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The Golden Rule of Public Finance: A Panacea?

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Abstract

The fiscal stimulus packages that were put in place in the wake of the recent global financial crisis consisted of massive public investment spending. Moreover, substantial increases in public debt levels in the aftermath of the crisis have highlighted the importance of fiscal discipline and thus the appropriate form of fiscal policy regimes. Motivated by these experiences, this paper provides a comparative assessment of two fiscal regimes: a balanced-budget rule with tax finance and a golden rule with debt finance, with special reference to the level and the efficiency of public investment. We find that, although the golden rule is likely to be more public investment-friendly, adopting a golden rule rather than a balanced-budget rule does not guarantee that public investment will improve economic outcomes. Our results suggest that only when the rate of return on public capital is greater than the cost of public borrowing expansion of public investment beneficial. As such, we argue that policymakers should prioritize the productivity of public investment, not just its level.

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1. Introduction

Massive fiscal stimulus packages put in place in the wake of the recent global financial crisis and subsequent increases in public debt in many countries have brought fiscal policy issues to the center of the international policy agenda. However, earlier, over the previous two decades, the issue of optimal choice for fiscal institutions had already been generating wide interest. This interest was mainly a response to sharp rises in deficit and debt levels in both industrialized and developing countries during the 1980s and 1990s, which required corrective action. The issue of fiscal policy design received particular attention in Europe during the formation of the Monetary Union, for which fiscal discipline was viewed as a prerequisite. The Stability and Growth Pact (SGP) was adopted in 1997 to make sure fiscal discipline was maintained, as defined by clear deficit and debt limits set out in the Maastricht Treaty of 1992.[1]

One major criticism of the original SGP has targeted its implications for public investment. It has been argued that the rules of the SGP seriously restrict policymakers' willingness and ability to commit public investment in member countries.[2] Central to these arguments has been the notion that public capital spending is intrinsically different from other types of public spending; it has the capacity to enhance the future output potential of an economy.[3] An alternative fiscal rule that has been at the center of the policy debate is the "golden rule" of public finances followed by the UK. One crucial difference between the UK's golden rule and the SGP is in the allowance for public investment in the former: it excludes public capital expenditures from deficit targets. In contrast, the rules of the SGP treat capital and current expenditure as the same. This aspect of the SGP has been viewed as a major drawback, especially given that public investment as a share of output has been falling in EMU countries since the 1970s and was almost half of that in the US at the end of the 1990s (see, e.g., Blanchard and Giavazzi, 2004).[4] As a result, a

1 The original SGP had set deficit and debt limits of 3% and 60% of GDP, respectively. The pact also had a uniform medium-term objective (MTO), which required the member states to aim for (or get as close as possible) to a balanced or surplus budget.

2 Pereé and Välilä (2005) present an empirical investigation of the link between fiscal rules and public investment in Europe.

3 See, e.g., Romp and De Haan (2007) for a survey of the link between public capital and economic growth.

4 Potential consequences of subjecting public investment to the same fiscal constraints as current spending have also been recognized by the IMF. Having acknowledged the contribution of public capital spending to a country's future public revenues and growth potential, the IMF has proposed new initiatives to promote public investment in countries under IMF-supported programs (see, Hemming and Ter-minassian, 2004).

number of proposals have been put forward in favor of adopting a golden rule in the eurozone instead of the framework specified by the original SGP (see, e.g., Fitoussi and Creel, 2002; Blanchard and Giavazzi, 2004).[5]

In 2005, the SGP was revised when many countries-including Germany and France –had failed to comply with the rules, particularly the 3% deficit limit, over the 2002-04 period. Although the *new* SGP allows more budgetary room to maneuver so that public investment can be funded, it still aims at (close to) a balanced budget over the medium term, especially for the euro area.[6] However, the unprecedented scale of the rescue packages implemented since the recent global crisis has led to a significant deterioration in budget balances, especially in industrialized countries. Many EMU countries, for instance, continue to face severe challenges in meeting the fiscal costs of the financial crisis without breaching the rules of the revised SGP (see, e.g., Bénassy-Quéré and Ribeiro, 2009). More recently, following the debt crises faced by Greece, Ireland and Portugal, European policymakers are considering tightening up the SGP in an effort to avert additional market panics (see, for example, De Grauwe, 2011). This turbulent background raises the inevitable question of how the members of the EMU will protect public investment while satisfying the requirements of tight fiscal rules. Safeguarding public investment while maintaining fiscal sustainability is also crucial for the US, where recent legislation introducing wide-ranging health-care reform and the size of the fiscal stimulus package reignited the debate over optimal fiscal institutions.[7]

Motivated by these observations, this paper provides an assessment of the role of public investment in macroeconomic performance under two fiscal regimes: a balanced-budget rule with tax finance and a golden rule with debt finance. This is done by utilizing a simple two-period policymaking model that explicitly incorporates the productivity-enhancing role of public investment. Our analysis differs in important ways from related existing work, which mainly focused on the effect of public investment on long-run growth

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5 An evaluation of various forms of golden rules for EMU can be found in Balassone and Franco (2000).

