DISCUSSION PAPER SERIES

No. 6139

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INTERNATIONAL MACROECONOMICS

Centre for Economic Policy Research

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Available online at: www.cepr.org/pubs/dps/DP6139.asp

ISSN 0265-8003

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Discussion Paper No. 6139
March 2007

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CEPR Discussion Paper No. 6139

March 2007

ABSTRACT

Public investment: a remedy or a curse? Examining the Role of Public Investment for Macroeconomic Performance*

This paper explores the implications of public investment for macroeconomic performance within a simple two-period policymaking model. We show that under the balanced-budget rule, the contribution of public investment to future output plays a key role in determining its effects on macroeconomic performance. When policymakers resort to debt issue in financing expenditures, the attractiveness of public investment crucially depends on the return from capital spending relative to the cost of public borrowing. We also consider the case of a capital borrowing rule where only public investment could be financed by additional borrowing and find similar results. Our findings point to the key role of the quality of public investment in its impact on macroeconomic outcome and highlight the importance of efficient mechanisms for selection, implementation and monitoring of public investment projects in both developed and developing countries.

JEL Classification: E62, H50 and H63
Keywords: macroeconomic performance, public debt and public investment

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*We would like to thank the ESRC for research support under the 'Understanding the Evolving Macroeconomy' Program (Grant L138251026). We also thank seminar participants at University of Birmingham, University of Cambridge, University of York, TEA 2006 International Conference in Economics, Ankara and ASSET 2006 Annual Meeting, Lisbon. A substantial part of this paper was written while Mustafa Ismihan was a visiting scholar at DERS, the University of York. He thanks DERS for the excellent research environment and Turkish Academy of Sciences (TUBA) for .nancial support (Postdoctoral scholarship-TUBA-DSYDAB-2006). The usual disclaimer applies.

Submitted 29 January 2007

1 Introduction

The emergence and the size of budget deficits and the subsequent sharp rises in public debt during the 1980s and the early 1990s in many industrial and developing countries were at the core of the debate on optimal fiscal institutions over the last decade.[1] Such experiences of high fiscal deficit and debt levels revived the debate on discretionary versus rules-based fiscal policy. Similar to the developments in monetary policymaking, this debate led to important steps towards the adoption of formal rules.[2] For example, eurozone countries, the UK, New Zealand, Japan, Sweden and Canada all enacted fiscal rules during the 1990s (see, for example, Kopits, 2001). Argentina and Brazil followed suit in 2000 and 2001, respectively.[3] The adoption of different fiscal rules and frameworks in different countries has created a lively and still ongoing debate on the optimality of one set of rules against another as well as on the effectiveness of formal fiscal rules.

The two prominent forms of fiscal rules that have been at the centre of the policy debate are the so-called 'golden rule' of public finances followed by the UK and the deficit ceilings enshrined in the Stability and Growth Pact (SGP) of the European Monetary Union (EMU). One crucial difference between the UK's golden rule and the SGP is in the allowance for public investment in the former as it excludes public capital expenditures from deficit targets. The golden rule, as is formulated in the UK, requires that no net borrowing be raised over the cycle for current spending but allows the government to borrow to finance investment. In contrast, the rules of the SGP treat capital and current expenditure 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 1990s (see, for example, Blanchard and Giavazzi, 2004 and Creel, 2003). In addition, it has been argued that in view of the EMU's declared aim of 'creating the most innovative area in the world' the unfavourable implications of the SGP's fiscal rules for public capital spending may be particularly damaging.[4] It has also been pointed out that existing rules may be too constraining for the new members of EMU that obviously have greater public investment needs. Potential consequences of subjecting public investment to the same fiscal constraints as current spending has also been recognized by the IMF. By acknowledging the public capital spending's contribution 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).

In spite of the above discussed role of public investment considerations in policy debates concerning the optimal choice of fiscal frameworks, this issue has been surprisingly absent in the formal analyses of fiscal rules.[5]This is difficult to reconcile with the exist-

[1] The scale of fiscal deficits observed over this period was hard to reconcile with the predictions of either the Keynesian theories of output stabilization or the Neoclassical theories of tax smoothing (see, for example, Corsetti and Roubini, 1998).

