease in public spending increases wealth by decreasing the present expected value of the tax burden; on the other hand, the direct negative impact on private factors productivity induces a negative wealth effect. Since the latter is stronger, there is a contractionary effect on output, induced by a significant decrease of investment.

In contrast, if the labor market was perfectly competitive, a consolidation based on a persistent cut in weakly-productive public employment would have short-term expansionary effects, driven by a crowding-in of investment (figure 10).

This can be explained essentially by two reasons. First, the reduction in public employment leads to a decline in real wages that is much stronger under perfect competition (more than 3 times, on impact, than under monopolistic competition) and works via two mechanisms: (i) the fall in private factors productivity generates a decrease in labor demand and, hence, in wages; (ii) lower public employment induces a lower reservation utility for private sector workers and, hence, a lower pressure on wage bargaining. Lower real wages means lower marginal costs, higher profits and, hence, higher investment. Second, the fiscal consolidation is stronger than it would be under monopolistic competition (figure 2), which generates a larger positive effect on wealth, and thus an upward pressure on private investment.

Overall, the results in this subsection highlight the advantages of combining fiscal policy consolidations based on public employment cuts with structural reforms in the labor market.

# 5 Concluding Remarks

This paper has used a new-Keynesian general equilibrium model, with an extended fiscal policy block, calibrated for the Euro Area, to assess the conditions under which fiscal consolidations with changes in the budget composition yield expansionary short-term investment and output effects.

The paper has been motivated by the lack of consensus on the size of the fiscal multiplier and on the macroeconomic effects of fiscal consolidations, as well as by the growing hypothesis that the success and the short-term effects of a fiscal consolidation depend on the budget composition.

The paper brings together two strands of literature. On the one hand, empirical and theoretical studies considering a direct association between several items of public expenditure and total aggregate productivity; in particular, estimating different output elasticities for different components of public expenditure. On the other hand, the state of the art sticky price new Keynesian dynamic stochastic general equilibrium models, that are currently the preferred framework for policy analysis but have been tailored for monetary rather than fiscal analysis.

Our model incorporates into the standard new-Keynesian DSGE model several classes of taxes and public expenditure, both government spending and public employment expenditures, allowing such variables to have a direct relation with total private factor productivity in the intermediate goods sector. We split public spending into highly-productive and weakly- or non-productive spending, and also allow public employment to have a strong and a weak productivity effect. The production elasticity of each class of public spending and employment have been calibrated according to the evidence in the literature.

The analysis has been developed in successive steps, each conducted, as a rule, for models with monopolistic and, alternatively, perfect competition in the labor market.

First, we assessed the ability of cuts in each class of public spending and employment to generate fiscal consolidations – *i.e.* sizeable and sustained deviations from the debt-ratio from its starting level.

Second, we studied the general equilibrium effects of fiscal consolidations based on the reduction of weakly-productive and non-productive spending, as well as based on changing the composition of the fiscal deficit in detriment of public spending with low productivity and in favor of spending with high productivity.

Third, we studied the general equilibrium effects of fiscal consolidations based on the reduction of weakly-productive public employment.

Our main conclusions may be summarized as follows.

The success of fiscal consolidations obtained via public spending reductions or employment costs reduction decreases with their productivity.

As long as consolidation involves the contraction of expenditures with some productivity, its success increases with the degree of competition in the labor market.

Consolidations through pure contractions of weakly-productive or non-productive public spending, generate short-run contractions of output. However, in the former investment crowds-out and output falls twice as much as does in the latter. Cuts in weakly-productive spending generate a negative wealth effect due to the reduction of overall productivity that surpass the standard wealth effect associated to the fall in future taxes (which is, by itself, smaller as the consolidation is weaker).

Consolidations with a structural change in the fiscal budget in favor of more productive spending – a cut in weakly- (or non-) productive spending together with a symmetric increase in highly-productive spending – have expansionary effects. The spending switch generates the standard wealth effect associated to expected future taxes as well as a direct increase in productivity, which both stimulate investment and output. The short-term expansionary effects are larger when the labor market features monopolistic competition, because the increase in labor demand due to the rise in productivity leads to a smaller rise in the real wage than in a perfectly competitive market, and thus to a larger net increase in profits and investment. A grid search has allowed the detection of thresholds for the spending switch: fiscal consolidation with short-term expansionary effects exist as long as highly-productive spending increases by 70 percent of the reduction in the weakly-productive spending (or 40 percent of the cut in non-productive spending).

Consolidations through a reduction in weakly-productive public employment generate short-term expansionary effects on investment and output, if there is perfect competition in the labor market. The expansion of investment occurs because in a perfect competition labor market, the fall in the demand for labor by the government decreases real wages throughout the market, reducing marginal costs, increasing profits and consequently private investment. Additionally, the consolidation develops quicker and the wealth effect further stimulates investment.

The results in this paper provide useful benchmarks for strategies of fiscal consolidation that reconcile fiscal discipline with short-term output expansion. They are particularly informative about the need to a "flight for quality" in what regards public spending and the need of combining public employment cuts with labor market reforms. At a methodological level, the paper establishes a model that may be used in further analyses of transmission mechanisms for alternative consolidation strategies. We intend to pursue such analyses in future work.