6 More specifically, the revised SGP sets limits on country-specific objectives—for eurozone and ERM II member states—ranging from 1% of GDP deficit for high potential growth/low debt countries to close to a balanced or surplus budget for low potential growth/high debt countries. See ECOFIN Council (2005) for more details on the revised SGP.

7 Creel and Farvaque (2009) argue that, in the US, politicians historically favored legal actions that resembled a balanced-budget rule rather than a golden rule at the federal level.

rates and/or fiscal sustainability.[8] Most of the existing studies have investigated growth performances under alternative fiscal regimes by using endogenous growth models (see, e.g., Ghosh and Nolan, 2007, and the references cited therein). In contrast to our model, these studies do not take into account the quality or the efficiency of public investment. Moreover, unlike in our framework, monetary policymaking and hence the monetary and fiscal policy interactions were absent in such models. Thus, the impact of public investment on the inflation rate cannot be analyzed within these models, making them difficult to reconcile with the widely held belief that fiscal rules are eventually aimed at preserving price stability (as in the case of the).

Our analysis yields a number of interesting results. In contrast to the existing studies, we show that the productivity or quality of public investment plays a crucial role in determining what happens to macroeconomic performance after such spending has been expanded, under both a balanced-budget rule and a golden rule. Furthermore, we find that adopting a golden rule rather than a balanced-budget rule does not guarantee that public investment will improve economic outcomes. Our results suggest that only when the rate of return on public capital is greater than the cost of public borrowing will the expansion of public investment be beneficial.

The rest of the paper is organized as follows. Section 2 sets out the basic model, presents the characterization of equilibrium outcome, and provides a discussion of the main results. Section 3 presents the overall conclusions.

2. The basic model

Consider the following two-period macroeconomic policymaking model that features explicit interactions between a fiscal authority (the government) and a monetary authority (the central bank).[9] The government, acting through the fiscal authority, controls the instruments of fiscal policy—i.e., taxes and public spending—while the monetary instrument, inflation, is controlled by an independent central bank.

Preferences and output supply

To explore the implications of the policymakers' strategic decision regarding the composition of public expenditure, we distinguish between two

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8 Buiter (2001), for instance, analyzes the role of a golden rule on government's solvency and fiscal stability but does not consider the role of public investment on macroeconomic outcomes.

9 Different variants of this model are used, for example, by Beetsma and Bovenberg (1999) and Özkan (2000), among others.

broad spending categories: investment (g^i) and consumption (g^c). Public investment spending consists of expenditure, for example, on infrastructure, health and education that has a positive impact on overall productivity. In addition to these favorable consequences in future periods, public investment spending also yields contemporaneous utility to the policymaker. Current utility also derives from current or consumption spending, which consists of public wages, current public spending on goods, and other government expenditure that may yield immediate benefits. Taken together, these suggest that the preferences of the fiscal authority can be described by the following loss function:

$$L_t^G = \frac{1}{2}\sum_{t=1}^{T=2}\beta_G^{t-1}[\delta_1\pi_t^2 + (x_t - \overline{x}_t)^2 + \delta_2(g_t^c - \overline{g}_t^c)^2 + \delta_3(g_t^i - \overline{g}_t^i)^2] \qquad (1)$$

where L_t^G denotes the welfare losses incurred by the government, π_t is the inflation rate, x_t and $\overline{x}_t$ are the (log of) actual and desired level of output, $g_t^c(g_t^i)$ and $\overline{g}_t^c(\overline{g}_t^i)$ are the actual and desired public consumption (investment) spending as shares of output, δ_1, δ_2 and δ_3 represent, respectively, the government's aversion to the deviations of inflation, public consumption and investment spending from their respective targets with respect to the deviations of output from its target, and β_G is the government's discount factor. The target inflation rate is taken to be zero, to indicate the desirability of price stability.

Likewise, the preferences of the central bank can be described as follows:

$$L_t^{CB} = \frac{1}{2}\sum_{t=1}^{T=2}\beta_{CB}^{t-1}[\mu_1\pi_t^2 + (x_t - \overline{x}_t)^2] \qquad (2)$$

where L_t^{CB} denotes the welfare losses incurred by the central bank, μ_1 is the central bank's inflation stability weight, β_{CB} is the central bank's discount factor. The independent central bank is more conservative than the elected government; $\mu_1 > \delta_1$ and it does not discount the future at as high a rate as the elected government; $\beta_{CB} > \beta_G$. Also note that no terms relating to g^c and g^i enter the central bank's loss function, since public spending impacts upon the welfare of the elected government but not that of the central bank.

