Public Debt, Sovereign Spreads and the Unpleasant Arithmetic of Fiscal Consolidations*

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Abstract

In response to severe fiscal consolidation policies implemented after the Great Recession and the euro area sovereign debt crisis, many have questioned the effectiveness of fiscal consolidations in reducing the burden of public debt. This paper revisits this fundamental policy debate qualitatively and quantitatively, studying conditions under which primary budget balance changes can successfully reduce government debt-to-GDP ratios. We first illustrate these conditions through a partial equilibrium setting. We then investigate the conditions quantitatively using a medium-scale New Keynesian DSGE model calibrated on periphery countries of the euro area. The analysis highlights the critical role of sovereign spreads in driving the debt-to-GDP dynamics following a restrictive primary balance shock. Fiscal consolidations turn out to successfully reduce the debt-to-GDP even for fairly low elasticities of spreads to fiscal variables. However, their effectiveness is quantitatively moderate and varies crucially with the initial spread level and with the degree of monetary policy accommodation.

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1 Introduction

After the Great Recession and the euro area sovereign debt crisis several countries have implemented fiscal consolidation policies. For example, from 2009 to 2018 deficit-to-GDP ratios were massively reduced both in the EU-28 (from 6.6% to 0.7%) and in the United States (from 9.8% to 3.8%). These severe fiscal consolidation processes have reignited the policy debate on the effectiveness of economic austerity (Gros and Maurer, 2012; Blanchard and Leigh, 2013; Mauro *et al.*, 2015). Critics of austerity policies challenge the view that fiscal consolidations can achieve reductions in the burden of public debt. Some point out that, by depressing the GDP, such consolidation policies may sometimes even result into increases of the debt-to-GDP ratio. A more established view is that fiscal consolidations can indeed succeed at reducing the burden of public

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debt, though at the cost of a GDP fall. Even within this view, however, opinions widely differ about the magnitude of the debt-to-GDP reductions that can be attained through fiscal consolidations.

Given the complex mechanisms through which primary balance changes can affect the stock of government liabilities relative to the GDP, this wide heterogeneity of points of view is not surprising. The goal of this paper is to revisit this fundamental policy debate in order to clarify and quantify the conditions under which a change in the government's primary balance produces a change of the same sign in the debt-to-GDP ratio. To this end, we first present a simple partial equilibrium example that illustrates the forces at work following fiscal consolidations shocks. Using the simple arithmetic of government budget constraints, we identify and discuss the conditions under which a change in the primary balance budget produces a change of the same sign in the government debt-to-GDP ratio. We then develop a quantitative analysis building a dynamic, general equilibrium medium-scale New Keynesian model à la Smets and Wouters (2003) augmented with a public sector. In the analysis, to capture the critical role played by sovereign debt spreads in the recent dynamics of public debts, we allow for endogenous feedback mechanisms between risk premia on government bonds and the debt-to-GDP ratio. We calibrate our baseline model economy to data from Italy, a country with a historically large debt-to-GDP ratio that has faced significant tensions in the government bond market during the European sovereign debt crisis (IMF, 2013; Lakdawala *et al.*, 2018). We then perform a comparative analysis across four economies of the euro area periphery (Italy, Spain, Portugal, and Greece) by adjusting our model calibration to country-specific parameters.

As illustrated in the partial equilibrium example, three forces are at work in the transmission from primary balance changes to the debt-to-GDP dynamics. One is direct: *ceteris paribus*, an increase/decrease in the government net absorption of resources causes an increase/decrease of the stock of nominal debt. The other two (as pointed out by Cottarelli and Jaramillo, 2012) are indirect, and work in opposite directions: an increase (decrease) in primary deficit increases (decreases) nominal growth in the short run and therefore reduces (increases) the debt-to-GDP ratio.¹ At the same time, by modifying risk premia on the existing and new debt, it increases (decreases) the average cost of government debt and therefore it also increases (decreases) the debt-to-GDP ratio.²

The results of the quantitative analysis highlight the key role played by risk premia and the average cost of debt in the dynamics of the debt-to-GDP ratio. Following a fiscal consolidation shock, the reduction in risk premia and in the average cost of debt tend to dominate over the contraction of the GDP, driving down the debt-to-GDP ratio even for conservative calibrations of the elasticity of the spread to the debt-to-GDP ratio. This unbalance between the influence of risk premia and that of GDP responses reflects the relatively low fiscal multipliers that are estimated in a broad range of macroeconomic models (see Smets and Wouters, 2003; Ratto *et al.*, 2009, Drautzburg and Uhlig, 2015). Nonetheless, the view that austerity policies can achieve large debt-to-GDP reductions finds only mixed support in our quantitative analysis. In our baseline economy, a 1% contraction in the level of public expenditure produces a 0.1% fall of the debt-to-GDP ratio

¹The Great Recession has made clear the relevance of this channel. As noted by IMF (2013), almost 60% of the 2008-2015 increase in debt/GDP ratios in G20 Advanced Economies was due to GDP losses.

²We consider the government primary balance as the primitive fiscal policy instrument, disregarding here the disaggregation between revenue and expenditure components of the budget (for more on this point see Baum *et al.*, 2012; Erceg and Lindé, 2013; Alesina *et al.*, 2013).

after one year and a 0.2% reduction after five years. These effects are somewhat larger, but still relatively limited, for a country such as Greece, where the same public spending cut triggers a drop of the debt-to-GDP ratio by slightly less than 0.3% after five years. Interestingly, we measure significant differences in the effectiveness of fiscal consolidations depending on the degree of tensions initially faced by the country in the sovereign debt market (as measured by the steady-state spread on government bonds). For the baseline Italian economy, a 1% public spending cut reduces the debt-to-GDP ratio by around 50% more when the spread is at the maximum historical level observed during the 2010s.

