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**Article**

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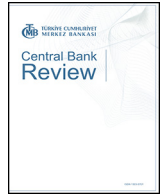
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# Fiscal policy effectiveness and the golden rule of public finance

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## ABSTRACT

The present paper uses a dynamic stochastic general equilibrium (DSGE) framework with imperfect competition and nominal rigidities in order to analyze the impact of two different fiscal rules on the effectiveness of fiscal policy. The first rule is called the golden rule of public finance which allows an upward shift in the share of public investment in total public spending but restricts the use of public debt for investment purposes alone. The second rule does not alter the allocation of public spending among investment and consumption but allows public consumption to be financed by public debt. The numerical results show that a fiscal expansion under the golden rule leads to a higher increase in output while maintaining a low level of public debt compared to the second rule. Moreover, the difference between the output responses under the two fiscal rules increase in the medium run implying that the benefits of a golden rule-based fiscal policy are higher especially in the medium run.

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## 1. Introduction

Between 1974 and 2015, the share of public investment in GDP decreased on average in OECD countries from 4.2% to 3.2%, with wide disparities between the countries.<sup>1</sup> In addition to this downward trend, short run fluctuations around the long run trend are also observed.<sup>2</sup> There are several possible explanations for this evolution, such as privatization policies, the emergence of new financing options in the form of public-private partnerships or fiscal discipline efforts in order to reduce budget deficits. Based on the European data between 1970 and 2003, Mehrotra and Vãlilã (2006) show empirically that the variations of the public investment-to-GDP ratio are mainly due to the efforts of fiscal consolidation in order to ensure public debt sustainability, suggesting that public investment serves as an adjustment variable. The use of public investment as an adjustment variable is justified according to Truger (2015) by the fact that a fall in public investment implies a lower political cost compared to a fall in government consumption or transfer payments. In order to avoid the

public investment fluctuations and their possible negative effects on output, several economists advocate for a fiscal discipline in the form of a golden rule of public finance. This golden rule consists of following a balanced budget and allows governments to resort to public debt only to finance public investment expenditures. This rule helps stimulate economic growth through an increase in public capital while avoiding a drift in public finance. It also allows for a more fair intergenerational distribution of the public debt burden.

Most of the analysis on the effectiveness of a fiscal policy based on the golden rule is carried out in an endogenous growth setup in order to assess and compare the long run effectiveness of the golden rule and alternative fiscal discipline rules. According to Groneck (2011), fiscal policy based on a golden rule leads to a higher growth rate compared to a fiscal policy that resorts to public debt for financing unproductive public consumption. Greiner and Semmler (2000) and Agénor and Yilmaz (2011) show that whether a fiscal expansion under a golden rule yields a higher growth performance compared to alternative rules depends on the composition of the debt-financed public spending. In contrast, Minéa and Villieu (2009) argue that the growth performance of a balanced-budget fiscal policy is higher than that of a fiscal expansion under the golden rule. While focusing on the long run effects of a fiscal policy based on the golden rule, the growth models provide some elements of short and medium run effects through transition dynamics. Although the dynamic stochastic general equilibrium (DSGE) framework is more appropriate for a short run analysis, the debate on the golden rule seems to be neglected in the DSGE setup.

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<sup>1</sup> In 2015, Hungary has the highest ratio of public investment-to-GDP (6.7%) whereas Israel has the lowest ratio with 1.5% (OECD, 2018).

<sup>2</sup> See Allain-Dupré et al. (2012) for the fluctuations in the public investment-to-GDP ratio in OECD countries between 1995 and 2007. The ratio increases from 3,6% in 2007 to 4,1% in 2009 and decreases again steadily until 2015 (OECD, 2018).

Indeed, analyzing the effects of the golden rule of public finance requires distinguishing between public consumption expenditures and public investment spending. However, the majority of the DSGE literature does not consider such a distinction.<sup>3</sup> Straub and Tchakarov (2007) and Stähler and Thomas (2012) are examples of a few exceptions that consider public consumption and investment separately. In addition, Straub and Tchakarov (2007) analyze the effect of a change in the composition of public spending at the expense of public investment similarly to the case of European Monetary Union (EMU). The authors show that a permanent increase in public consumption combined with an equivalent decrease in public investment, leaving total public spending unchanged, has a negative impact on output. Based on those results, the authors suggest reversing this trend and advocate for an increase in public investment.

Following Straub and Tchakarov (2007) the present paper considers a reversal in the composition of public spending in a DSGE setup. In addition, it incorporates the golden rule of public finance in order to see whether the introduction of a golden rule improves the effectiveness of fiscal policy. This policy exercise is compared to the traditional fiscal policy where public consumption can also be debt-financed in contrast to the golden rule. Public spending is assumed to increase by the same amount under both fiscal regimes. However, under the golden rule, the share of public investment in GDP increases whereas the share of public consumption falls. In addition, under the golden rule, public debt is allowed to finance only public investment expenditures. Under the alternative rule, the share of public investment-to-GDP remains constant and public debt is used for financing public consumption alone.

The present paper contributes to the golden rule literature in several ways. First, the DSGE setup allows to consider the short and medium run effects in contrast to the growth literature which focuses on the long run effects. Moreover, by allowing nominal price rigidities, the present framework incorporates monetary policy alongside the fiscal policy. Thus, in contrast to real endogenous growth literature, it becomes possible to consider the effect of monetary and fiscal policy interactions on the transmission of fiscal policy under alternative fiscal rules. Moreover, the assumption of nominal rigidities strengthens the role of public consumption since goods supply becomes partially demand driven when prices are sticky.