Now consider a representative competitive firm facing the following production function: $X_t = A_t N_t^{\gamma}$, where X_t represents output, N_t represents labor, A_t represents the level of productivity in period t, and $0 < \gamma < 1$. The firm's profits are given by $P_t(1-\tau_t)A_t N_t^{\gamma} - W_t N_t$, where P_t is the price level, W_t is the wage rate, and τ_t is the tax rate on the total revenue of the firm in period t.[10] The representative firm chooses labor to maximize profits by taking P_t, W_t and τ_t as given. The resulting output supply function is given by $\alpha(p_t + \frac{1}{\gamma}a_t - w_t - \tau_t) + z$, where lower-case letters represent logs, e.g., $\alpha = \gamma/(1-\gamma)$, $\ln(1-\tau) \approx -\tau$ and $z = \alpha ln(\gamma)$.

Our formulation of the productivity effect of public investment is based on Ismihan and Özkan (2004) and is as follows: $a_t = a_0 + \zeta g_{t-1}^{i}$, where $\zeta > 0$.[11] Substituting a_t into the above given output supply function, then normalizing output by subtracting the constant term, $z + \alpha a_0/\gamma$, for simplicity[12] and utilizing $w_t = p_t^{e}$, where superscript e denotes expectation, yields the following normalized output supply function:

$$x_t = \alpha(\pi_t + \psi g_{t-1}^{i} - \pi_t^{e} - \tau_t) \quad (3)$$

In equation (3), x is the normalized (log) output, π^{e} is expected inflation, ψ $(= \zeta/\gamma)$ is a measure of the productivity or the quality of public investment, and other variables are as defined earlier. Equation (3) suggests that a rise in public investment in $t = 1$ raises output in $t = 2$ through improved productivity.

The government budget constraint creates the link between the fiscal and monetary policies, which is formally given by:

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10 It must be noted that τ_t is imposed on the firm's revenue and not on labor earnings. In a more general framework, variations in tax rates might also have labor supply effects that are absent from our model.

11 Ismihan and Özkan (2004) explore the real effects of central bank independence in a simplified framework that abstracts from public debt considerations. Ismihan and Özkan (2011) also use a similar framework but do not consider the golden rule of public finance.

12 This normalization ($z + \alpha a_0/\gamma = 0$) of output supply function does not affect the qualitative nature of the results derived in this paper.

$$g_t^c + g_t^i + (1 + r_{t-1})d_{t-1} = k\pi_t + \tau_t + d_t \qquad (4)$$

where d_{t-1} denotes the amount of single-period indexed public debt issued (as a ratio of output) in period *t-1* and to be repaid in period t, r_{t-1} represents the rate at which it is borrowed, d_t is the new debt issue in period t, and k is the real holdings of base money as share of output.[13] On the left in equation (4) are the outlays consisting of current public consumption spending, public investment and the current debt service. On the right are the sources of financing for these outlays: seigniorage, revenue taxes and new borrowing.

Equilibrium under the two fiscal rules

In what follows, we consider two alternative fiscal arrangements corresponding to a “golden rule” and a balanced-budget rule. The first is a simple form of the golden rule that allows the policymaker to run a deficit equal to the amount of public investment. Such a rule implies that only public investment can be paid for by public borrowing, as given by

$$d_t = g_t^i \qquad (5)$$

A balanced-budget rule still applies to current spending, which has to be paid out of current revenues.

The second fiscal regime we consider is a balanced-budget rule, where public spending—both public consumption and public investment—has to be paid out of current revenues. Under this regime, the budget constraint takes the following form:

$$g_t^c + g_t^i = k\pi_t + \tau_t \qquad (6)$$

where all variables are as defined earlier.[14]

Under both regimes, the government and the central bank play a Nash game in both periods, where the former's choice of variables consists of public

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[13] As is standard in the existing literature on monetary-fiscal interactions, we take the interest rate, r, to be exogenous. Endogenizing r would require modeling the financial sector, which is beyond the scope of this paper. See, Özkan et al. (2010) for an analytical framework incorporating the role of both demand and supply conditions in determining the cost of public borrowing.

[14] For simplicity, we assume that the initial level of public debt is zero. In practice, balanced-budget rules require that public spending be equal to public revenues, which does not necessarily imply zero public debt. However, this simplification does not affect the qualitative nature of our results.

spending (both the level and the composition) and the tax rate and that of the latter of inflation. The model is solved recursively starting from $t = 2$. Both d_t and g_t^i are chosen only in $t = 1$, given that both debt repayments and return on public investment are due with one period lag, and $t = 2$ is the final period. Tables 1 and 2 present the equilibrium outcomes for the two fiscal regimes, where the superscripts *GR* and *BB* are used to indicate outcomes under the golden rule and the balanced-budget rule, respectively (the details of how the equilibrium outcomes are derived are presented in the Appendix).