The limited response of the debt-to-GDP ratio carries the unpleasant implication that non-trivial GDP sacrifices are needed to achieve noticeable debt-to-GDP reductions through fiscal consolidations. This is especially true if the fiscal consolidation aims at quickly lowering the public debt burden: in our quantitative experiments the cumulated GDP loss is around twice larger when the same debt-to-GDP reduction is obtained in one year rather than gradually in five years.

In the last part of the analysis we re-examine the effects of fiscal consolidations under different degrees of monetary policy accommodation (responsiveness of the policy rate to changes in output and inflation). The benefits of an accommodative monetary policy are important. The same public spending cut induces a 70% larger reduction of the debt-to-GDP ratio under an accommodating monetary policy than under a non-accommodating policy.

The rest of the paper unfolds as follows. In Section 2, we illustrate the mechanisms at work through a simple partial equilibrium example. In Section 3, we outline the quantitative model. Section 4 presents the calibration and the simulation results. In that section we also perform a comparison of the effects of fiscal consolidation policies across euro area countries. Section 5 concludes. Technical details on the derivations are relegated to the Appendix.

2 A partial equilibrium example

To provide a general understanding of the forces at work following fiscal consolidations, this section presents a simple, static framework that illustrates the links between changes in the policy instrument (the primary budget) and the target (the debt-to-GDP ratio). The starting point is the nominal government flow budget constraint:

$$B_t = R_t^G B_{t-1} + D_t^{pr}, \quad (1)$$

where B_t is the end-of-the-period stock of nominal government liabilities, D_t^{pr} is the primary budget deficit defined as the difference between public expenditure and tax revenue, and R_t^G is the gross interest rate paid on the outstanding public debt. As noted, we allow for a risk premium (spread) between R_t^G and the policy rate. In particular, we define $R_t^G = R_t + rp_t$, where R_t denotes the policy rate and rp_t is the spread. Further, we let the risk premium depend on both the primary deficit and the debt-to-GDP ratio, that is $rp_t \left(\frac{B_t}{Y_t}; D_t^{pr} \right)$.³ Regarding the policy rate R_t , in this example we take a reduced-form, agnostic approach,

³Several macroeconomic models used in public institutions features an endogenous risk premium on sovereign bonds. Notable examples include the QUEST III model of the European Commission (see Ratto *et al.*, 2009), the GIMF model used by the

and let R_t depend on the primary deficit, that is $R_t(D_t^{pr})$. This is an admittedly crude specification of the policy rate; we will propose a fully fledged determination in the quantitative model.

As we are interested in relative rather than absolute measures, we express fiscal variables in (1) as ratios to nominal GDP (Y_t) and compute the derivative of the debt-to-GDP ratio with respect to the primary deficit:

$$\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} = \left[1 - \frac{\partial r p_t}{\partial \left(\frac{B_t}{Y_t} \right)} \frac{B_{t-1}}{Y_t} \right]^{-1} \left\{ \frac{R_t B_{t-1}}{D_t^{pr} Y_t} \left[\epsilon^{DR^G} - \left(1 + \frac{r p_t}{R_t} \right) \epsilon^{DY} \right] - \frac{\epsilon^{DY} - 1}{Y_t} \right\}, \quad (2)$$

where we denote by $\epsilon^{DR^G} \left(= \frac{\partial R_t^G}{\partial D_t^{pr}} \frac{D_t^{pr}}{R_t^G} \right)$ and by $\epsilon^{DY} \left(= \frac{\partial Y_t}{\partial D_t^{pr}} \frac{D_t^{pr}}{Y_t} \right)$ the elasticity of, respectively, the debt average cost and nominal output with respect to the primary deficit.⁴ In deriving equation (2) we explicitly take into account that changes in primary deficit contemporaneously affect the GDP level.

It is important to highlight that ϵ^{DY} is the product of the fiscal policy multiplier and the primary deficit-to-GDP ratio, so it is pretty much dependant on the cyclical position of the economy. In the short run, $\epsilon^{DY} > 0$ in the presence of nominal rigidities. Regarding the sign of ϵ^{DR^G} a broad range of empirical studies point to a positive, though possibly non-linear, relationship between deteriorations of the government budget positions and the average cost of debt, through the increase in risk premia resulting from escalating credit risk (see Bernoth *et al.*, 2012; Ardagna *et al.*, 2007; Laubach, 2009; Sgherri and Zola, 2009; Caceres *et al.*, 2010). Finally, the same considerations suggest that the derivative of the risk premium with respect to the debt-to-GDP ratio is also positive.