[2] Taylor (2000) provides an account of why discretionary fiscal policy is no longer a realistic policy option.

[3] The US and Germany already had rules in place prior to this period.

[4] See, for example, Creel (2003), p.15. Similarly, it has been suggested that the potential reduction in public investment spending, which might be brought about by the fiscal rules contained within the SGP may contradict with other European Union objectives, such as those regarding transportation networks (see, Le Cacheux, 2002).

[5] To the best of our knowledge, the two exceptions are Buiter (1998) and Dur *et al* (1997). However,

ing empirical literature on the positive impact of public investment on productivity and output (see, for example, Aschauer, 1989a,b, Morrison and Schwartz, 1996, Pereira, 2000 and Mittnik and Neuman, 2001). Additional empirical support for the beneficial role of public capital spending for macroeconomic performance has been provided by the experience of countries that resorted to various fiscal adjustment programs. Existing research reveals that the composition of such adjustments plays a crucial role on the probability of their success. More specifically, it has been shown that adjustments that entail largely capital expenditure cuts are likely to be contractionary as opposed to those carried out by current expenditure cuts, which points to the favourable impact of capital spending on output (see, for example, Perotti, 1996 and Alesina and Ardagna, 1998).

Motivated by these findings on the potentially significant role of public investment on output performance, this paper explores the implications of varying the composition of public spending for economic outcomes, with a particular emphasis on the role of public capital spending. In order to study both the determinants and the consequences of public spending decisions -both the level and the composition- we provide an analytical framework that explicitly incorporates the distinction between non-productive current (consumption) spending and productive capital spending (public investment). This is done within a simple two-period model of monetary and fiscal policy where policy decisions regarding monetary and fiscal instruments are taken in a decentralized fashion. The government acting through the fiscal authority oversees the spending, tax and borrowing decisions while inflation is controlled by an independent central bank.

This paper is the first attempt to incorporate the distinction between public consumption and investment into a dynamic policymaking framework with monetary and fiscal interactions in the presence of public debt. We show that this framework enables us to extend our understanding of the dynamics of public spending and the implications for economic outcomes in a number of important ways. First, our framework allows for an explicit analysis of the fiscal authority's decision regarding how to divide total expenditure between current spending, which may have popularity enhancing benefits but no real effects on the economy, and public investment, which enhances the future output prospects. Thus, this framework enables one to evaluate the role of different types of public spending on economic outcomes. Given the persistent declines in public investment as a proportion of GDP almost universally over the last three decades, understanding the potential consequences of changes in the composition of spending is clearly of great relevance.[6] Second, the key to our framework is the incorporation of the quality of public investment, and this help us to evaluate the consequences of public investment decisions in a more realistic way. Third, the increasing prominence of formal fiscal rules in current policy environment calls for a better understanding of the implications of these rules for macroeconomic outcomes

our analysis differs from both in important ways. Buiter (1998) analyzes the role of a capital borrowing rule on government's solvency and fiscal stability but does not consider the role of public investment on macroeconomic outcomes. On the other hand, Dur *et al* (1997) explores the effectiveness of fiscal rules in preventing politically motivated strategic behaviour in terms of public investment and output. In contrast to our model, neither takes into account the productivity or quality of public investment. Moreover, monetary policy making and hence the monetary and fiscal policy interactions were absent in both Buiter (1998) and Dut *et al* (1997).

[6] IMF (2004), for example, reports that such persistent falls in public investment led to significant infrastructure gaps especially in less developed countries since the private investment has not increased over this period.

and, thus, also the likelihood of their success. By explicitly incorporating public investment considerations, our framework enables one to better evaluate fiscal policy structures especially those that differ in their allowance for public capital provision.