Table 1. Macroeconomic outcomes under the golden rule (GR)

$g_1^{i,GR} = d_1^{GR} = \Psi[\hat{o}(\frac{1}{\alpha}\bar{x}_2 + \bar{g}_2^c) + \bar{g}_1^i]$
$\pi_1^{GR} = \frac{1/\mu_1}{S}(\frac{1}{\alpha}\bar{x}_1 + \bar{g}_1^c)$
$(\bar{g}_1^c - g_1^c)^{GR} = \frac{1/\delta_2}{S}(\frac{1}{\alpha}\bar{x}_1 + \bar{g}_1^c)$
$(\bar{x}_1 - x_1)^{GR} = \frac{1/\alpha}{S}(\frac{1}{\alpha}\bar{x}_1 + \bar{g}_1^c)$
$\pi_2^{GR} = \frac{1/\mu_1}{S}[\Pi(\frac{1}{\alpha}\bar{x}_2 + \bar{g}_2^c) - \psi_N \Psi \bar{g}_1^i]$
$(\bar{g}_2^c - g_2^c)^{GR} = \frac{1/\delta_2}{S}[\Pi(\frac{1}{\alpha}\bar{x}_2 + \bar{g}_2^c) - \psi_N \Psi \bar{g}_1^i]$
$(\bar{x}_2 - x_2)^{GR} = \frac{1/\alpha}{S}[\Pi(\frac{1}{\alpha}\bar{x}_2 + \bar{g}_2^c) - \psi_N \Psi \bar{g}_1^i]$

Note: $\psi_N = \psi - (1 + r_1), S = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{k}{\mu_1}, \hat{\beta}_G = \beta_G \frac{S^*}{S},$

$S^* = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{\delta_1}{\mu_1^2}, \hat{o} = \frac{1}{\delta_3 S}\psi_N \hat{\beta}_G, \Psi = 1/(1 + \psi_N \hat{o}) > 0$

and $\Pi = 1 - \psi_N \hat{o} \Psi > 0$.

Note that in Tables 1 and 2 outcomes are defined as gaps between the targeted and the actual values of the relevant variable except for inflation, where the target value is 0. In what follows, we analyze the qualitative effects of a rise in g_1^c and g_1^i by working out the implications of a rise in $\overline{g}_1^c$ and $\overline{g}_1^i$ as $\partial g_1^c / \partial \overline{g}_1^c$ and $\partial g_1^i / \partial \overline{g}_1^i$ are always positive.

Table 2. Macroeconomic outcomes under the balanced-budget rule (BB)

$g_1^{i,BB} = \Theta[\hat{\beta}_G \psi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) - (\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c) + \delta_3 S \overline{g}_1^i]$
$\pi_1^{BB} = \frac{1/\mu_1}{S}[\Theta \hat{\beta}_G \psi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) + \Phi(\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c)] + \frac{\delta_3}{\mu_1}\Theta \overline{g}_1^i$
$(\overline{g}_1^c - g_1^c)^{BB} = \frac{1/\delta_2}{S}[\Theta \hat{\beta}_G \psi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) + \Phi(\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c)] + \frac{\delta_3}{\delta_2}\Theta \overline{g}_1^i$
$(\overline{x}_1 - x_1)^{BB} = \frac{1/\alpha}{S}[\Theta \hat{\beta}_G \psi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) + \Phi(\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c)] + \frac{\delta_3}{\alpha}\Theta \overline{g}_1^i$
$\pi_2^{BB} = \frac{1/\mu_1}{S}[\Xi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) + \Theta\psi(\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c)] - \frac{\delta_3}{\mu_1}\Theta\psi \overline{g}_1^i$
$(\overline{g}_2^c - g_2^c)^{BB} = \frac{1/\delta_2}{S}[\Xi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) + \Theta\psi(\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c)] - \frac{\delta_3}{\delta_2}\Theta\psi \overline{g}_1^i$
$(\overline{x}_2 - x_2)^{BB} = \frac{1/\alpha}{S}[\Xi(\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c) + \Theta\psi(\frac{1}{\alpha}\overline{x}_1 + \overline{g}_1^c)] - \frac{\delta_3}{\alpha}\Theta\psi \overline{g}_1^i$

Note: $\Theta = 1/(1+\delta_3 S + \hat{\beta}_G \psi^2)$, $\Phi = 1-\Theta > 0$, $\Xi = 1-\Theta\hat{\beta}_G \psi^2 > 0$ and S, S^* and $\hat{\beta}_G$ are as defined in Table 1.