In order to assess whether a fiscal consolidation ($D_t^{pr} < 0$) decreases $\left(\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} > 0 \right)$ or increases $\left(\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} < 0 \right)$ the debt-to-GDP ratio we need to study the sign of (2). To account for the possibility that the primary budget position displays a surplus rather than a deficit, the condition (2) can be expressed in absolute values. We therefore state that, for example, a reduction in the primary budget induces a drop in debt-to-GDP ratio if:

$$\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} > 0 \iff |\epsilon^{DR^G}| > \left[\frac{D_t^{pr}}{R_t^G B_{t-1}} \left(1 + \frac{r p_t}{R_t} \right) + 1 \right] |\epsilon^{DY}| - \frac{D_t^{pr}}{R_t^G B_{t-1}}. \quad (3)$$

On the contrary, a decrease in the primary deficit will increase the debt-to-GDP ratio if:

$$\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} < 0 \iff |\epsilon^{DR^G}| < \left[\frac{D_t^{pr}}{R_t^G B_{t-1}} \left(1 + \frac{r p_t}{R_t} \right) + 1 \right] |\epsilon^{DY}| - \frac{D_t^{pr}}{R_t^G B_{t-1}}. \quad (4)$$

In other words, the effectiveness of a fiscal consolidation policy in reducing the stock of government liabilities relative to nominal income depends on the value of ϵ^{DR^G} with respect to the threshold $\epsilon^* = \left[\frac{D_t^{pr}}{R_t^G B_{t-1}} \left(1 + \frac{r p_t}{R_t} \right) + 1 \right] \epsilon^{DY} - \frac{D_t^{pr}}{R_t^G B_{t-1}}$. The effectiveness of a fiscal consolidation in reducing the debt-to-GDP ratio can be represented in the $(\epsilon^{DR^G}, \epsilon^{DY})$ space as shown in Figure 1.

A given combination of the two elasticities ϵ^{DR^G} and ϵ^{DY} allows a primary budget consolidation to cause

International Monetary Fund (see Kumhof *et al.*, 2010) and OECD Fiscal (see Furceri and Mourougane, 2010).

⁴The full derivation of equation (2) is reported in the Appendix.

an actual debt-to-GDP reduction only if it falls in the “effectiveness” region. The threshold line ϵ^* represents the locus of elasticities ϵ^{DY} and ϵ^{DR^G} that leave the debt-to-GDP ratio unchanged. Further, as shown by equation (2), conditional on being in the effectiveness region, the degree of effectiveness will depend, among other things, on the responsiveness of the risk premium to the debt-to-GDP ratio ($\partial rp_t / \partial (B_t / Y_t)$).

This simple static representation provide us with a basic intuition about the conditions under a which a fiscal consolidation plan is more or less likely to succeed. Clearly, the lower the fiscal policy multiplier (and the lower the primary deficit-to-GDP ratio) the higher the probability that the economy falls in the effectiveness region. At the same time, higher interest rate payments on outstanding debt ($R_t^G B_{t-1}$) shrink the effectiveness region (as the ϵ^* line rotates counterclockwise). Also, if the government displays a budget surplus ($D_t^{pr} < 0$), the ϵ^* line is downward sloping and the effectiveness region is larger. Finally, but perhaps more importantly, the effectiveness of a consolidation policy will depend on the responsiveness of the risk premium, and more in general of the average cost of debt, to the primary deficit and to the debt-to-GDP ratio.

3 The quantitative model

We now turn to study the above issues in a quantitative dynamic general equilibrium framework. We consider a medium-scale closed-economy New Keynesian model similar to that developed by Smets and Wouters (2003). The model features monopolistic competition in both goods and labor markets, nominal rigidities for price and wage setting, endogenous capital accumulation and the presence of rule-of-thumb consumers (see Galí *et al.*, 2007) to better capture the effects of fiscal policy. The model is augmented with a public sector and also features feedback mechanisms between risk premia faced by the government and the debt-to-GDP ratio. As our model builds on Smets and Wouters (2003), we refer to their paper for further details on some derivations.

3.1 Households

We assume a continuum of infinitely lived households, indexed by $j \in [0, 1]$. Following Galí *et al.* (2007), a fraction η of households is Ricardian, i.e., they choose consumption and labor supply by solving an intertemporal optimization problem. Moreover, the representative household chooses the capital stock, investment, and the utilization rate of capital. The remaining fraction $(1 - \eta)$ of households is non-Ricardian, i.e., they just consume their current labor income without solving an intertemporal optimization problem.

3.1.1 Ricardian households

Variables referring to Ricardian households are denoted by a superscript R . The representative household j derives utility from consumption and disutility from labor and maximizes an intertemporal utility function:

$$E_t \sum_{t=0}^{\infty} \beta^t \left[\ln (C_t^R(j) - hC_{t-1}^R(j)) - \frac{N_t^R(j)^{1+\varphi}}{1+\varphi} \right], \quad (5)$$

where E_t is the expectation operator conditional on time t information, $C_t^R(j)$ denotes the consumption of the household of type j , $N_t^R(j)$ is its labor supply, β is the subjective discount factor, h denotes the internal habits on consumption and φ is the inverse of the Frisch elasticity. The maximization of the utility is subject to a budget constraint that is specified as follows:

$$P_t C_t^R(j) + P_t I_t^R(j) + P_t B_t^R(j) \leq P_t W_t(j) N_t^R(j) + R_t^K P_t u_t(j) K_{t-1}^R(j) + R_t^G P_t B_{t-1}^R(j) + P_t \Psi_t^R(j) - P_t T_t(j), \quad (6)$$

where P_t is the price index, $I_t^R(j)$ represents gross investment, $P_t B_t^R(j)$ is the stock of nominal bonds of the government paying a gross interest rate R_t^G , $W_t(j)$ is the real wage paid to j -type worker, $K_t^R(j)$ is the physical capital, $u_t(j)$ indicates the utilization rate of capital, R_t^K is the rental price of capital, $\Psi_t^R(j)$ are profits accruing to households from firms' ownership, and $T_t(j)$ are lump-sum taxes.