# Figures

FIGURE 1 - Impact of government spending cut on debt

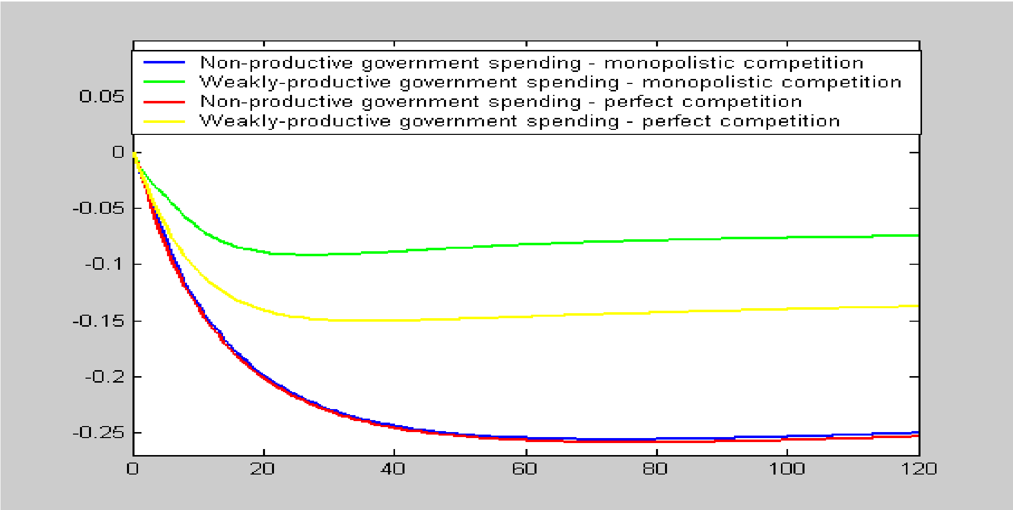



FIGURE 2 - Impact of public employment reduction on debt

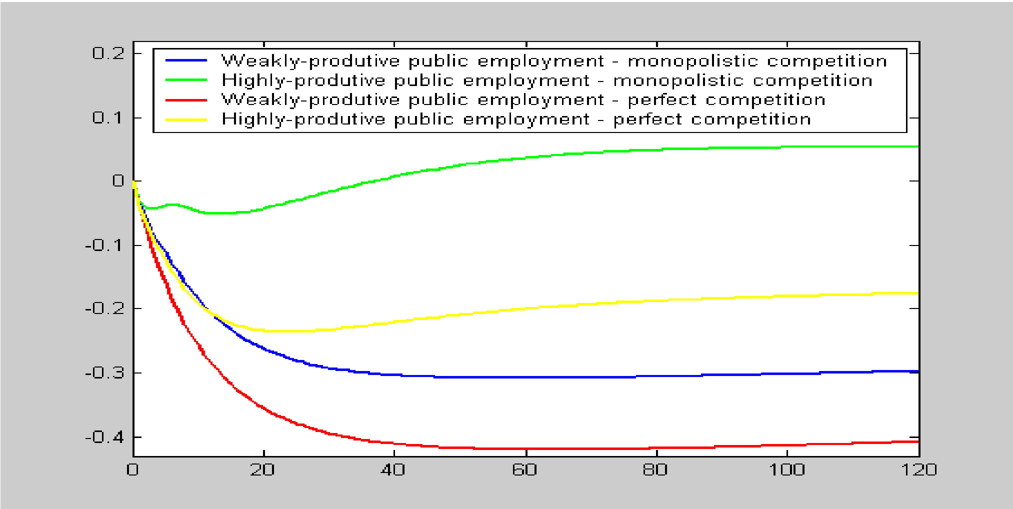


**FIGURE 3 - Non-productive government spending**

(monopolistic competition in labor market)