The results show that a fiscal expansion implemented under the golden rule leads to a higher short run fiscal multiplier for output and employment compared to the same fiscal expansion implemented under the alternative rule. The short run as well as the medium run responses of the key variables depend on the evolution of public capital and thus on the type of fiscal rule. The increase in public capital plays a major role on the positive output response despite the crowding-out effect on private investment. The golden rule implies a higher tax burden in the short run which creates a higher negative wealth effect on private consumption compared to the alternative rule. However, this trend is reversed in the medium run implying that the tax burden becomes lower under the golden rule in the medium run. Moreover, public debt increases significantly less under the golden rule. This suggests that a fiscal expansion based on the golden rule of public finance allows for output growth and budget discipline at the same time.

The rest of the paper is organized as follows: the second section presents the framework. The third section calibrates the model and

gives the results. Fourth section runs a robustness analysis by varying several parameters and the fifth section concludes.

## 2. The setup

We consider a closed economy, inhabited by a continuum of infinitely-lived households with rational expectations, monopolistically-competitive firms and the policy makers. Each firm produces a single good that is an imperfect substitute to other goods, using labor and capital and sets the price of the good in Calvo (1983) fashion.

### 2.1. Households

There are two types of households: the first type has access to financial markets and is called asset-holders. The second group of households is assumed to consume the entire disposable income at each period and therefore does not hold financial assets. The share of non-asset holders is equal to  $\lambda$  while the asset holders represent  $1-\lambda$  of the population. The assumption of non-asset-holders allows to eliminate the Ricardian equivalence.

#### 2.1.1. Asset holders

In any period  $t$ , a representative asset holder  $j$  maximizes the following utility function with respect to consumption  $C^j$  and leisure  $(1-L^j)$  where  $L^j$  is the supply of labor and time endowment is normalized to 1:

$$U_t^j = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[ \frac{(C_s^j)^{1-\rho}}{1-\rho} + \eta \log(1-L_s^j) \right]; 0 < \beta < 1, \eta > 0, \rho \geq 1 \quad (1)$$

In the above equation  $\beta$  and  $\rho$  represent respectively the subjective discount factor and the inverse of the intertemporal substitution elasticity.

The real consumption bundle  $C^j$  is a CES type function defined as:

$$C^j = \left[ \int_0^1 c^j(h)^{\frac{\sigma-1}{\sigma}} dh \right]^{\frac{\sigma}{\sigma-1}} \quad (2)$$

where  $\sigma > 1$  is the elasticity of substitution between goods produced within the country and  $c^j(h)$  represents the consumption of a single good  $h$ .

The price index  $P_t$  corresponding to  $C_t^j$  is defined as follows where  $p(h)$  is the price of a single good  $h$ :

$$P_t = \left[ \int_0^1 p_t(h)^{1-\sigma} dh \right]^{\frac{1}{1-\sigma}} \quad (3)$$

Home asset-holder  $j$  invests in capital  $K$  which he/she rents to private firms at a real rental rate  $R$  and receives profits  $\int_0^1 \Pi_t^i di$  from firms, buys public bonds  $D$  which yield the interest rate  $R^D$ , earns wage income by supplying labor at the nominal wage rate  $W$  in the perfectly competitive labor market and pays lump sum taxes denoted by  $T$ . Hence, the budget constraint of the household can be written as follows in real terms:

<sup>3</sup> Finn (1998) and Pappa (2009) are few examples of dynamic general equilibrium models which break down public spending into different categories. However, they distinguish only between public purchases of goods and public wage bill components of public spending.

$$C_t^j + I_t^j + D_{t+1}^j = (1 + R_t^D)D_t^j + R_t K_t^j + \frac{W_t^j}{P_t} L_t^j + \int_0^1 \Pi_t^i di - T_t^j \quad (4)$$

where  $D_{t+1}$  denotes public bonds held during period  $t$  and arriving at maturity in the beginning of period  $t+1$ . In equation (4)  $I$  denotes the private investment which evolves according to the standard law of motion, given below, with  $\delta$  denoting the depreciation rate of private capital:

$$I_t = K_{t+1} - (1 - \delta)K_t \quad (5)$$

Given (2) and (3), the individual demand of the representative asset holder  $j$  for a typical good  $h$  is given as follows:

$$c_t^j(h) = \left[ \frac{p_t(h)}{P_t} \right]^{-\sigma} C_t^j \quad (6)$$

Equation (6) states that the demand of any good  $h$  depends negatively on its relative price and that this substitution effect (relative price effect) increases with  $\sigma$ . It is assumed that public demand takes the same form as private demand (6), implying that public demand is given similarly to (6) with public consumption  $C^g$  replacing private consumption  $C$ .

Asset holders maximize utility given in equation (1) under the budget constraint (4) with respect to  $C_t^j$ ,  $L_t^j$ ,  $K_{t+1}^j$  and  $D_{t+1}^j$ . The resulting first order conditions imply the following equations:

$$C_t^{-\rho} = \beta E_t \left[ C_{t+1}^{-\rho} (1 + R_{t+1} - \delta) \right] \quad (7)$$

$$L_t^j = 1 - \frac{\eta P_t C_t^\rho}{W_t} \quad (8)$$

$$R_{t+1}^D = R_{t+1} - \delta$$

where we dropped the superscript  $j$  for ease of notation since all asset-holders are identical.

Equation (7) is the usual consumption Euler equation which gives the law of motion for asset holders' consumption. Equation (8) is the labor-leisure trade-off which equates the marginal utility of leisure to the marginal utility of consumption. The resulting labor supply increases with the real wage and decreases when the consumption increases. The last equation translates the no-arbitrage condition implying the equality of the net return on capital and public bond, which necessarily holds in non-segmented financial markets.

### 2.1.2. Non-asset holders

In contrast to an asset holder, a representative non-asset holder  $j$  consumes his/her entire disposable income at each period. Thus, the consumption of a representative non-asset holder is given as follows:

$$C_t^j = \frac{W_t}{P_t} L_t^j - T_t^j \quad (9)$$

Equations (1)–(3) and (6) and (8) hold also for non-asset holders.