We have a number of interesting results providing new insights into the understanding of public spending dynamics. First, it is shown that under a balanced-budget rule the quality of public investment plays a key role in determining the effects of public investment on macroeconomic performance. Second, our analysis suggests that the attractiveness of expanding capital spending crucially depends on the benefits of public investment relative to the cost of public borrowing under a discretionary policymaking regime. Therefore, unless the rate of return on investment projects is sufficiently high -at least to cover the costs of borrowing that is required to finance this investment- there is no *a priori* argument in favour of this type of spending at the expense of others. We have also considered the implications of a golden rule where only public investment could be financed by additional borrowing. We find that there is no guarantee that public investment will be productive under such a capital borrowing rule and higher public investment may still yield *un*favourable effects on macroeconomic performance if the returns from investment are low. Overall, our results point to the crucial importance of improving the quality of public investment by strenghtening systems for public investment prioritization and management. Our findings also suggest that increasing public investment without due consideration of its costs and benefits is not a substitute for improving its quality.

The remainder of this paper is organized as follows. Section 2 presents the basic model by explicitly incorporating the distinction between the productivity enhancing public investment and current consumption and considers the role of public investment and consumption on macroeconomic performance under a balanced-budget case. Section 3 extends the basic model by allowing for public borrowing as an additional source of finance for public outlays. This section investigates the consequences of public capital spending and borrowing decisions as well as their interactions on macroeconomic performance under a discretionary policymaking regime. Section 4 considers the implications of a golden rule for macroeconomic outcome. Finally, Section 5 concludes the paper.

2 Public Investment Dynamics Under a Balanced Budget Rule

We formulate a simple two-period model of macroeconomic policymaking that features explicit interactions between a fiscal authority (the government) and a monetary authority (the central bank).[7] The government acting through the fiscal authority controls the instruments of fiscal policy; taxes and public spending while the monetary instrument, inflation, is controlled by an independent central bank. To explore the implications of the policymaker's strategic decision regarding the composition of public expenditure, we distinguish between two broad spending categories; investment (g^i) and consumption (g^c). Public investment spending consists of spending, for example, on infrastructure, health

[7] Different variants of this model are used, for example, by Alesina and Tabellini (1987), Beetsma and Bovenberg (1997, 1999) and Ozkan (2000).

and education that has a positive impact on overall productivity. In addition to these favourable 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 spending which may yield immediate benefits. Taken together, these suggest that the preferences of the fiscal authority can be described by the following loss function

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

where L_t^G denotes the welfare losses incurred by the government, π_t is 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 for 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. 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

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

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 a high 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: $Y_t = A_t N_t^\gamma$, where Y_t represents output, N_t represents labour, A_t represents the level of productivity in period t and $0 < \gamma < 1$. The firm's profits is 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. The representative firm chooses labour to maximize profits by taking P_t,W_t and τ_t as given. The resulting output supply function is $y_t = \alpha(p_t + \frac{1}{\gamma}a_t - w_t - \tau_t) + z$, where lower case letters represent logs, e.g. $y_t = ln(Y_t)$, $\alpha = \gamma/(1-\gamma)$, $\ln(1-\tau) \simeq -\tau$ and $z = \alpha ln(\gamma)$.

Our formulation of the productivity effect of public investment is based on Ismihan and Ozkan (2004) and is as follows: $a_t = a_0 + \zeta g^i_{t-1}$, where $\zeta > 0$.[8] Substituting a_t into the previous equation, then normalizing output by subtracting the constant term, $z + \alpha a_0/\gamma$, for simplicity and utilizing $w_t = p^e_t$, where superscript e denotes expectation, yields the following normalized output supply function:

$$x_t = \alpha(\pi_t + \psi g^i_{t-1} - \pi^e_t - \tau_t) \tag{3}$$

In equation (3) x is the normalized (log) output, π^e is expected inflation, ψ $(= \zeta/\gamma)$ is a measure of the productivity of public investment and other variables are as defined before.

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

$$g^c_t + g^i_t = k\pi_t + \tau_t \tag{4}$$

where k is the real holdings of base money as share of output and all the other variables are as defined earlier.