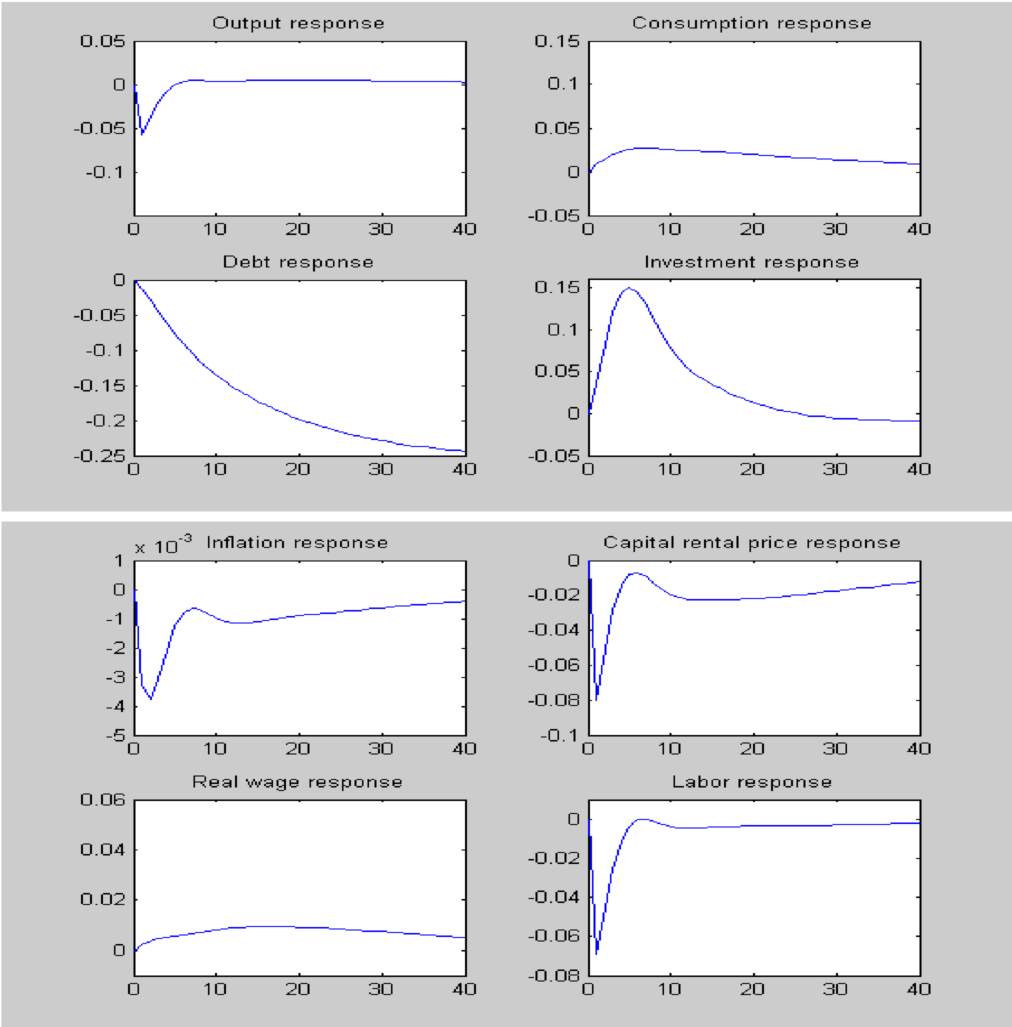


**FIGURE 4 - Weakly-productive government spending**

(monopolistic competition in labor market)