As the representative household chooses the capital stock, investment, and the utilization rate, it faces a further constraint given by the capital accumulation equation:

$$K_t^R = [1 - \delta(u_t)] K_{t-1}^R + \left[1 - \frac{\psi}{2} \left(\frac{I_t^R}{I_{t-1}^R} - 1 \right) \right] I_t^R, \quad (7)$$

where ψ is the investment adjustment cost and $\delta(u_t)$ is the capital depreciation expressed in terms of utilization rate of capital. Following Schmitt-Grohé and Uribe (2012), the function describing the behavior of the capital depreciation is

$$\delta(u_t) = \delta_0 + \delta_1(u_t - 1) + \frac{\delta_2}{2}(u_t - 1)^2. \quad (8)$$

In steady state $u = 1$, thus the steady state depreciation rate is δ_0 and $\delta_1 = \frac{1}{\beta} - 1 + \delta_0$.

3.1.2 Non-Ricardian households

Variables referring to households that are non-Ricardian are denoted by a superscript NR . Non-Ricardian households have the following instantaneous utility function

$$\left[\ln(C_t^{NR}(j) - h C_{t-1}^{NR}) - \frac{N_t^{NR}(j)^{1+\varphi}}{1+\varphi} \right]. \quad (9)$$

The budget constraint faced by non-Ricardian households is

$$P_t C_t^{NR}(j) \leq P_t W_t(j) N_t^{NR}(j) - P_t T_t(j). \quad (10)$$

Non-Ricardian households are assumed to entirely consume their current labor income and thus do not choose consumption according to an intertemporal optimization problem. Then, the level of consumption for non-Ricardian households will equal labor income net of lump-sum taxes, i.e., it will be given by (10).

3.1.3 Wage setting

We posit that households supply differentiated labor, thus there is monopolistic competition in the labor market. As a consequence, households are wage setters and choose the wage that maximizes their utility. Wages are sticky and wage rigidity is modeled according to a Calvo model (1983). In each period a random fraction $(1 - \theta_w)$ of households are able to post a new wage. Moreover, non-updating households can index their nominal wage to lagged inflation at rate ζ_w . The evolution of the real wage is

$$W_t^{1-\varepsilon_w} = (1 - \theta_w) \left(\frac{W_t^*}{W_{t-1}} \right)^{1-\varepsilon_w} + \theta_w \Pi_t^{\varepsilon_w - 1} W_{t-1}^{1-\varepsilon_w} \Pi_{t-1}^{\zeta_w(1-\varepsilon_w)} \quad (11)$$

where W_t^* is the real reset wage, ε_w is the elasticity of substitution between differentiated workers and Π_t is the inflation rate. The term W_t denotes the aggregate wage index and is given by the following Dixit-Stiglitz-type aggregator function

$$W_t = \left[\int_0^1 W_t(j)^{1-\varepsilon_w} dj \right]^{\frac{1}{1-\varepsilon_w}}. \quad (12)$$

3.1.4 Aggregation

The levels of aggregate consumption (C_t) and labor (N_t) are a weighted average of the respective variables for Ricardian and non-Ricardian households:

$$C_t \equiv \eta C_t^R + (1 - \eta) C_t^{NR}, \quad (13)$$

$$N_t \equiv \eta N_t^R + (1 - \eta) N_t^{NR}. \quad (14)$$

Aggregate investment and capital are instead given by

$$I_t \equiv \eta I_t^R, \quad (15)$$

$$K_t \equiv \eta K_t^R. \quad (16)$$

3.2 Firms

We assume imperfect competition in the final goods market under the form of monopolistic competition. There is a continuum of firms indexed by $i \in [0, 1]$. The representative firm of type i produces final output $Y_t(i)$ according to a Cobb-Douglas production function:

$$Y_t(i) = A_t (u_t K_{t-1}(i))^\alpha N_t(i)^{1-\alpha}, \quad (17)$$

where $N_t(i)$ is the quantity of labor employed by the i -firm and $K_{t-1}(i)$ is the stock of capital used by the i -type firm. The parameter α indicates the capital share, whereas A_t is a stationary TFP shock obeying the

following process

$$A_t = \rho_a A_{t-1} + e_t^a, \quad (18)$$

with e_t^a following a white noise process.

Cost minimization under the constraint (17) entails the following factor demands

$$W_t = MC_t(1 - \alpha) \frac{Y_t(i)}{N_t(i)}, \quad (19)$$

$$R_t^k = MC_t \alpha \frac{Y_t(i)}{u_t K_{t-1}(i)}, \quad (20)$$

where MC_t is the real marginal cost that is common to all firms.

3.2.1 Price setting

Given the presence of monopolistic competition in the goods market, firms are price makers and face nominal price rigidities as in Calvo (1983). Thus, each firm can reset its price with probability $(1 - \theta_p)$ in any given period. Accordingly, in each period a fraction $(1 - \theta_p)$ of producers is allowed to reset their price, while the remaining fraction do not. Moreover, we allow non-resetting firms to index their price to past inflation, according to a parameter ζ_p . Then, the evolution of inflation is:

$$\Pi_t^{1-\varepsilon_p} = \theta_p \Pi_{t-1}^{\zeta_p(1-\varepsilon_p)} + (1 - \theta_p) \left(\frac{P_t^*}{P_{t-1}} \right)^{1-\varepsilon_p} \quad (21)$$

where ε_p is the elasticity of substitution between differentiated goods and P_t^* is the optimal reset price. The aggregate level of prices P_t is given according to a Dixit-Stiglitz aggregator:

$$P_t = \left[\int_0^1 P_t(i)^{1-\varepsilon_p} di \right]^{\frac{1}{1-\varepsilon_p}}. \quad (22)$$