## 2.2. Firms

The monopolistic competition assumption implies that each good is an imperfect substitute of the other goods. Each monopolistically competitive firm  $i$  produces a quantity  $Y_t^i$  of a single good

according to the following production function:

$$Y_t^i = A_t (L_t^i)^\gamma (K_t^i)^{1-\gamma} \quad (10)$$

In the equation above,  $A_t$  represents the total factor productivity which depends on the public capital stock denoted by  $K_t^g$  such that  $A_t = (K_t^g)^\phi$ . In this setup, expenditures on infrastructure increase the private sector productivity.<sup>4</sup> As stated in [Ismihan and Ozkan \(2012\)](#), the contribution of public capital to the private sector productivity is a key element for the analysis of a golden rule for fiscal policy. In the present setup,  $\phi$  measures the public capital elasticity of private production.

Cost minimization implies the following capital/labor trade-off:

$$\frac{\gamma L_t}{(1 - \gamma)K_t} = \frac{R_t P_t}{W_t} \quad (11)$$

where we drop the superscript  $i$  since all firms are identical.

Using the above equation along with the production function to rewrite the total cost in terms of output and taking the derivative with respect to output allows to express the marginal cost  $MC$  as follows:

$$MC_t = \frac{R_t^\gamma (W_t)^\gamma}{A_t \gamma^\gamma (1 - \gamma)^{1-\gamma}} \quad (12)$$

where  $W_t^r = W_t/P_t$  is the real wage.

In this setup firms are price-makers and set their prices according to the price adjustment mechanism defined by [Calvo \(1983\)](#) who assumes that, in each period, only a randomly selected fraction  $1 - \alpha$  of firms gets the chance to reset their prices by maximizing their market value defined as the expected discounted value of current and future profits. The future profit at date  $t + s$  is affected by the choice of price at time  $t$  to the extent that the firm does not receive another occasion of adjusting its price until  $t + s$ . The new optimal price chosen by the firm  $i$  in period  $t$  is the same for all adjusting firms. Maximizing the market value taking account of the demand equation given in (6) yields the optimal price as follows:

$$p_t^o = \frac{\sigma E_t \sum_{s=t}^{\infty} (\alpha)^{s-t} q_{t,s} Y_s MC_s}{(\sigma - 1) E_t \sum_{s=t}^{\infty} (\alpha)^{s-t} q_{t,s} Y_s P_s^{\sigma-1}} \quad (13)$$

where  $q_{t,s}$  is the discount factor between date  $t$  and  $s$ . Equation (13) states that the firm has to take into account not only the current marginal cost but also the expected future marginal costs when given the chance to change its price.

The price index for goods is then an average of the optimal price  $p_t^o$  charged by the adjusting firms and the average of the price charged by the remaining firms:

$$P_t^{1-\sigma} = (1 - \alpha) (p_t^o)^{1-\sigma} + \alpha P_{t-1}^{1-\sigma} \quad (14)$$

Equation (14) states that current prices depend on past prices, which implies price-stickiness. The degree of price-stickiness is measured by  $\alpha$ . Since prices are not fully flexible in this setup, output will be demand driven, albeit partially. The real growth models under-estimate the role of public consumption as they exclude nominal rigidities. The same is true for monetary models with flexible prices (e.g. [Ismihan and Ozkan, 2012](#)).

<sup>4</sup> Total factor productivity independent of the public capital stock ( $A$ ) is normalized to 1.

### 2.3. Fiscal authority

The fiscal authority levies a lump sum tax and issues a one-period real bond. These revenues are used to finance public investment  $I_t^g$  and consumption  $C_t^g$  as well as for servicing the previous debt. The investment expenditure covers not only the new investment but also the replacement of depreciated public capital. Therefore, public capital evolves similarly to equation (5). The intertemporal budget constraint of the fiscal authority can be written in aggregate real terms as follows:

$$D_{t+1} = (1 + R_t^D)D_t + I_t^g + C_t^g - T_t \quad (15)$$

It is assumed that public spending  $G_t$ , defined as the sum of public consumption and public investment, is allocated between these two components as follows:

$$I_t^g = akG_t \quad (16a)$$

$$C_t^g = (1 - ka)G_t \quad (16b)$$

where  $a$  is the steady-state share of public investment in total public spending and  $k \geq 1$  depending on the fiscal rule.

The present paper considers an exogenous one-time increase in public spending (i.e. a joint increase in both public consumption and investment) under two different cases. In the first case, the steady-state distribution of public spending between consumption and investment remains unchanged implying that  $k=1$ . Put differently, the share of public investment in total public spending remains equal to  $a$ . However, we introduce an asymmetry regarding the way of financing the extra public spending. Specifically, following Groneck (2010), the first case assumes that the budget deficit and hence public debt resulting from the fiscal expansion is used solely for financing the increase in public consumption. This implies that the increase in public investment will be entirely tax-financed. This case will be referred to as the public consumption regime. In the second case, it is assumed that  $k > 1$ , which will allow for a shift in the allocation of public spending between consumption and investment in favor of the latter. This implies that, in the second case, the share of public investment in total public spending will increase compared to the steady-state. This type of policy will be accompanied by a golden rule of public finance which allows for a budget deficit and thereby public debt for financing only the increase in public investment. Indeed, compared to the balanced budget rule, the golden rule is considered to provide a higher freedom for fiscal authorities to increase public investment and thereby shift the distribution of public spending between various types of expenditure even when the upper limit of public debt is reached if such a limit exists as in the EMU. In the golden rule, a budget deficit and an increase in public debt is allowed if and only if the public debt is used to finance public investment.