We now turn to exploring the macroeconomic outcomes under the golden rule versus the balanced-budget rule. Outcomes presented in Table 1 suggest that there are clear differences between the implications of current spending and public investment. Given that, under the golden rule, public investment is fully financed by public borrowing, this approach has no contemporaneous effect on macroeconomic performance;[15] $\partial\pi_1^{GR}/\partial\overline{g}_1^i = 0$, $\partial(\overline{g}_1^c - g_1^c)^{GR}/\partial\overline{g}_1^i = 0$ and

[15] This is also due to the assumption that the return from public investment is due with a one-period lag.

$\partial(\bar{x}_1 - x_1)^{GR} / \partial \bar{g}_1^i = 0$. In contrast, current or consumption spending has to be paid out of current taxation—either revenue or the inflation tax—and taxes are distortionary; higher revenue taxes reduce output, and higher inflation is undesirable. Thus, as is seen from Table 1, public consumption has an unfavorable contemporaneous effect on macroeconomic performance, $\partial \pi_1^{GR} / \partial \bar{g}_1^c > 0$ and $\partial(\bar{x}_1 - x_1)^{GR} / \partial \bar{g}_1^c > 0$.

The asymmetry between public consumption and public investment does not disappear even when both types of spending need to be paid out of current resources, as is the case under the balanced-budget rule. As is clear from Table 2, a rise in public consumption pushes upward both current and future inflation and brings about deviations of output from its target. In contrast, a rise in public investment improves economic outcomes in future, $\partial \pi_2^{BB} / \partial \bar{g}_1^i < 0$, $\partial(\bar{x}_2 - x_2)^{BB} / \partial \bar{g}_1^i < 0$ and $\partial(\bar{g}_2^c - g_2^c)^{BB} / \partial \bar{g}_1^i < 0$. There are two channels through which public investment committed today affects future outcomes. One is the direct effect; expanding public investment in $t = 1$ expands the productivity and thus the equilibrium output—and hence the tax base—in $t = 2$. The greater the productivity coefficient, ψ, the larger the scale of output expansion in $t = 2$. This is the case under both debt and tax finance. The second is the indirect effect, arising due to the implications of servicing the public debt in $t = 2$ that was raised in $t = 1$ to pay for the public investment; such implications only appear when debt finance is involved. Clearly, the first effect is favorable, and the second is unfavorable. Nevertheless, a rise in public capital spending in the first period is only possible by lowering public consumption in the same period under tax finance, $\partial g_1^{c,BB} / \partial \bar{g}_1^i < 0$ and $\partial(\bar{g}_1^c - g_1^c)^{BB} / \partial \bar{g}_1^i > 0$. Moreover, the balanced-budget rule requires that public investment be paid for by current revenues, with obvious distortionary consequences on inflation and output in the same period ($\partial \pi_1^{BB} / \partial \bar{g}_1^i > 0$ and $\partial(\bar{x}_1 - x_1)^{BB} / \partial \bar{g}_1^i > 0$). It follows, therefore, that the cost of public investment falls on the first period under tax finance and the second period under debt finance.

A glance at the equilibrium of public investment under the two cases suggests that the golden rule is likely to be more investment friendly (the first line in both tables). This is because public spending (both consumption and investment spending) is paid for out of current taxation under the balanced-budget case and is therefore constrained by the first period's distortions. For example, a higher output target in the first period requires a lower tax rate, limiting the revenue base that the policymaker can draw on to pay for public investment. Similarly, a policymaker with a greater public consumption target would have less room to maneuver when trying to channel resources towards public investment; thus, $\bar{x}_1$ and $\bar{g}_1^c$ have negative coefficients in the expression for g_1^i in the first row of Table 2. In contrast, under the golden rule, public investment is entirely paid for out of public borrowing, and, hence, there is no role for the first-period distortions in determining its level. In this case, the unfavorable consequences of having to pay for public investment in the first period is postponed till $t = 2$, and the impact of public investment on the second period's macroeconomic performance depends on the benefits of public investment (ψ) relative to the costs of public borrowing ($1+r_1$). Under the balanced-budget rule, however, the cost of expanding public investment is immediate, which limits the scope and thus the potential benefits of public investment to future economic performance. It is widely argued, for instance, that myopic governments—such as those facing an election in the near term—tend to favor current expenditures over public investment, due to fiscal stringency (see, for example, De Haan *et al.*, 1996). Indeed, such shortsightedness is obviously more likely under the balanced-budget rule, with the inevitable damaging effects on future macroeconomic outcomes.