3.3 Fiscal and monetary authorities

The resource constraint of the economy (in real terms) is

$$Y_t = C_t + I_t + G_t, \quad (23)$$

where G_t is a public spending shock evolving as a stationary AR(1) process

$$G_t = \rho_G G_{t-1} + e_t^G, \quad (24)$$

with ρ_G denoting the autoregressive coefficient and e_t^G following a white noise process. The flow budget constraint of the government is:

$$B_t = R_t^G B_{t-1} + G_t - T_t, \quad (25)$$

where B_t denotes the stock of public debt. To ensure that the fiscal budget constraint is met, the fiscal authority is assumed to adopt a fiscal rule responding to public debt. Then, the instrumental fiscal rule followed by the government involves that lump-sum taxes are set as follows:⁵

$$T_t = \tau_B B_{t-1}, \quad (26)$$

where τ_B is the feedback parameter of the fiscal rule.

To capture tensions in sovereign bond markets we assume that there exists a spread between the risky rate paid on bonds issued by the government (R_t^G) and the policy rate set by the central bank (R_t). In particular:

$$R_t^G = R_t + rp_t, \quad (27)$$

where rp_t denotes the risk premium. We allow the risk premium on government bonds to depend on the level of the debt-to-GDP ratio. In specifying the dependence of the risk premium on the debt-to-GDP ratio we follow several models used by policy institutions such as QUEST III (Ratto *et al.*, 2009), GIMF (Kumhof *et al.*, 2010) and OECD Fiscal (Furceri and Mourougane, 2010):

$$rp_t = \left(\frac{B_t}{Y_t} \right)^\phi, \quad (28)$$

where ϕ measures the elasticity of the risk premium to the debt-to-GDP ratio.

Finally, the monetary policy is set according to a Taylor rule:

$$R_t = R_{t-1}^{\rho_R} \left[(\pi_t)^{\phi_\pi} + (Y_t)^{\phi_y} \right]^{1-\rho_R} e_t^R, \quad (29)$$

where ρ_R denotes the degree of interest rate smoothing, e_t^R is a monetary policy shock, and ϕ_π and ϕ_y measure the monetary policy response to inflation and output, respectively.

4 Simulation results

In this section we present the results of our simulations. We consider a fiscal consolidation plan implemented through a public expenditure reduction and study how such a policy affects the dynamics of the debt-to-GDP ratio, in line with the simple static exercise carried out in Section 2. We further analyze the effects on spread, output and primary deficit. Then, we analyze how different steady state levels of the spread affect the effectiveness of the fiscal consolidation plan.

We calibrate our baseline economy to Italy and subsequently perform a comparison across four “periphery countries” of the euro area, Italy, Greece, Portugal and Spain. In performing this comparison we adjust our calibration to meet the country-specific fiscal positions as well as the spreads historically paid by the countries in sovereign bond markets. Finally, we also evaluate how the effectiveness of fiscal consolidation depends on

⁵A similar rule is used in policy models such as GIMF, QUEST III and OECD Fiscal.

the monetary stance.

4.1 Calibration

The model is calibrated to quarterly frequency and solved numerically by locally approximating around the non-stochastic steady state. In our baseline simulation, we study the dynamics of the model calibrated on data for Italy. The parameter values are shown in Table 1.

We use fairly standard parameters for preferences, technologies and the monetary and government sectors. Parameters affecting the utility function are calibrated according to empirical estimates of medium scale DSGE models (see, e.g., Smets and Wouters, 2003; Justiniano *et al.*, 2013). The Frisch elasticity of labor supply is set to 4, in line with the suggestion of Chetty *et al.* (2011) for macro models. The share of non-Ricardian households is set to 0.35, in line with the value estimated by Ratto *et al.* (2009). Calvo parameters for price (θ_p) and wage-setting (θ_w) parameters are set in order to obtain a duration of a price and wage spell equal to three quarters, whereas the degree of price (ζ_p) and wage (ζ_w) indexation is 0.2. The elasticity of substitution between goods (ε_p) and workers (ε_w) are set to 6, implying a net mark-up of 20%. The parameters affecting the Taylor rule are in line with the estimates of Smets and Wouters (2003), whereas the feedback coefficient (τ_B) of the fiscal rule is calibrated in order to guarantee the stationarity of public debt.

The aforementioned parameters are common among the four euro area economies that we include in our study. There are some parameters that are instead country specific. In the baseline economy, we calibrate the elasticity of the spread to the debt-to-GDP ratio to 0.001038, involving a steady state spread of 220 basis points, that is the average spread observed on Italian government bonds since the onset of the European government debt crisis (2011-2019).⁶ The steady state ratios (i.e., G/Y , T/Y and B/Y) are calibrated in order to meet those observed for Italy in the same period.

4.2 Simulation

We investigate the impact on the debt-to-GDP ratio of a fiscal consolidation plan consisting of a reduction in the level of public expenditure. Recall that the evolution of the debt-to-GDP ratio is driven by the following forces: on the one hand, a drop in government consumption tends to reduce the primary deficit and thus the stock of public debt; on the other hand, it reduces the GDP both directly and through a multiplier effect. Changes in the level of public spending also affect the spread between the interest rate on government bonds and the policy rate. In turn, a change in the spread influences the speed of accumulation of interest payments on the outstanding debt and, hence, the evolution of the debt-to-GDP ratio.