Given the two types of policy exercises defined above, it is possible to write the evolution of taxes as follows:

$$T_t = \varphi_1 I_t^g + \varphi_2 C_t^g + R_t D_t \quad (17)$$

where  $\varphi_1$  is the share of tax-financed public investment and  $\varphi_2$  is the share of tax-financed public consumption. Equation (17) states that taxes are used to finance public investment, consumption and the interest payments on previous debt. Note that, the values assigned to  $\varphi_1$  and  $\varphi_2$  will allow to distinguish between the two types of fiscal policy defined above. Under the public consumption policy, public consumption expenditures are allowed to be financed

(partially) by public debt implying that  $0 < \varphi_2 < 1$  and public investment is entirely tax-financed implying that  $\varphi_1 = 1$ . In contrast, under the golden rule, debt-financing of public consumption is ruled out so that  $\varphi_2 = 1$  implying that public consumption is entirely tax-financed while public investment is both tax ( $0 < \varphi_1 < 1$ ) and debt-financed ( $1 - \varphi_1 > 0$ ). Interest payments on previous public debt will be entirely tax-financed under both types of fiscal policy.

It is assumed that the log of total public spending follows a typical AR (1) process given below:

$$\ln G_t = \kappa \ln G_{t-1} + v_t \quad (18)$$

where  $\kappa < 1$  gives the degree of persistence of the fiscal shock  $v_t$ , which is defined as a one-time i. i.d innovation to total public spending.

### 2.4. Monetary authority

In contrast to the endogenous growth models cited earlier, the present framework introduces nominal rigidities and money. This requires taking into account the policy decisions of the monetary authority. The latter is assumed to set the nominal interest rate according to a Taylor rule by responding to the inflation and output deviations from the steady-state denoted by  $\pi$  and  $Y$  respectively:

$$i_{t+1} = (1 - \varphi_i)i + \varphi_i i_t + \varphi_\pi(\pi_t - \pi) + \varphi_Y(Y_t - Y) \quad (19)$$

where any variable without a time subscript refers to the steady-state level of that variable. In equation (19), the interest rate  $i_{t+1}$  is the nominal interest rate set in the beginning of period  $t$  which will remain constant until the beginning of period  $t+1$ . The fact that the interest rate depends on its lagged value implies that the monetary authority pursues an interest rate smoothing policy and the parameter  $\varphi_i$  gives the degree of interest smoothing motive. As  $\varphi_i$  increases, large jumps in the nominal interest rate as a response to the deviation of inflation and output will be less likely.

### 2.5. General equilibrium

The equilibrium is a sequence of choice variables  $\{C_t, K_{t+1}, Y_t, L_t, I_t\}$  and policy instruments  $\{D_{t+1}, I_t^g, C_t^g, T_t, i_{t+1}\}$  in per capita terms along with a sequence of prices  $\{P_t, W_t, R_t, R_t^D\}$ , satisfying:

- the households' optimality conditions (6)–(9),
- the firms' optimality conditions and the production function (10)–(13),
- the interest rate rule (19),
- the usual transversality condition,
- the budget constraints (4) and (15) which together define the resource constraint (goods market clearing condition), given (i) the policy decisions (16a,b) and (17) (ii) the definition of the shock (18) and (iii) the steady-state (i.e. initial) values.

Moreover, total private consumption is given by  $C_t = (1 - \lambda)C_t^{AH} + \lambda C_t^{HM}$  and total labor supply is given by  $L_t = (1 - \lambda)L_t^{AH} + \lambda L_t^{HM}$ .

## 3. Parameterization and results

The analysis considered in the present framework compares the effectiveness of a one-time joint increase in public consumption and investment under two different fiscal regimes defined in section 2.4. In the first case, which we will refer to as the public consumption regime, public consumption is allowed to be debt-

financed while public investment is entirely tax-financed, without any change in the ratio of public investment to public consumption. The alternative case combines an increase in the latter and the golden rule of public finance implying that only public investment is allowed to be debt-financed whereas public consumption is entirely tax-financed.

The model is solved numerically under the rational expectations assumption, after log-linearizing the relevant equations around the steady-state which is unique and stationary. The steady state is defined as the flexible-price long run equilibrium characterized by the absence of inflation. The next section presents the choice of values for various parameters.

### 3.1. Parameterization

Solving the model numerically requires assigning values to the parameters. The choice of parameter values is discussed below by providing a short rationale.

The discount factor  $\beta$  in equation (1) is set to 0.9875 which implies that the steady state real interest rate on public bonds is roughly around 1.3 per cent. The inverse of intertemporal elasticity of consumption substitution  $\rho$  is set to 1.35 according to the estimations of Smets and Wouters (2003). According to Monacelli and Perotti (2008) setting  $\sigma = 6$  and  $\kappa = 0.8$  is the most widely used calibration for the elasticity of substitution in the goods market and the degree of persistence of the public spending shock.

Since the budget constraint for non-asset holders is different from the budget constraint of asset holders, the steady state consumption of both households are different. This, in turn, implies that steady-state labor supply will also differ across households. Therefore, in this setup, the value of  $\eta$  cannot be calibrated to have a steady state labor supply equal to one third of the available time. Since no estimations are available for the disutility of labor,  $\eta$  will be normalized to 1 implying that households put the same weight on leisure and consumption in the utility function.

The share of non-asset holders  $\lambda$  is set to 0.25 which is the average range estimated by Kaplan et al. (2014) in a cross-sectional analysis covering UK, Germany, France, Italy, Spain, Canada, Australia and U.S.A. The authors show that the share of non-asset holders exceeds 30% in the USA, UK and Canada whereas the ratio is around 30% in Germany. Italy, France, Spain and Australia have the lowest share of non-asset holders which is close to 20%. The measure of price rigidity  $\alpha$  in equation (14) is equal to 0.75 which, on a quarterly basis, implies that prices remain fixed during one year on average.

As in Gali et al. (2007), the depreciation rates of public and private capital  $\delta$  are assumed to be equal and are set to 0.025 and the share of capital in GDP  $\gamma$  is set to 0.35, which are the standard values in the literature. Bom and Ligthart (2014) estimate the elasticity of output with respect to public capital in OECD countries using meta-regression analysis and find a short run value of 0.083 as well as a long run value of 0.122 at the central government level. The authors also indicate that this value almost doubles if the regional/local government is taken into account and report an average value of 0.106. Accordingly, in the benchmark calibration  $\phi$  is set to 0.2 but a sensitivity analysis will be run for  $\phi = 0.1$ .