Overall macroeconomic performance

What determines whether public investment improves macroeconomic outcomes over the whole period under the two cases? Table 2 suggests that a rise in public investment under the balanced-budget rule imakes for a better overall macroeconomic performance if $\psi > 1$. This, in turn, requires highly productive public investment projects. Proposition 1 formalizes these arguments.

Proposition 1 *Under the balanced-budget rule, a rise in public investment committed in* $t = 1$ *improves overall macroeconomic performance if* $\psi > 1$ *holds, and vice versa otherwise.*

Proof. The derivatives of inflation, output and public consumption gaps in $t = 1$ with respect to the public investment target are $\partial\pi_1^{BB}/\partial\bar{g}_1^i = \frac{\delta_3}{\mu_1}\Theta$, $\partial(\bar{x}_1 - x_1)^{BB}/\partial\bar{g}_1^i = \frac{\delta_3}{\alpha}\Theta$ and $\partial(\bar{g}_1^c - g_1^c)^{BB}/\partial\bar{g}_1^i = \frac{\delta_3}{\delta_2}\Theta$. Similarly, in

$t = 2$, $\partial\pi_2^{BB}/\partial\overline{g}_1^i = -\frac{\delta_3}{\mu_1}\Theta\psi$, $\partial(\overline{x}_2 - x_2)^{BB}/\partial\overline{g}_1^i = -\frac{\delta_3}{\alpha}\Theta\psi$ and $\partial(\overline{g}_2^c - g_2^c)^{BB}/\partial\overline{g}_1^i = -\frac{\delta_3}{\delta_2}\Theta\psi.$ It therefore follows that for $\partial\pi_1^{BB}/\partial\overline{g}_1^i + \partial\pi_2^{BB}/\partial\overline{g}_1^i$, $\partial(\overline{x}_1 - x_1)^{BB}/\partial\overline{g}_1^i + \partial(\overline{x}_2 - x_2)^{BB}/\partial\overline{g}_1^i$ and $\partial(\overline{g}_1^c - g_1^c)^{BB}/\partial\overline{g}_1^i + \partial(\overline{g}_2^c - g_2^c)^{BB}/\partial\overline{g}_1^i$ to be non-positive, $\psi > 1$ is a pre-condition.

Under the golden rule, the overall impact of public investment would be determined by the net productivity effect, $\psi_N = \psi - (1 + r_1)$. This can be seen in Table 1. The three values corresponding to $\pi_2^{GR}, (\overline{g}_2^c - g_2^c)^{GR}$ and $(\overline{x}_2 - x_2)^{GR}$ are all unambiguously negative functions of ψ_N, suggesting a favorable effect in the presence of positive net productivity. That is, expanding public investment in $t = 1$ makes the policymaker better off in $t = 2$ only when $\psi_N > 0$. Given that public investment had no contemporaneous effect under the golden rule, the condition for it to boost overall macroeconomic performance is given by $\psi_N > 0$. In contrast, in countries where return from investment is low relative to the cost of public borrowing, $\psi_N < 0$, expanding public investment is likely to deteriorate the overall macroeconomic environment.

The below proposition formalizes these relationships.

Proposition 2 *Under the golden rule, the higher public investment is in the first period, the lower the inflation rate, public consumption gap and output gap are; hence, overall macroeconomic performance is better if* $\psi_N > 0$, *and vice versa otherwise*.

Proof. The derivative of π_2^{GR} with respect to $\overline{g}_1^i$ is $-\frac{1/\mu_1}{S}\psi_N\Psi,$ and this derivative is unambiguously negative (positive) when $\psi_N > 0$ $(\psi_N < 0)$. Similarly, the derivatives $\partial(\overline{g}_2^c - g_2^c)^{GR}/\partial\overline{g}_1^i$ and $\partial(\overline{x}_2 - x_2)^{GR}\partial\overline{g}_1^i$ are $-\frac{1/\delta_2}{S}\psi_N\Psi$ and $-\frac{1/\alpha}{S}\psi_N\Psi,$ respectively, which are again negative (positive) if $\psi_N > 0$ $(\psi_N < 0)$. It is straightforward to show that $\partial\pi_1^{GR}/\partial\overline{g}_1^i + \partial\pi_2^{GR}/\partial\overline{g}_1^i$, $\partial(\overline{x}_1 - x_1)^{GR}/\partial\overline{g}_1^i + \partial(\overline{x}_2 - x_2)^{GR}/\partial\overline{g}_1^i$ and $\partial(\overline{g}_1^c - g_1^c)^{GR}/\partial\overline{g}_1^i +$ $\partial(\overline{g}_2^c - g_2^c)^{GR}/\partial\overline{g}_1^i$ are unambiguously negative (positive) when $\psi_N > 0$ $(\psi_N < 0)$, given that $\partial\pi_1^{GR}/\partial\overline{g}_1^i =$ 0, $\partial(\overline{g}_1^c - g_1^c)^{GR}/\partial\overline{g}_1^i = 0$ and $\partial(\overline{x}_1 - x_1)^{GR}/\partial\overline{g}_1^i = 0$.