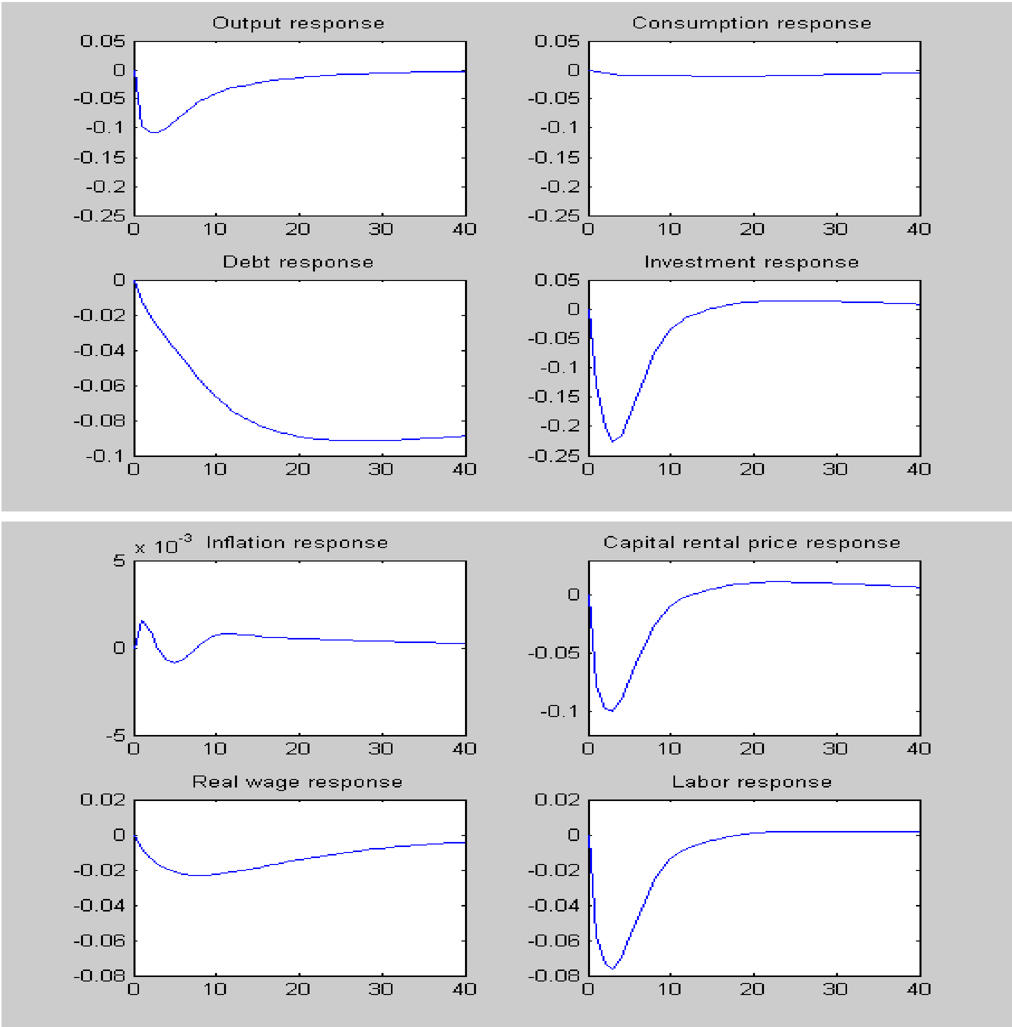


**FIGURE 5 -** Switching from non-productive to highly-productive spending (monopolistic competition in labor market)

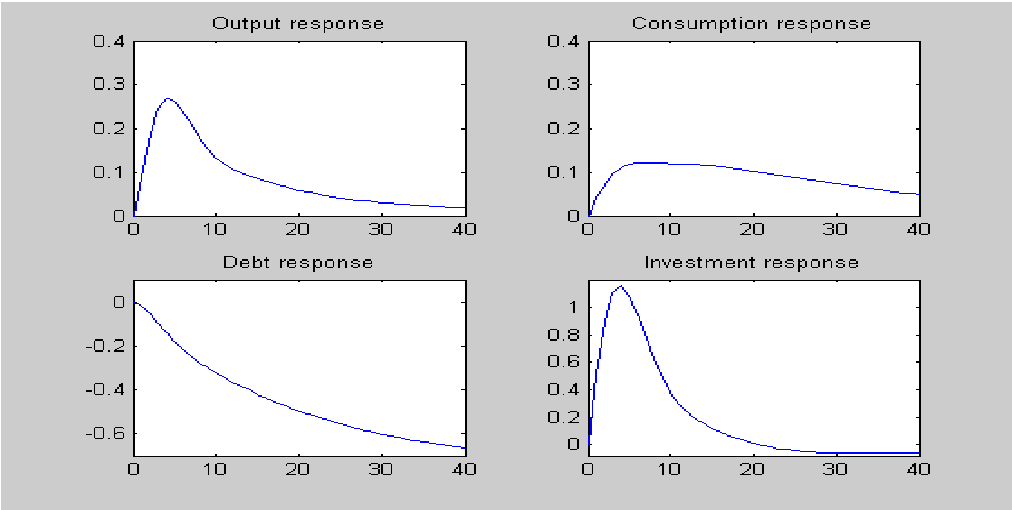



**FIGURE 6 -** Switching from non-productive to highly-productive spending (perfectly competitive labor market)

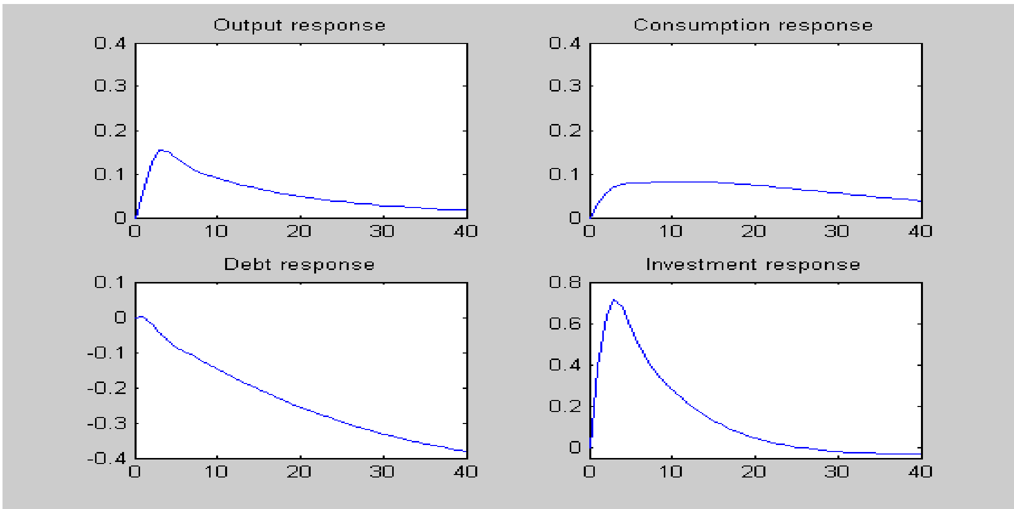


**FIGURE 7 -** Switching from weakly-productive to highly-productive