The steady-state share of public investment in total public spending  $a$  is determined endogenously in the model. The current calibration implies that public investment is around 6% of the total public spending in the steady-state. This ratio remains constant in the public consumption regime but increases under the golden rule regime. This increase is captured by the parameter  $k$  which is set to 1 by definition under the public consumption regime and to 1.3 under the golden rule, implying that the share of public investment rises to around 7.5% of the total public spending by allowing for a debt-financed public investment. This is close to the OECD average in 2015.

Under the golden rule regime, it is assumed that 20% of public investment and the entire public consumption are tax-financed implying that  $\varphi_1 = 0.2$  and  $\varphi_2 = 1$ . Under the public consumption regime, 30% of public consumption and the entire public investment is tax-financed implying that  $\varphi_1 = 1$  and  $\varphi_2 = 0.3$ .

The steady-state share of public spending in GDP is set to 38% which is the OECD average in 2007. Similarly, the steady-state debt-to-GDP ratio is set to the OECD average in 2007 which is 73 per cent. Given the increased volatility of the debt-to-GDP ratio since the 2008 global crisis, pre-shock values are taken as the benchmark.

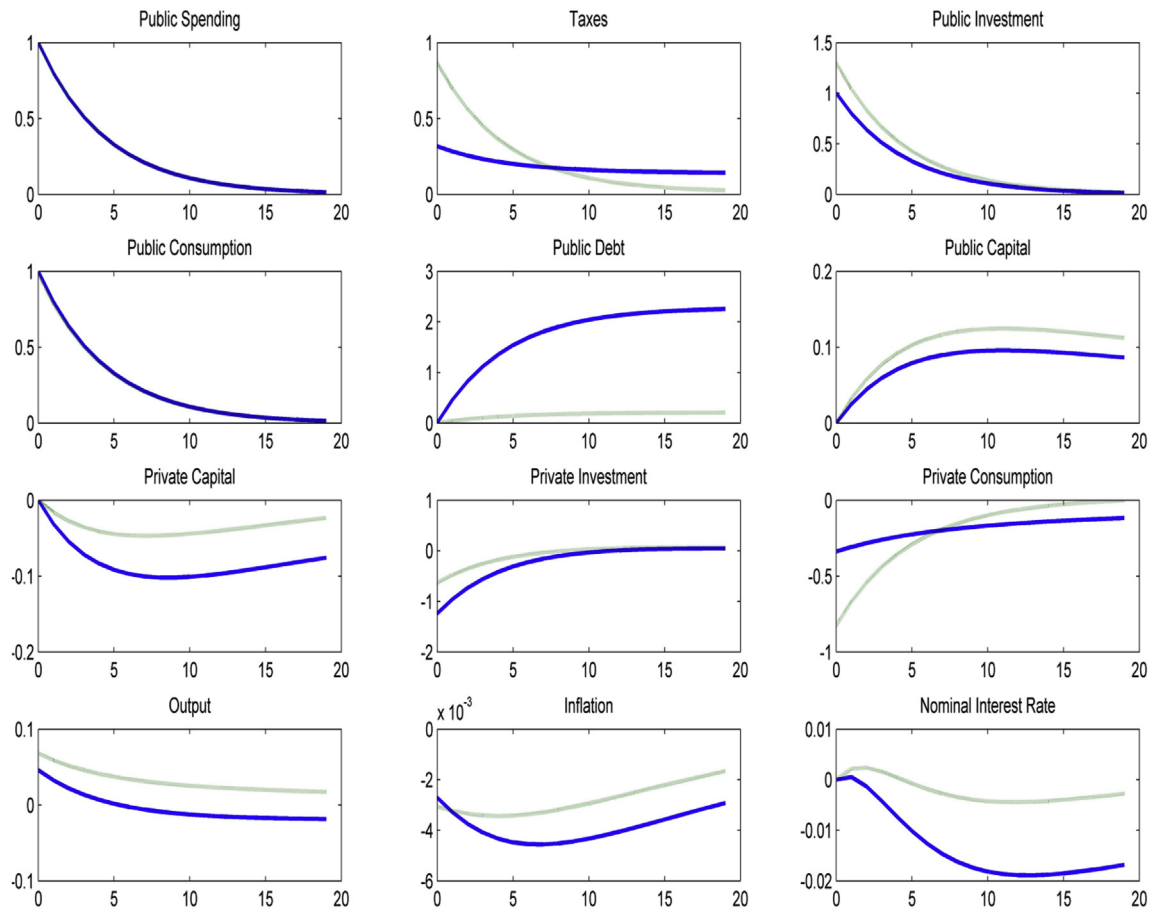
As for the monetary policy parameters,  $\varphi_i$  is arbitrarily set to 0.6 whereas the present setup assumes  $\varphi_\pi = 1.5$  and  $\varphi_Y = 0.1$  which are the widely used values in the literature. Table 1 below summarizes the values assigned to the parameters of the model. For some of the parameters, alternative values will be considered to check the robustness of the results.