With these forces in mind, in Figure 2 we study the dynamic responses of the spread, debt-to-GDP ratio, primary deficit and GDP when public expenditure is reduced by 1%. The government deficit responds endogenously to the fiscal stance because of automatic stabilizers, so that the post-stimulus change in the deficit is lower than the public spending cut (see Coenen *et al.*, 2012). The impulse response functions (IRFs)

⁶We calculated the spread between the ten year government bond and the same maturity bond issued by the German government during the period 2011-2019.

suggest that in the very early periods the fiscal consolidation shock goes in the unintended direction of raising the debt-to-GDP ratio. This depends on the fact that, as shown by the IRF of the GDP, the spending cut reduces the GDP from the onset of the policy while it does not immediately translate into a reduction of the interest rate paid on government bonds. Indeed, initially the spread jumps up. The negative response of the GDP initially dominates over the direct effect due to the decline of the primary deficit; accordingly, the debt-to-GDP ratio initially increases. To summarize, in the immediate aftermath of the shock the negative effects of the public spending cut on output prevail over the positive effects on debt reduction.

As Figure 2 shows, as time goes by, the response of the spread becomes a key driving force of the debt-to-GDP pattern. In particular, the reduction in the level of public expenditure starts to produce its attenuating effect on the spread and hence on the interest rate paid on government debt (recall that the fall in the level of public debt involves a lower R_t^G and the spread progressively reduces). The reduction in the spread outweighs the continuing decline of the GDP, overall driving down the debt-to-GDP ratio.⁷ Summing up, a fiscal consolidation involves short-run negative effects on the debt-to-GDP ratio mainly due to the slow adjustment of the interest rate that takes some periods to drop. In the medium run, however, the reduction in the spread brings down the average cost of debt. Together with the direct effect of the deficit reduction, the drop in the average cost of debt makes the fiscal consolidation successful in reducing the debt-to-GDP ratio.

Quantitatively, the 1% reduction in public expenditure produces a reduction of the debt-to-GDP ratio of 0.2% after two years. This is especially driven by the fall of the spread which shrinks by two basis points. A relevant element to consider in this discussion is the relative limited effect of the reduction of the denominator of the debt-to-GDP ratio. The GDP drops by around 0.25% on impact, which suggests a value of the instantaneous multiplier significantly lower than one. This low value of the public spending instantaneous multiplier is in line with what empirically found by Smets and Wouters (2003) on which our model is built and is in the ballpark, although slightly lower, than that estimated in the QUEST III model used by the European Commission (see Ratto *et al.*, 2009).⁸

To gain additional insights, in Figures 3 and 4 we carry out two comparisons: one across different steady state levels for our reference economy (Italy) and the other across four periphery economies of the euro area. To avoid cluttering the figures, we focus on the IRFs of the spread and of the debt-to-GDP ratio. In Figure 3, we consider two scenarios for the spread for the case of Italy. We consider a scenario in which the steady-state spread is at its historical minimum (95 basis points) and one in which the steady-state spread is at its historical maximum (521 basis points) in the 2011-2019 period. This comparison yields insights into the effectiveness of austerity policies depending on the initial degree of tensions faced by the country in public debt markets (as captured by the level of the spread). The comparison is also useful to verify the robustness of our findings to different calibrations of ϕ , the elasticity of the spread to the debt-to-GDP ratio.

From the figure, we can observe that when the steady state spread is higher (red dotted lines) the fiscal consolidation policy is more effective in reducing the debt-to-GDP ratio relative to the scenario with a smaller spread (blue continuous line). After five years the difference in the reduction of the debt-to-GDP

⁷Observe that as time goes by the direct effect due to the reduction in the primary deficit fades away.

⁸Dräutzburg and Uhlig (2015) also estimate fiscal multipliers substantially lower than one.

ratio between the two scenarios is sizeable: the debt-to-GDP reduction is 30% larger in the maximum spread scenario. Intuitively, when the spread is higher a fiscal consolidation plan permits the country to enjoy a larger reduction in the spread and, thus, the decrease in the average cost of debt is stronger, inducing a more pronounced fall of the debt-to-GDP ratio. Importantly, the similarity in the qualitative patterns of the response of the debt-to-GDP ratio is reassuring about the robustness of our findings to the calibration of the ϕ parameter.⁹

In Figure 4 we plot the comparison across four euro area economies. In each case we calibrate the elasticity of the spread ϕ to match the observed average value of the spread in the 2011-2019 period. In that period the average spread was 946 basis points for Greece, 385 basis points for Portugal and 190 basis points for Spain.¹⁰

As in the baseline case, we still observe that in the short run the fiscal consolidation induces an increase of the debt-to-GDP ratio, while in the medium run the beneficial effect of a government consumption reduction transfers to the debt-to-GDP pattern that starts to fall. In all the countries a fiscal consolidation characterized by a reduction of public expenditure is thus successful in reducing the debt-to-GDP ratio. It is interesting to observe that across the four countries, Greece is the one that in the medium run experiences the largest reduction in the debt-to-GDP ratio, while Italy experiences the lowest reduction. Portugal and Spain lie in between the two extremes. The effectiveness of the fiscal consolidation policy in the different countries appears to be mostly driven by the initial level of the spread, which is also associated with the elasticity of the spread to the debt-to-GDP ratio. Indeed, Greece, which has the highest steady-state spread, is the country that most benefits from the fiscal consolidation in terms of debt-to-GDP reduction.