spending (monopolistic competition in labor market)

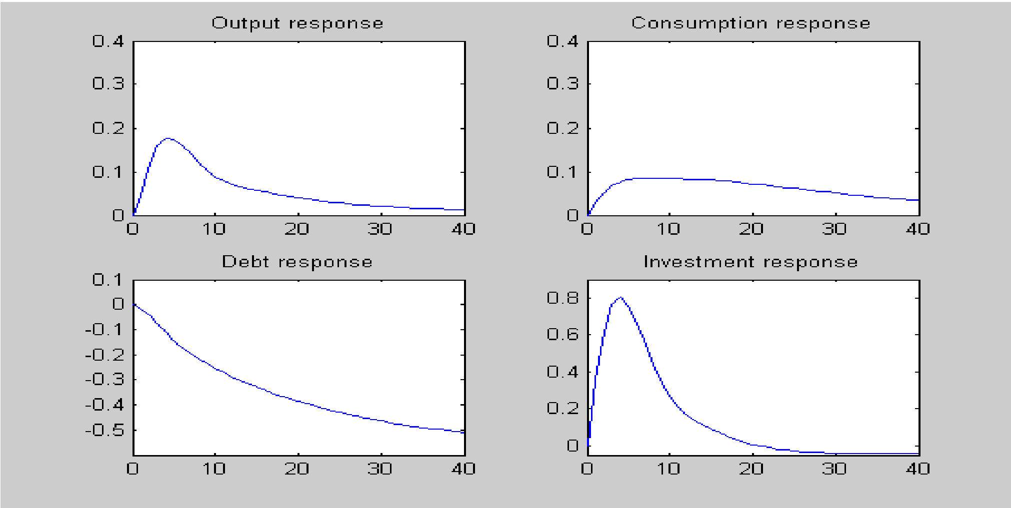



**FIGURE 8 -** Switching from weakly-productive to highly-productive spending (perfectly competitive labor market)

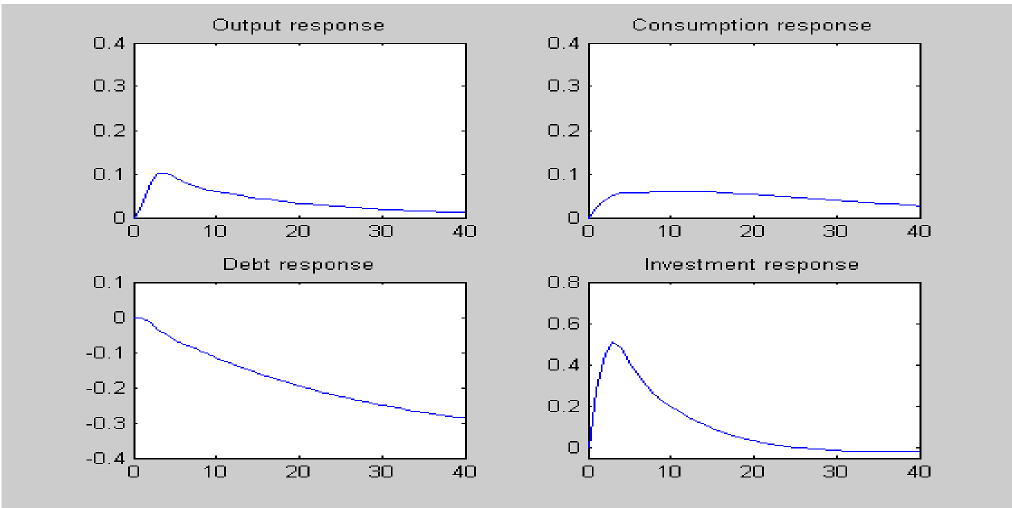


**FIGURE 9 - Weakly-productive public employment**

(monopolistic competition in labor market)

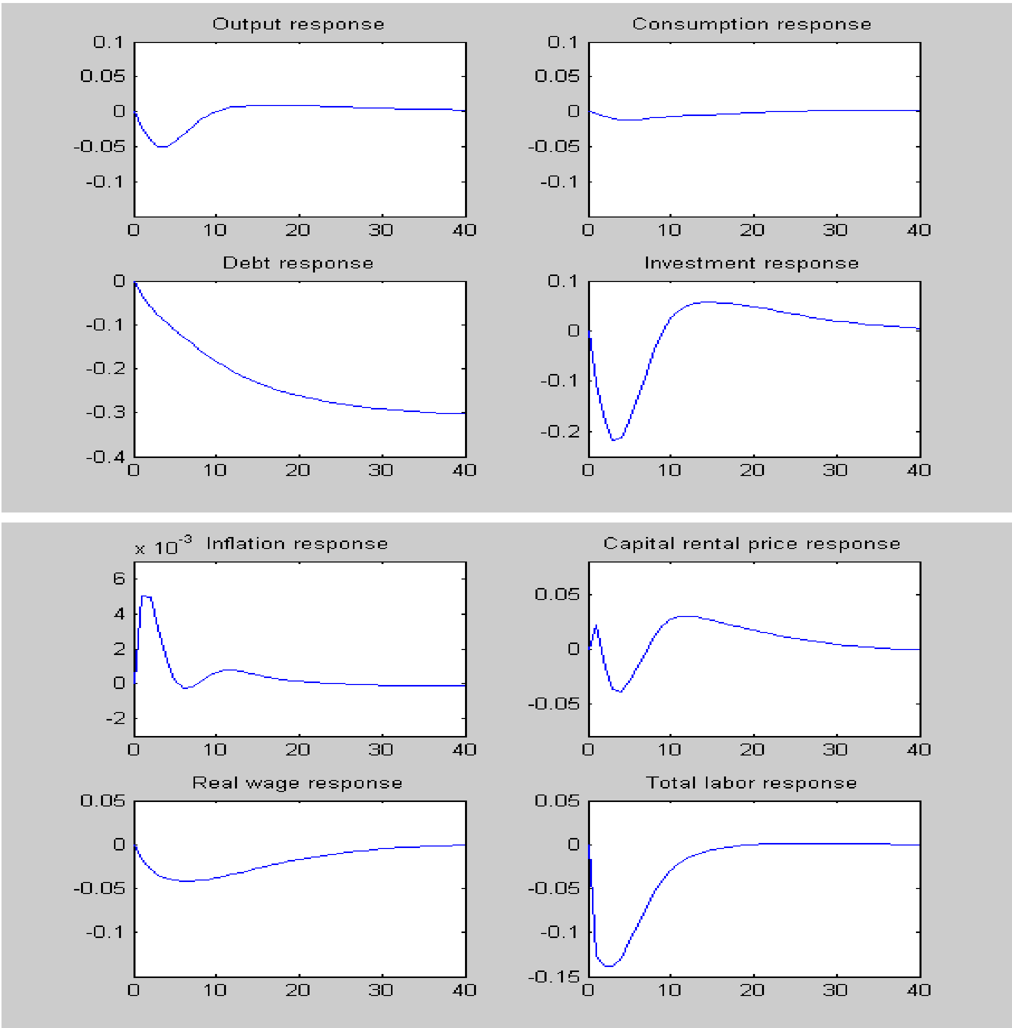
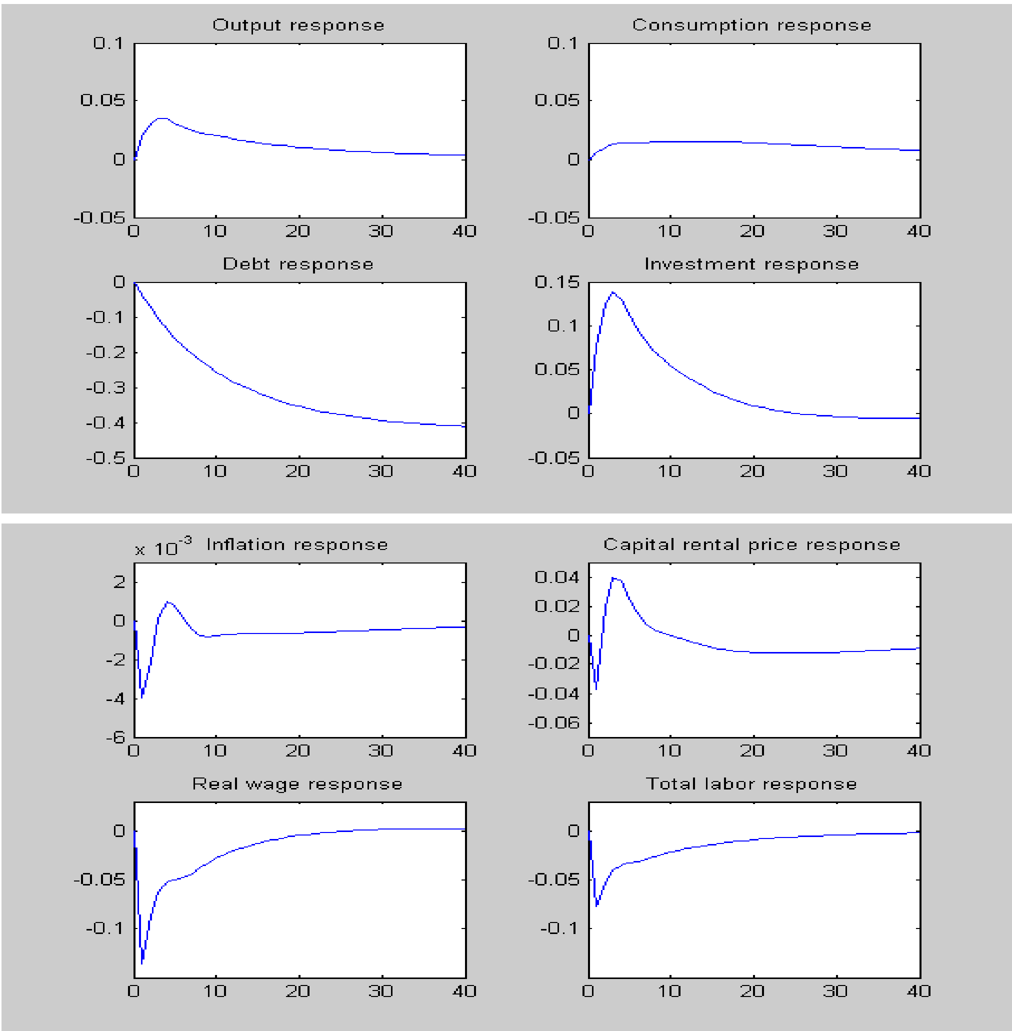