It is clear from the above propositions that under debt finance, policymakers face a more strict requirement ($\psi > 1 + r$) for public investment to be seen as demonstrably advancing national macroeconomic performance over the whole period, compared to tax finance (for which the relevant condion is $\psi > 1$).

However, it must be noted that, in an environment where interest rates vary with the borrowing requirement and the lending conditions, the impact of public investment on the overall macroeconomic outcome would be less clear-cut. We would expect that, when interest rates rise in response to higher borrowing, additional public investment could only be financed with higher productivity, as compared with the exogenous interest rate case. This is all the more true under debt finance.

3. Concluding remarks

What does this analysis suggest for the relevance of governments' policies on public investment spending? We have two main results. First, we show that the golden rule of public finance is likely to be more public-investment friendly than the balanced-budget rule by allowing the policymaker to borrow for it, delaying the unfavorable cost implications. However, we also find that adhering to the golden rule rather than the balanced-budget rule does not guarantee that public investment will improve economic outcomes. We show that expanding capital spending under the golden rule improves macroeconomic performance only when its productivity contribution exceeds the cost of public borrowing. This, in turn, implies that the golden rule necessitates higher returns from public investment projects, compared to the balanced-budget rule, in order to yield favorable overall macroeconomic outcomes. As such, we argue that policymakers should aim to enhance the productivity of public investment, not just its level. Thus, our results point to the importance of well-functioning public financial management systems with proper mechanisms for appraisal, selection and monitoring of public investment projects. Indeed,this has been widely advocated by the proponents of reforming the

SGP in favor of a golden rule in the eurozone. The IMF's recent proposals for providing help to countries under IMF-supported programs in project evaluation is also based on the recognition of this principle. Overall, our results indicate that a properly functioning public financial system committed to the quality of public investment projects is essential. This is also relevant for the long-term macroeconomic consequences of the fiscal stimulus packages that involve substantial public investment components.

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Appendix

Derivation of the equilibrium outcomes under the golden rule

In this decentralized policymaking framework, the government and the independent central bank play a Nash game in both periods. More formally, after the nominal wages are set, both the fiscal and monetary authorities act simultaneously to choose their respective instruments.

Solution in $t = 2$

The central bank chooses inflation (π_2) to minimize the welfare losses in $t = 2$, taking the government's action and expectations, as given:

$$\frac{1}{2}\left[\mu_1\pi_2^2 + \left(x_2 - \bar{x}_2\right)^2\right] \tag{A1}$$

Combining the first-order condition (FOC) with the output supply function and, then, rearranging for π_2 yields the following reaction function of the central bank:

$$\pi_2 = \frac{\alpha}{\mu_1 + \alpha^2}[\alpha(\pi_2^e + \tau_2 - \psi g_1^i) + \bar{x}_2] \tag{A2}$$

Likewise, the government minimizes its in-period losses with respect to τ_2 and g_2^c subject to the budget constraint and output supply function by taking the central bank's action and expectations as given (note that g^i and d are not among the choice variables in $t = 2$). Also note that $g_1^i = d_1$ (due to the presence of the golden rule), and they are taken as given in $t = 2$. Hence, by substituting output supply function into the loss function in $t = 2$, the final-period Lagrangean of the policymaker can be written as follows

$$£_2 = \frac{1}{2}[\delta_1\pi_2^2 + (\alpha(\pi_2 + \psi g_1^i - \pi_2^e - \tau_2) - \bar{x}_2)^2 + \delta_2(g_2^c - \bar{g}_2^c)^2]$$

$$+ \lambda_2(g_2^c + (1 + r_1)g_1^i - \tau_2 - k\pi_2) \tag{A3}$$

where λ_2 is the Lagrange multiplier associated with the government's budget constraint in the final period.