Our simulations confirm a well-established result: a fiscal consolidation always leads to a drop in the GDP level. It is also possible to quantify how large is the sacrifice, in terms of output reduction, that a country has to suffer in order to achieve a reduction of its debt-to-GDP ratio through a fiscal consolidation policy. To this end, we implement the following analysis. We consider three scenarios each involving a different fiscal consolidation plan that achieves a 1% fall of the debt-to-GDP ratio in one year, two years and five years, respectively. Then, we calculate how many cumulated points of GDP are lost in each scenario. We perform this exercise for the four euro area countries under consideration. Table 2 collects the results. In the cells we report the cumulated GDP loss experienced by each country when the fiscal consolidation attains a debt-to-GDP ratio drop of 1% in one year, two years or five years.

Clearly, the cost of a fiscal consolidation in terms of GDP reduction is higher for plans aiming at reducing the debt-to-GDP in one year. As the gradualism of the policy increases, the sacrifice brought about by a fiscal consolidation, measured in terms of GDP fall, lowers. The table shows that in all the countries a shock therapy that tries to aggressively reduce the debt-to-GDP ratio in one year entails a non-trivial loss in terms of cumulated GDP fall. Comparing the GDP sacrifice across countries, we observe that Italy has to bear the highest cost in terms of output reduction in each of the cases considered. Greece, on the other hand, appears to suffer the most from adopting a shock therapy rather than a more gradualist approach.

⁹For the other countries included in our analysis we obtain IRFs that are qualitatively similar to those shown in Figures 2 and 3.

¹⁰The steady state ratios (i.e., G/Y , T/Y and B/Y) are calibrated to the values observed in these countries.

4.3 Fiscal consolidation effectiveness and monetary rules

We enrich our study by analyzing how the effectiveness of a fiscal consolidation in reducing the debt-to-GDP ratio is influenced by the behavior of the central bank in setting the monetary stance. Under a fiscal consolidation plan, both output and inflation go down and, then, a monetary authority implementing a Taylor rule like (29) should lower the policy rate. In the baseline economy, this “accommodative” monetary policy helps the real economy to recover after the shock that cuts the level of public spending. In line with Coenen *et al.* (2012), we investigate the responses of our model variables when the central bank does not pursue such an accommodative monetary policy. In this alternative framework the central bank keeps the policy rate fixed for some periods, i.e., it reacts with some delay to the changing macroeconomic conditions.

More specifically, we consider three scenarios: in the baseline case the central bank sets the policy rate following the Taylor rule described by (29); in the second scenario, the central bank maintains the policy rate fixed for one year after the shock; in the third scenario the monetary authority keeps the rate fixed for two years. Figure 5 plots the simulation of this exercise. The IRFs refer to those generated by a model calibrated for Italy with a spread equal to its average value for the 2011-2019 period.¹¹

We observe that when the central bank leaves the policy rate fixed the GDP falls more relative to the case in which the monetary policy is accommodative. Moreover, the longer the monetary authority keeps the policy rate fixed, the stronger the output fall. Therefore, the debt-to-GDP ratio increases more on impact and, then, the spread jumps up relatively more, given its dependence on the debt-to-GDP pattern. As a consequence, the fiscal consolidation is less effective the slower is the response of the central bank. The difference in the reduction of the debt-to-GDP ratio after five years between the baseline scenario and the scenario in which the central bank keeps the policy rate unaltered for two years is 0.1%, around 40% of the total reduction.

Thus, the analysis suggests that a good coordination between monetary and fiscal authorities can significantly improve the effectiveness of a fiscal consolidation. In order to facilitate a larger debt-to-GDP reduction, the central bank should swiftly adjust the policy rate according to what implied by the Taylor rule, instead of maintaining the policy rate unchanged.

5 Conclusions

In this paper we have looked closely at the conditions under which fiscal consolidation policies can achieve a reduction in the debt-to-GDP ratio, and the timing with which this may occur. The analysis suggests that fiscal consolidations through a public expenditure reduction are moderately successful in reducing the debt-to-GDP ratio, even for fairly low elasticities of government debt risk premia to fiscal variables. However, relevant sacrifices in terms of GDP losses have to be borne in order to achieve sizeable debt-to-GDP reductions. The quantitative analysis further reveals that fiscal consolidations are significantly more effective when a country experiences tensions in the sovereign debt market and when they are accompanied

¹¹The IRFs are qualitatively similar among the Euro-Area countries considered in our study. Results are available upon request.

by an accommodative monetary stance. A comparison across countries of the euro area periphery shows noticeable differences in the effectiveness of fiscal consolidations, especially driven by the different spread levels to which such countries have been exposed since the European sovereign debt crisis.

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Table 1 - Baseline calibration

Parameter	Value	Description
Households		
β	0.99	Discount factor
h	0.70	Habit parameter
φ	0.25	Inverse of Frisch elasticity (goods sector)
η	0.65	Fraction of non-Ricardian households
ε_w	6	Elasticity of substitution between workers
ζ_w	0.2	Degree of wage indexation
θ_w	0.66	Probability of not adjust a wage
Firms		
α	0.33	Capital share
δ_0	0.025	Steady state depreciation rate
δ_2	0.10	Parameter adjustment cost
ψ	1.5	Investment adjustment cost
ε_p	6	Elasticity of substitution between goods
ζ_p	0.2	Degree of price indexation
θ_p	0.66	Probability of not adjust a price
Fiscal and monetary authority		
ϕ_π	1.50	Feedback parameter inflation
ϕ_y	0.125	Feedback parameter output
ρ_R	0.70	Interest rate smoothing
ϕ	0.001038	Elasticity of risk premium to debt-to-GDP ratio
τ_B	0.05	Feedback parameter public debt (fiscal rule)
Steady states		
G/Y	0.196	Public expenditure as a fraction of the GDP
T/Y	0.426	Tax revenue over GDP
B/Y	5.288	Steady state public debt

Table 2 - Fiscal consolidation plan gradualism and GDP loss¹²

	Greece	Italy	Portugal	Spain
Scenario				
1-Year	-8.81	-9.00	-8.29	-6.67
2-Years	-3.54	-3.84	-3.58	-3.24
5-Years	-2.64	-3.56	-3.14	-3.17

¹²Column 1 reports the number of years by which the policy maker aims to achieve a 1% drop of the debt-to-GDP ratio.