**FIGURE 10 - Weakly-productive public employment**

(perfectly competitive labor market)



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# Appendix

## The Linearized Model

In this appendix we present the model's linear rational expectations equations. In what follows a variable with a hat denotes its log deviation from steady-state.

### Consumption equation

The consumption equation results from the linearization of equation (12):

$$\begin{aligned}\widehat{C}_t &= \frac{1}{1+h}\mathrm{E}_t\widehat{C}_{t+1} + \frac{h}{1+h}\widehat{C}_{t-1} - \frac{1-h}{\sigma_c(1+h)}\left(\widehat{R}_t - \mathrm{E}_t\widehat{\pi}_{t+1}\right) \\ &\quad - \frac{(1-h)\overline{\tau}^c(1-\rho_{\tau^c})}{\sigma_c(1+h)(1+\overline{\tau}^c)}\widehat{\tau}_t^c + \frac{(1-h)(1-\rho_b)}{\sigma_c(1+h)}\varepsilon_t^b. \end{aligned} \quad (51)$$

Thus, current consumption depends (i) positively on a weighted average of past and expected future consumption, with the corresponding elasticity depending on the habit persistence parameter ($h$); and (ii) negatively on the ex-ante real interest rate, with the interest rate elasticity of consumption depending on the habit persistence parameter and on the inverse of the intertemporal elasticity of substitution ($\sigma_c$). Preferences shocks have also a positive impact on current consumption and, as expected, the consumption tax shock has a negative impact.

### Investment equation

The investment equation results from the linearization of equation (16):

$$\widehat{I}_t = \frac{1}{1+\beta}\widehat{I}_{t-1} + \frac{\beta}{1+\beta}\mathrm{E}_t\widehat{I}_{t+1} + \frac{\varphi}{(1+\beta)}\widehat{q}_t - \frac{(1-\beta\rho_I)}{1+\beta}\varepsilon_t^I \quad (52)$$

where $\varphi = 1/S''(\bar{\cdot})$.

Thus, current investment depends positively (i) on past and expected future investment, with elasticities that depend on the rate of time preference $\beta$, and (ii) on the value of installed capital, with an elasticity that is a function of $\beta$ and $\varphi$, a parameter summarizing the investment adjustment costs. A positive shock to the adjustment cost function temporarily reduces investment.