### 3.2. The effect of public spending under alternative fiscal regimes

Fig. 1, below, depicts the dynamic responses of selected variables in the public and the private sector to a temporary government spending shock equal to one percent of the steady state output under two alternative fiscal regimes. Public consumption regime

**Table 1**  
Parameter values.

| Parameter     | Value    | Description  |
|---------------|----------|--|
| $\beta$       | 0.9875   | Discount factor  |
| $\rho$        | 1.35     | Inverse of intertemporal substitution elasticity of consumption  |
| $\eta$        | 1        | Weight of leisure in the utility function  |
| $\lambda$     | 0.25     | Share of hand-to-mouth households  |
| $\sigma$      | 6        | Intertemporal elasticity of substitution between goods   |
| $\kappa$      | 0.8      | Persistence of public spending shock   |
| $\delta$      | 0.025    | Depreciation rate of capital   |
| $\alpha$      | 0.75     | Degree of price stickiness   |
| $\gamma$      | 0.35     | Share of private capital in the production function  |
| $\phi$        | 0.2      | Output elasticity of public capital  |
| $\varphi_1$   | 0.2 or 1 | Share of tax-financed public investment  |
| $\varphi_2$   | 0.3 or 1 | Share of tax-financed public consumption   |
| $D/Y$         | 0.45     | Steady-state debt-to-GDP ratio   |
| $G/Y$         | 1/3      | Steady-state public spending-to-GDP ratio  |
| $\varphi_i$   | 0.6      | Degree of interest rate smoothing  |
| $\varphi_\pi$ | 1.5      | Response of interest rate to inflation   |
| $\varphi_Y$   | 0.1      | Response of interest rate to output  |
| $k$           | 1 or 1.3 | Policy design parameter indicating a shift in the distribution of public spending in favor of investment |



**Fig. 1.** The Effect of Public Spending on Key Variables.

Notes: Blue line corresponds to the public consumption regime while the green line represents the golden rule. The horizontal axis gives time in quarters. The vertical axis gives the percentage deviation of the relevant variable from the steady-state.

allows for a debt-financed increase in public consumption keeping constant the allocation of public spending between consumption and investment. The golden rule regime allows for a debt-financed public investment shifting, at the same time, the allocation of public spending in favor of investment.

### 3.2.1. Public sector

An increase in public spending implies higher public consumption and investment under both regimes. However, given the design of the fiscal regimes, public investment increases more under the golden rule whereas the increase in public consumption is slightly lower especially due to the reallocation of public spending in favor of investment under the golden rule. Given equations (16a) and (16b), the evolution of public consumption and investment is similar to that of public spending given by the log-linear version of equation (18). In all periods, public investment remains higher under the golden rule compared to the public consumption regime whereas the opposite is true for public consumption. However, the gap between the responses under alternative fiscal regimes is gradually reduced due to the fact that the fiscal shock is temporary.

Initially, the fiscal expansion leads to a higher increase in taxes under the golden rule compared to the public consumption regime. This is due to the fact that, under the golden rule, public consumption is financed by taxes only. Given the high share of public consumption in total public spending, the possibility of financing public investment with public debt rather than taxes is not enough to prevent the raise in taxes. However, the tax burden is not only

due to the rise in public consumption and investment but also to the public debt service since interest payments on public debt are assumed to be entirely tax-financed regardless of the type of fiscal rule. Since interest payments on public debt increase especially in the medium run under the public consumption regime, in contrast to the short run, taxes become higher in the public consumption regime in the medium run.

There is a significant difference between the two fiscal rules regarding the public debt response. Indeed, the golden rule of public finance is designed not only to allow an increase in public investment as a growth stimulus but also to ensure a low level of public debt by excluding debt-financed public consumption. In contrast, given the high share of public consumption in total public spending, public debt increases significantly when public consumption is allowed to be debt-financed.

### 3.2.2. Private sector

Higher taxes required for financing the fiscal expansion reduce the disposable income and thereby the consumption of non-asset holders. Asset-holders also reduce their consumption both because of the negative wealth effect of taxes and the higher real interest rate. Since the initial negative wealth effect is higher under the golden rule, private consumption reduction is also higher compared to the alternative rule. This reduction in private consumption increases the marginal utility of consumption and decreases that of leisure, which induces households to increase labor supply (in terms of hours worked) as implied by the labor-leisure trade-off equation given by Eq. (8). Labor supply increases more

than the labor demand (due to the rise in output) which leads to a slight fall in real wages. This fall in real wages is initially higher in the golden rule case due to the fact that private consumption falls more compared to the alternative rule. However, to the extent that the negative wealth effect under the golden rule falls below the negative wealth effect of the public consumption regime, the relative evolution of real wages is reversed in the medium run (not shown in the Figure).

The increase in public investment leads to a crowding-out effect on private investment similarly to the findings reported in various frameworks (Finn, 1998; Straub and Tchakarov, 2007; Gronneck, 2010). This crowding-out effect results from the fact that public capital enters in the production function as a third input at zero cost for the firm (since in the present setup only households are subject to taxes) while the private capital costs the real interest rate which is positive given the calibration choice. Therefore, when public capital increases, firms respond by substituting private capital with public capital and thereby decrease private investment.

Output increases on impact for several reasons under both fiscal rules. First, the increase in public capital contributes to output by increasing the productivity despite the crowding-out effect on private capital. Moreover, since prices are sticky in the present setup, output responds positively to the increase in total demand.<sup>5</sup> In addition, the rise in employment (defined as the hours worked) contributes to the positive response of output. The short run output expansion is higher under the golden rule compared to the public consumption regime. This is due to the fact that public capital increases more while the crowding-out of private capital is lower (due to a lower interest rate as a result of lower public debt). In the medium run, the gap between the output responses under the two rules become larger, implying that the output enhancing effect of the fiscal expansion is more persistent under the golden rule whereas the output response may even become slightly negative in the medium run under the alternative rule. The persistence of the output response under the golden rule results from the higher level of public capital as well as the lower crowding-out effect on private capital. This implies that the advantages of a golden rule are more visible in the medium run. This result confirms the findings of the golden rule literature carried out within the endogenous growth framework which report that golden rule enhances the long run growth rate of output (Gronneck, 2011).