The FOCs for τ_2 and g_2^c can be written, respectively, as follows :

$$-\alpha(\alpha(\pi_2 + \psi g_1^i - \pi_2^e - \tau_2) - \bar{x}_2) = \lambda_2 \tag{A4}$$

$$\delta_2(\bar{g}_2^c - g_2^c) = \lambda_2 \tag{A5}$$

Eliminating λ_2 from the above two-equation system yields the following:

$$g_2^c = \frac{\alpha}{\delta_2}[\alpha(\pi_2 + \psi g_1^i - \pi_2^e - \tau_2) - \bar{x}_2] + \bar{g}_2 \tag{A6}$$

Combining (A6) with the budget constraint yields the government's reaction function, as in the following:

$$\tau_2 = \frac{1}{\delta_2 + \alpha^2}[(\alpha^2 - k\delta_2)\pi_2 + (\alpha^2\psi + \delta_2(1 + r_1))g_1^i - \alpha^2\pi_2^e - \alpha\bar{x}_2 + \delta_2\bar{g}_2^c] \tag{A7}$$

After imposing the rational expectations condition (i.e. $\pi_2^e = \pi_2$) on the above two reaction functions, equilibrium values of π_2 and τ_2 are obtained. Similarly, it is straightforward to solve for equilibrium values of g_2^c and x_2 by using the budget constraint and output supply function. Thus, the second period outcomes, π_2, $(\bar{x}_2 - x_2)$ and $(\bar{g}_2^c - g_2^c)$, in terms of the first period's public investment (g_1^i), can be written as follows:

$$\pi_2 = \frac{1/\mu_1}{S}(\bar{g}_2^c + \frac{1}{\alpha}\bar{x}_2 - \psi_N g_1^i) \tag{A8}$$

$$(\bar{g}_2^c - g_2^c) = \frac{1/\delta_2}{S}(\bar{g}_2^c + \frac{1}{\alpha}\bar{x}_2 - \psi_N g_1^i) \tag{A9}$$

$$(\bar{x}_2 - x_2) = \frac{1/\alpha}{S}(\bar{g}_2^c + \frac{1}{\alpha}\bar{x}_2 - \psi_N g_1^i) \tag{A10}$$

where $S = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{k}{\mu_1}$ and $g_1^i = d_1$

Solution in $t=1$

The central bank and the government play a Nash game in $t=1$ as in $t=2$. The central bank chooses π_1 to minimize $\frac{1}{2}[\mu_1\pi_1^2+(x_1-\bar{x}_1)^2]$. Rearranging the FOCs for π_1 yields the following reaction function of the central bank,

$$\pi_1=\frac{\alpha}{\mu_1+\alpha^2}[\alpha(\pi_1^e+\tau_1)+\bar{x}_1] \tag{A11}$$

Similarly, the fiscal authority chooses τ_1, g_1^c and g_1^i to minimize its intertemporal loss function, taking the central bank's action and expectations as given. Formally, by substituting the equilibrium values from $t=2$ and the output supply function into the fiscal policymaker's intertemporal loss function in $t=1$, the first-period Lagrangean can be written as follows:

$$\pounds_1=\frac{1}{2}[\delta_1\pi_1^2+(\alpha(\pi_1-\pi_1^e-\tau_1)-\bar{x}_1)^2+\delta_2(g_1^c-\bar{g}_1^c)^2+\delta_3(g_1^i-\bar{g}_1^i)^2]$$

$$+(1/2)\beta_G\frac{S^*}{S^2}(\bar{x}_2/\alpha+\bar{g}_2-\psi_N g_1^i)^2+\lambda_1(g_1^c-\tau_1-k\pi_1) \tag{A12}$$

where λ_1 is the Lagrange multiplier associated with the budget constraint in the first period and $S=\frac{1}{\alpha^2}+\frac{1}{\delta_2}+\frac{k}{\mu_1}$, $S^*=\frac{1}{\alpha^2}+\frac{1}{\delta_2}+\frac{\delta_1}{\mu_1^2}$ and $\psi_N=\psi-(1+r_1)$.

The FOCs for τ_1, g_1^c and g_1^i can be written, respectively, as follows,

$$-\alpha(\alpha(\pi_1-\pi_1^e-\tau_1)-\bar{x}_1)=\lambda_1 \tag{A13}$$

$$\delta_2(\bar{g}_1^c-g_1^c)=\lambda_1 \tag{A14}$$

$$\delta_3(g_1^i-\bar{g}_1^i)=\psi_N\beta_G\frac{S^*}{S^2}(\bar{x}_2/\alpha+\bar{g}_2^c-\psi_N g_1^i) \tag{A15}$$

The equilibrium outcome for g_1^i is directly derived from (A15). In order to derive the equilibrium outcome for the rest of the variables in $t=1$, initially,

λ_1 is eliminated from (A13) and (A14), and then the rational expectations condition (i.e. $\pi_1^e = \pi_1$) is imposed. Finally, combining the resulting equations with the budget constraint and the output supply function yields the equilibrium outcome for g_1^c, π_1 and x_1 in the first period appearing in Table 1.

Derivation of the equilibrium solution under the balanced-budget rule

The equilibrium outcomes under the balanced-budget rule—as shown in Table 2—can be derived by following the same procedure as above, utilizing the relevant budget constraint, $g_t^c + g_t^i = k\pi_t + \tau_t$.