### Value of capital stock equation

The equation for the value of capital stock results from the linearization of equation (15):

$$\begin{aligned}\widehat{q}_t &= \beta(1-\delta)\mathrm{E}_t\widehat{q}_{t+1} - \left(\widehat{R}_t - \mathrm{E}_t\widehat{\pi}_{t+1}\right) + \beta(1-\overline{\tau}^k)\overline{r}^k\mathrm{E}_t\widehat{r}^k_{t+1} \\ &\quad +\rho_{\tau^k}(\delta-\beta\overline{r}^k)\overline{\tau}^k\widehat{\tau}^k_t + \eta^q_t. \qquad (53)\end{aligned}$$

It is easy to see that, around the steady-state,

$$\overline{r}^k = \frac{\frac{1}{\beta} - \delta\overline{\tau}^k + \delta - 1}{1-\overline{\tau}^k}. \qquad (54)$$

Thus, the current value of the capital stock depends positively on its expected future value and on the expected rental rate, and negatively on the ex-ante real interest rate. As expected, it depends negatively on the capital income tax rate as $(\delta - \beta\overline{r}^k)$ is always negative.[16] In equation (53) we have considered an equity premium shock ($\eta^q_t$) that affects positively the value of installed capital, which is meant to capture changes in the cost of capital that may be due to stochastic variations in the external finance premium, and is assumed to follow an i.i.d.-normal process.

### Capital accumulation equation

The capital accumulation equation results from the linearization of equation (13):

$$\widehat{K}_t = (1-\delta)\widehat{K}_{t-1} + \frac{\overline{I}}{\overline{K}}\widehat{I}_{t-1} \Leftrightarrow \widehat{K}_t = (1-\delta)\widehat{K}_{t-1} + \delta\widehat{I}_{t-1}. \qquad (55)$$

### Inflation equation

The inflation equation derives from the linearization and aggregation of equations (36) and (38):

$$\begin{aligned}\widehat{\pi}_t &= \frac{\gamma_p}{1+\beta\gamma_p}\widehat{\pi}_{t-1} + \frac{\beta}{1+\beta\gamma_p}\mathrm{E}_t\widehat{\pi}_{t+1} + \frac{(1-\beta\xi_p)(1-\xi_p)}{\left(1+\beta\gamma_p\right)\xi_p} \times \\ &\quad \times \left[(1-\alpha)\widehat{w}_t + \alpha\widehat{r}^k_t - \gamma\widehat{G}^{lp}_t - \eta\widehat{G}^{hp}_t - \nu\widehat{N}^g_t - \varepsilon^a_t\right] + \eta^p_t, \qquad (56)\end{aligned}$$

[16]It can be easily shown that, $(\delta - \beta\overline{r}^k) = \frac{(1-\beta)\left[\delta\left(1-\overline{\tau}^k\right)-1\right]}{1-\overline{\tau}^k} < 0$.

Current inflation depends positively on past and expected future inflation and on current real marginal costs, which are a positive function of real wages and the rental cost of capital. The elasticity with respect to changes in past inflation is essentially dependent on the degree of price indexation ($\gamma_p$) while the elasticity with respect to changes in marginal costs depends crucially on the degree of price stickiness ($\xi_p$). The productivity process ($\varepsilon_t^a$) impacts negatively on inflation, as do the government spending processes ($\widehat{G}_t^{lp}$, $\eta\widehat{G}_t^{hp}$, $\widehat{N}_t^g$) which enhance the productivity of private factors. Following Smets and Wouters (2003), we have introduced a "cost push" shock ($\eta_t^p$) into the inflation equation (56), which affects positively the price markup, and thus inflation. This shock is assumed to follow an i.i.d.-normal process.

**Real wage equation**

The real wage equation derives from the linearization and aggregation of equations (21) and (22):

$$\begin{aligned}\widehat{w}_t &= \frac{\beta}{1+\beta}\mathrm{E}_t\widehat{w}_{t+1} + \frac{1}{1+\beta}\widehat{w}_{t-1} + \frac{\beta}{1+\beta}\mathrm{E}_t\widehat{\pi}_{t+1} - \frac{1+\beta\gamma_w}{1+\beta}\widehat{\pi}_t \\ &\quad + \frac{\gamma_w}{1+\beta}\widehat{\pi}_{t-1} - \frac{(1-\beta\xi_w)(1-\xi_w)}{(1+\beta)\,\xi_w\left(1+\frac{(1+\lambda_w)\sigma_N}{\lambda_w}\right)} \times \\ &\quad \times \left[\widehat{w}_t - \sigma_N\widehat{N}_t - \frac{\sigma_c}{1-h}(\widehat{C}_t - h\widehat{C}_{t-1}) - \frac{\overline{\tau}^c}{1+\overline{\tau}^c}\widehat{\tau}_t^c - \frac{\overline{\tau}^n}{1-\overline{\tau}^n}\widehat{\tau}_t^n - \widehat{\varepsilon}_t^N\right] + \eta_t^w.\end{aligned} \tag{57}$$

The real wage is (i) positively related to past and future expected real wage, past and future expected inflation, labor demand, current consumption and tax rates; and (ii) negatively related to current inflation and past consumption. The elasticities of the real wage with respect to inflation are dependent on the degree of indexation of the non-optimized wages ($\gamma_w$). In turn, the elasticities with respect to labor demand and consumption are intrinsically related to the degree of wage stickiness ($\xi_w$). There is also a positive effect on the current real wage from a labor supply preference shock ($\widehat{\varepsilon}_t^N$), and a shock to the wage markup ($\eta_t^w$), which is assumed to follow an i.i.d.-normal process.