Figure 1 - Regions of effectiveness of a fiscal consolidation in reducing the debt-to-GDP ratio.

Figure 2 - Effects of a fiscal consolidation on the model variables.

Figure 3 - Effectiveness of the fiscal consolidation for different steady state spread.

Figure 4 - Effectiveness of fiscal consolidation for Euro-Area economies.

Figure 5 - Effectiveness of fiscal consolidation for different level of monetary accomodation.

Appendix

In this appendix we provide the full derivation of the condition for the effectiveness of fiscal consolidation reported in Section 2. In particular, condition (3) shows that the elasticities ϵ^{DR^G} and ϵ^{DY} , denoting respectively the response of the interest rate and GDP to primary deficit, play a pivotal role in determining whether a fiscal consolidation is able to achieve a reduction in the debt-to-GDP pattern.

Our point of departure is the flow budget constraint of the government (1) expressed in terms of debt-to-GDP dynamics:¹³

$$\frac{B_t}{Y_t} = R_t^G \frac{B_{t-1}}{Y_t(D_t^{pr})} + \frac{D_t^{pr}}{Y_t(D_t^{pr})}. \quad (30)$$

The rate paid on government bonds (R_t^G) can be expressed as a premium (rp_t) over the safe asset (R_t), i.e., $R_t^G = R_t + rp_t$. Then,

$$\frac{B_t}{Y_t} = (R_t + rp_t) \frac{B_{t-1}}{Y_t(D_t^{pr})} + \frac{D_t^{pr}}{Y_t(D_t^{pr})}. \quad (31)$$

The above expression is the familiar law of motion of the stock of government liabilities relative to aggregate output. Assuming the policy instrument to be the primary deficit D_t^{pr} we analyze how B_t/Y_t is affected by policy changes. Partial derivative of (31) with respect to D_t^{pr} reads:

$$\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} = \left[1 - \frac{\partial rp_t}{\partial \left(\frac{B_t}{Y_t} \right)} \frac{B_{t-1}}{Y_t} \right]^{-1} \left\{ \frac{R_t B_{t-1}}{D_t^{pr} Y_t} \left[\epsilon^{DR^G} - \left(1 + \frac{rp_t}{R_t} \right) \epsilon^{DY} \right] - \frac{\epsilon^{DY} - 1}{Y_t} \right\}. \quad (32)$$

If (32) is positive, it means that a deficit reduction succeeds in causing a reduction in debt-to-GDP ratio. In this case the fiscal consolidation is qualitatively effective, because a given decrease in primary budget is effective in reducing the stock of government liabilities as a ratio to nominal income. If, on the other hand, (32) is negative, then a deficit reduction increases the debt-to-GDP ratio and the budget consolidation results to be ineffective.

In order to compute the necessary and sufficient conditions for the effectiveness of a fiscal consolidation it is necessary to study the sign of (32):

$$\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} > 0 \implies \frac{R_t B_{t-1}}{D_t^{pr} Y_t} \left[\epsilon^{DR^G} - \left(1 + \frac{rp_t}{R_t} \right) \epsilon^{DY} \right] - \frac{\epsilon^{DY} - 1}{Y_t} > 0, \quad (33)$$

which means

$$\frac{R_t B_{t-1}}{D_t^{pr}} \left[\epsilon^{DR^G} - \left(1 + \frac{rp_t}{R_t} \right) \epsilon^{DY} \right] - (\epsilon^{DY} - 1) > 0. \quad (34)$$

To account for the possibility that the primary budget position displays a surplus rather than a deficit, the above condition can be expressed in absolute values. We therefore state that a given change in primary

¹³We explicitly take into account that changes in primary deficit contemporaneously affect the level of income. We express this dependency as $Y_t(D_t^{pr})$. Moreover, we assume that the risk-premium depends on the level of the debt-to-GDP ratio.

budget is successful in creating the expected change in debt-to-GDP ratio if:

$$\frac{\partial \left(\frac{B_t}{Y_t} \right)}{\partial D_t^{pr}} > 0 \iff |\epsilon^{DR^G}| > \left[\frac{D_t^{pr}}{R_t^G B_{t-1}} \left(1 + \frac{rp_t}{R_t} \right) + 1 \right] |\epsilon^{DY}| - \frac{D_t^{pr}}{R_t^G B_{t-1}}. \quad (35)$$

In other words, the effectiveness of a fiscal policy aimed at reducing the stock of government liabilities relative to nominal income depends on the position of ϵ^{DR^G} with respect to a threshold $\epsilon^* = \left[\frac{D_t^{pr}}{R_t^G B_{t-1}} \left(1 + \frac{rp_t}{R_t} \right) + 1 \right] \epsilon^{DY} - \frac{D_t^{pr}}{R_t^G B_{t-1}}$.