Under Calvo-type pricing decisions, inflation is a forward-looking procedure depending on the current marginal cost and the inflation expectations. Therefore, the immediate effect of public spending on inflation depends on the inflation expectations as well as on the rental rate of capital along with the real wage which make up the marginal cost for a given level of public capital (see Eq. (12)). A fiscal expansion incorporating the golden rule leads to a fall in the marginal cost whereas the response of the marginal cost is positive under the alternative case. Indeed, according to Eq. (12), higher public capital and lower real wage put a downward pressure on the marginal cost while the increase in the rental rate of private capital puts an upward pressure. The first effect dominates the second under the golden rule as public capital increases more compared to the public consumption regime. In contrast, the upward pressure of the rental rate of private capital dominates the downward effect of public capital and real wages under the public consumption regime in the short run. Although marginal cost decreases under both rules in the medium run as public capital accumulates, the decrease is

lower under the golden rule due to the slight increase in real wages in the medium run.<sup>6</sup> Therefore, while prices are expected to fall below the steady-state value in both cases, the public consumption regime implies a higher fall in prices compared to the golden rule case. Given the inflation expectations, prices fall less on impact under the golden rule.

The fall in prices requires a reduction of the nominal interest rate according to the interest rule given in Eq. (19) while the increase in output requires a positive reaction of the nominal interest rate. The effect of output dominates and the monetary authority responds by increasing the nominal interest rate under the golden rule whereas the short run response of the interest rate is very weak under the alternative case. Consequently, the real interest rate also increases under both cases. As the output returns to its steady-state level in the medium run, the nominal interest rate starts to fall below the steady-state level due to the evolution of prices. Therefore, the real interest rate also starts to fall in the medium run but stays above the steady-state value. The real interest rate increases more under the public consumption regime.

The mitigated response of the real interest rate under the golden rule implies that the tax burden related to the public debt repayment is lighter compared to the alternative rule. Moreover, since the asset holders' consumption is sensitive to the real interest rate as implied by Eq. (7), the golden rule regime implies a lower decrease in the consumption of asset-holders. Finally, the lower response of the real interest rate under the golden rule regime also determines the response of the rental rate of capital according to the no-arbitrage condition.

#### 4. Sensitivity analysis

The results of the previous section depend on the composition of public spending and the method for financing the public spending as well as on the specification of the production function. The composition of public spending is measured by the share of public investment in public spending given by  $ak$  in the previous section where  $k = 1$  in the public consumption regime and  $k = 1.3$  under the golden rule representing a shift in the allocation of government expenditures. The choice regarding the method of financing the public spending is given by the parameters  $\varphi_1$  and  $\varphi_2$  which measure respectively the share of tax-financed public investment and of tax-financed public consumption. In the benchmark calibration, public consumption regime sets  $\varphi_2 = 0.3$  and  $\varphi_1 = 1$  implying that only 30% of public consumption is tax-financed whereas public investment is entirely tax-financed. In contrast, the golden rule assumes  $\varphi_1 = 0.2$  and  $\varphi_2 = 1$ , implying that 20% of public investment is tax-financed while public consumption is entirely tax-financed. In both cases, the benchmark calibration sets the output elasticity with respect to public capital ( $\phi$ ) to 0.2.

The allocation of public spending can vary according to the policy preferences of the fiscal authorities and hence differ from one country to another. As for the elasticity of output with respect to public capital, various estimations have been reported since Aschauer (1989). Therefore, it would be appropriate to run a sensitivity analysis to see whether the results are robust against alternative values of the relevant parameters. Fig. 2, below, illustrates how the short run response of output varies with the parameters  $k$ ,  $\varphi_2$  and  $\phi$ .<sup>7</sup> In addition, Table 2 gives the short run response of the key variables under alternative values for the same

<sup>5</sup> Total demand increases thanks to the public demand despite the fall in private consumption.

<sup>6</sup> The mitigating effect of public capital on the marginal cost is also pointed out by Straub and Tchakarov (2007).

<sup>7</sup> The short run response of a variable is measured by the cumulative 4-period response which can be interpreted as the annual response since each period corresponds to a quarter.



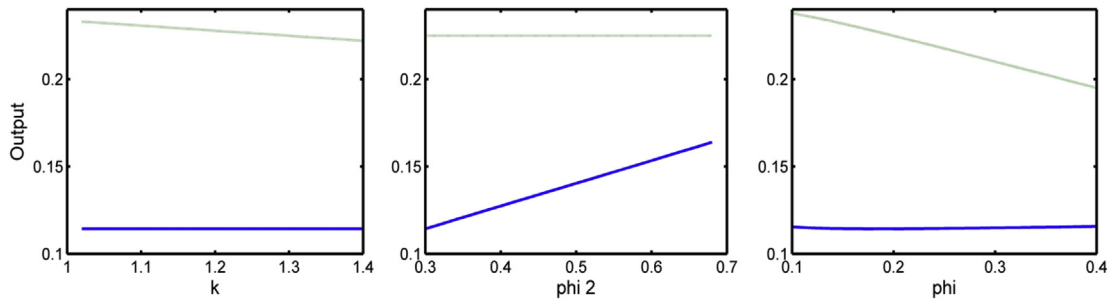


Fig. 2. Output Response Sensitivity.

Notes: Blue line corresponds to the public consumption regime while the green line represents the golden rule. The vertical axis gives the percentage deviation of output from the steady-state.

Table 2  
Sensitivity analysis.

|                   |                        | $I^g$  | $C^g$  | $T$    | $C$     | $I$     | $K$     | $Y$    | $K^g$  |
|-------------------|------------------------|--------|--------|--------|---------|---------|---------|--------|--------|
| Benchmark         | Public Consump.Regime  | 2.952  | 2.952  | 1.0881 | -1.1903 | -3.4937 | -0.1564 | 0.1143 | 0.1286 |
| Calibration       | Golden Rule            | 3.8376 | 2.8974 | 2.5828 | -2.4776 | -1.7196 | -0.0787 | 0.2249 | 0.1672 |
| $k = 1.4$         | Public Consump. Regime | 2.952  | 2.952  | 1.0181 | -1.1903 | -3.4937 | -0.1564 | 0.1143 | 0.1286 |
|                   | Golden Rule            | 4.1328 | 2.8792 | 2.5712 | -2.4556 | -1.7455 | -0.0800 | 0.2220 | 0.1801 |
| $\varphi_2 = 0.5$ | Public Consump.Regime  | 2.952  | 2.952  | 1.5572 | -1.5798 | -2.7909 | -0.1256 | 0.1404 | 0.1286 |
|                   | Golden Rule            | 3.8376 | 2.8974 | 2.5828 | -2.4776 | -1.7196 | -0.0787 | 0.2249 | 0.1672 |
| $\phi = 0.1$      | Public Consump.Regime  | 2.952  | 2.952  | 1.1261 | -1.2615 | -3.3843 | -0.1505 | 0.1154 | 0.1286 |
|                   | Golden Rule            | 3.8326 | 2.8746 | 2.5245 | -2.5050 | -1.6166 | -0.0730 | 0.2378 | 0.1672 |

parameters. The inspection of Table 2 shows that the responses are similar to those reported in the previous section.