**Real wage equation under a perfectly competitive labor market**

Under perfect competition, the real wage equation is derived from the linearization of equation (24):

$$\widehat{w}_t = \sigma_N \widehat{N}_t + \frac{\sigma_c}{1-h}(\widehat{C}_t - h\widehat{C}_{t-1}) + \frac{\overline{\tau}^c}{1+\overline{\tau}^c}\widehat{\tau}_t^c + \frac{\overline{\tau}^n}{1-\overline{\tau}^n}\widehat{\tau}_t^n + \varepsilon_t^N. \tag{58}$$

The real wage is (i) positively related to the quantity of labor, current consumption and tax rates (consumption and labor income); and (ii) negatively related to past consumption. There is also a positive effect on the current real wage from a labor supply preference shock ($\widehat{\varepsilon}_t^N$).

**Labor demand function**

The labor demand function results from the linearization of equation (31):

$$\widehat{N}_t^p = -\widehat{w}_t + \widehat{r}_t^k + \widehat{K}_t, \tag{59}$$

Labor demand depends negatively on the real wage, with a unit elasticity, and positively on the real rental price of capital and on the capital stock.

**Production function**

The production function is obtained from the linearization of equation (29):

$$\widehat{Y}_t = \varepsilon_t^a + \alpha\widehat{K}_t + (1-\alpha)\widehat{N}_t^p + \gamma\widehat{G}_t^{lp} + \eta\widehat{G}_t^{hp} + \nu\widehat{N}_t^g, \tag{60}$$

**Monetary policy rule**

Linearization of the simple interest rate rule expressed by equation (39), yields:

$$\widehat{R}_t = \rho\widehat{R}_{t-1} + (1-\rho)\phi_\pi\widehat{\pi}_t + \eta_t^R. \tag{61}$$

The interest rate reacts to current inflation but exhibits persistence, with a degree of smoothing $\rho$. It is also assumed that there is a monetary policy shock which is a temporary i.i.d. normal interest rate shock ($\eta_t^R$).

**Government budget constraint and fiscal policy rule**

Linearization of the government budget constraint (equation (40)) around a steady-state yields:

$$\widehat{B}_t = \frac{1}{\beta}\widehat{B}_{t-1} + \frac{1}{\beta}\frac{\gamma_{g^{lp}}}{\gamma_b}\widehat{G}_t^{lp} + \frac{1}{\beta}\frac{\gamma_{g^{hp}}}{\gamma_b}\widehat{G}_t^{hp} - \frac{1}{\beta}\frac{\gamma_t}{\gamma_b}\widehat{T}_t + \widehat{R}_t - \frac{1}{\beta}\frac{\gamma_{wn}\overline{\tau}^n}{\gamma_b}(\widehat{\tau}_t^n + \widehat{N}_t) - $$
$$-\frac{1}{\beta}\frac{\gamma_k\overline{\tau}^k\overline{r}^k}{\gamma_b}\widehat{r}_t^k + \frac{1}{\beta}\frac{\gamma_k\overline{\tau}^k(\delta - \overline{r}^k)}{\gamma_b}(\widehat{\tau}_t^k + \widehat{K}_t) - \frac{1}{\beta}\frac{\gamma_c\overline{\tau}^c}{\gamma_b}(\widehat{\tau}_t^c + \widehat{C}_t) +$$
$$+\frac{1}{\beta}\frac{\gamma_{wn^g}}{\gamma_b}\widehat{N}_t^g + \frac{1}{\beta}\frac{(\gamma_{wn^g} - \gamma_{wn}\overline{\tau}^n)}{\gamma_b}\widehat{w}_t, \tag{62}$$

where, $\gamma_{g^{lp}} = \frac{\overline{G^{lp}}}{\overline{Y}}$, $\gamma_{g^{hp}} = \frac{\overline{G^{hp}}}{\overline{Y}}$, $\gamma_t = \frac{\overline{T}}{\overline{Y}}$, $\gamma_b = \frac{\frac{\overline{B}}{\overline{P}}}{\overline{Y}}$ , $\gamma_{wn} = \frac{\overline{wN}}{\overline{Y}}$, $\gamma_k = \frac{\overline{K}}{\overline{Y}}$, $\gamma_c = \frac{\overline{C}}{\overline{Y}}$ and $\gamma_{wn^g} = \frac{\overline{wN^g}}{\overline{Y}}$.

As expected, debt depends positively on government spending and on the debt service (past debt and real interest rate), and negatively on taxes.

The fiscal policy rule is,

$$\widehat{T}_t = \phi_b\widehat{B}_t + \phi_g\widehat{G}_t. \tag{63}$$

**Market clearing conditions**

The goods market equilibrium condition results from the linearization of equation (50):

$$\widehat{Y}_t = \gamma_c\widehat{C}_t + \delta\gamma_k\widehat{I}_t + \gamma_{g^{lp}}\widehat{G}_t^{lp} + \gamma_{g^{hp}}\widehat{G}_t^{hp}, \tag{64}$$

Finally, from the linearization of equation (49), we get:

$$\widehat{N}_t = \vartheta_{n^p}\widehat{N}_t^p + \vartheta_{n^g}\widehat{N}_t^g \tag{65}$$

where, $\vartheta_{n^p} = \frac{\overline{N^p}}{\overline{N}}$ and $\vartheta_{n^g} = \frac{\overline{N^g}}{\overline{N}}$, are the steady-state ratios of private and public employment to total employment.