Allowing for a bigger shift in the allocation of public spending in favor of investment by setting  $k = 1.4$  instead of  $k = 1.3$  modifies the responses under the golden rule. Specifically, as shown in Table 2 below, taxes increase less compared to the benchmark calibration since public consumption (financed by taxes) increases less. Hence, the lower negative wealth effect implies a lower reduction in private consumption. This, in turn, leads to a lower increase in labor supply and thereby the real wage falls less. Therefore, in the short run output increases less. Indeed, as a bigger share of public spending falls on investment, public capital increases more when  $k = 1.4$  compared to the benchmark case, which implies a positive effect on output. On the other hand, the lower increase in labor supply more than compensates this positive effect since private capital does not change significantly. Therefore, an increase in  $k$  lowers the short run output multiplier under the golden rule which is still higher than the output response under the alternative case. Moreover, public debt increases more as implied by the lower increase in taxes.

By setting  $\varphi_2$  to 0.5 instead of 0.3, the government decides to rely more on taxes and less on public debt to finance public consumption in the public consumption regime which implies a higher negative wealth effect compared to the benchmark calibration. This leads to a higher reduction in private consumption (see Table 2 below) and to a higher increase in labor supply. Moreover, private capital falls less. This, in turn, brings about a higher increase in output (see Fig. 2 above) along with a stronger fall in real wages. Therefore, an increase in  $\varphi_2$  implies that the short run output multiplier in the public consumption regime converges towards that of the golden rule. However, golden rule still yields a higher short run output response. Moreover, fiscal policy based on a higher  $\varphi_2$  can be difficult to implement due to the high fiscal pressure on households.

A lower output elasticity with respect to public capital  $\phi$  has two opposite effects on the short run output response. First, there is a direct negative effect that comes from the fact that when  $\phi$  falls, the same level of public capital leads to a lower output as implied by

the production function given in Eq (10). Second, there is an indirect positive effect that comes from the fact that private capital falls less when  $\phi$  falls. Indeed, with  $\phi = 0.1$ , private consumption falls more both under the golden rule and the public consumption regime, which increases private investment. This leads to a lower crowding-out of private capital under both regimes. The positive effect dominates the negative direct effect and output increases more regardless of the regime when  $\phi$  falls. However, the effect of  $\phi$  is negligible in the public consumption regime. Again, the short run output multiplier is higher under the golden rule.

## 5. Conclusion

Following the economic crisis in 2008, public authorities in many countries realized that a budget consolidation through a cut in public investment may discourage economic growth. The risk of hindering economic growth calls for a fiscal policy characterized by a higher share of public investment which should, at the same time, be less sensitive to business cycles. On the other hand, it is desirable to impose fiscal rules on government budget expansions in order to guarantee a low level of public debt. The golden rule of public finance is believed to achieve both of the goals mentioned above by restricting the use of public debt only for financing an increase in public investment while targeting a higher share of public investment in total public spending.

Accordingly, the present paper analyzes the effects of an increase in the share of public investment while resorting to public debt for investment financing purposes alone. For this, the paper uses a DSGE framework and extends the literature on the effects of a shift in government spending composition (e.g. Straub and Tchakarov, 2007) by incorporating the golden rule of public finance which is generally analyzed within the endogenous growth framework.

The present paper compares two types of policy exercise. The first one consists of increasing the share of public investment at the expense of public consumption while using public debt for financing investment alone. This policy is referred to as the golden

rule. In the second case, public investment share remains constant following the fiscal expansion and public consumption is allowed to be debt-financed, which is referred to as the public consumption regime. The results show that a fiscal expansion leads to a higher increase in output under the golden rule, which is in line with the findings of the literature. However, the transmission mechanism in the present setup implies a crucial role for public capital compared to other studies on the subject. Indeed, the crowding-out effect of public capital on private capital implies that the output growth is mainly driven by the public capital stock especially under the golden rule policy. Moreover, the golden rule policy succeeds in achieving a low budget deficit and public debt without sacrificing economic growth whereas allowing public consumption to be debt-financed increases budget deficit significantly. This result goes against the policy often advocated for especially in Europe, which consists of a slowdown in public investment in order to achieve a budget consolidation. However, in the present setup, the low budget deficit under the golden rule is achieved also by a higher tax pressure and a lower private consumption in the short run compared to the alternative policy. This situation is reversed in the medium run since tax pressure is alleviated and the private consumption improves under the golden rule.

The present paper can be extended in several ways. First, instead of measuring the policy effectiveness by its effect on output, one can choose welfare as the effectiveness criteria. For example, Groneck (2010, 2011) analyzes the effect of a golden rule policy on welfare within an endogenous growth setup. As a second extension, one can decompose public investment into sub-categories such as health, environment or energy investments as in Agénor and Yilmaz (2011) in order to analyze the effects of various types of public investment. Indeed, according to Straub and Tchakarov (2007), it is difficult to show empirically a significant positive relation between total public investment and output while various studies conclude that public investment of a specific type, namely infrastructure expenditures are likely to induce a significant positive effect on private sector output. Finally, instead of lump sum taxes, one can impose distortionary taxes on firms which would induce an implicit cost for public capital and reduce the degree of substitution between public and private capital.

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