Equation (4) indicates that all spending is financed by taxes and seigniorage. By restricting financing to current fiscal revenues, we are effectively imposing a *balanced-budget rule*. This assumption is adopted in this section to abstract from debt dynamics at this stage and to provide a benchmark for the outcomes under discretion and the capital borrowing rule to be analyzed later on.

2.1 Characterization of equilibrium

Government and the central bank play a Nash game in both periods where the former's choice variables are public spending (both the level and the composition) and the tax rate while that of the latter is inflation. The equilibrium outcome is found by using backwards induction. The policymakers in $t = 2$ act simultaneously and non-cooperatively to minimize their in-period losses with respect to their choice variables, for given levels of g^i_1. The decision regarding the composition of public spending is made only in the first period given that the return from public investment is due with one period lag and $t = 2$ is the final period. The government makes this choice in $t = 1$ by distributing distortions among both intratemporal and intertemporal instruments. Table 1 presents the equilibrium outcomes for public consumption gap, output gap and inflation in both $t = 1$ and $t = 2$ and public consumption and public investment in $t = 1$.[9]

[8] Ismihan and Ozkan (2004) explores the real effects of central bank independence in a simplified framework which abstracts from public debt considerations.

[9] Details of the derivation of equilibrium outcomes in both $t = 1$ and $t = 2$ are presented in the Appendix.

Table 1 Macroeconomic outcomes under the balanced budget rule

Variable	$\phi_{\overline{x}_2}$	$\phi_{\overline{g}_2^c}$	$\phi_{\overline{x}_1}$	$\phi_{\overline{g}_1^c}$	$\phi_{\overline{g}_1^i}$
g_1^i	$\frac{1}{\alpha}\Theta\widehat{\beta}_G\psi$	$\Theta\widehat{\beta}_G\psi$	$-\frac{1}{\alpha}\Theta$	$-\Theta$	$\delta_3 S\Theta$
g_1^c	$-\frac{1}{\alpha}\frac{1/\delta_2}{S}\Theta\widehat{\beta}_G\psi$	$-\frac{1/\delta_2}{S}\Theta\widehat{\beta}_G\psi$	$-\frac{1}{\alpha}\frac{1/\delta_2}{S}\Phi$	Θ^*	$-\frac{\delta_3}{\delta_2}\Theta$
π_1	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\Theta\widehat{\beta}_G\psi$	$\frac{1/\mu_1}{S}\Theta\widehat{\beta}_G\psi$	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\Phi$	$\frac{1/\mu_1}{S}\Phi$	$\frac{\delta_3}{\mu_1}\Theta$
$(\overline{g}_1^i - g_1^i)$	$-\frac{1}{\alpha}\Theta\widehat{\beta}_G\psi$	$-\Theta\widehat{\beta}_G\psi$	$\frac{1}{\alpha}\Theta$	Θ	Ξ^*
$(\overline{g}_1^c - g_1^c)$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\Theta\widehat{\beta}_G\psi$	$\frac{1/\delta_2}{S}\Theta\widehat{\beta}_G\psi$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\Phi$	$\frac{1/\delta_2}{S}\Phi$	$\frac{\delta_3}{\delta_2}\Theta$
$(\overline{x}_1 - x_1)$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\Theta\widehat{\beta}_G\psi$	$\frac{1/\alpha}{S}\Theta\widehat{\beta}_G\psi$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\Phi$	$\frac{1/\alpha}{S}\Phi$	$\frac{\delta_3}{\alpha}\Theta$
π_2	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\Xi$	$\frac{1/\mu_1}{S}\Xi$	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\Theta\psi$	$\frac{1/\mu_1}{S}\Theta\psi$	$-\frac{\delta_3}{\mu_1}\Theta\psi$
$(\overline{g}_2^c - g_2^c)$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\Xi$	$\frac{1/\delta_2}{S}\Xi$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\Theta\psi$	$\frac{1/\delta_2}{S}\Theta\psi$	$-\frac{\delta_3}{\delta_2}\Theta\psi$
$(\overline{x}_2 - x_2)$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\Xi$	$\frac{1/\alpha}{S}\Xi$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\Theta\psi$	$\frac{1/\alpha}{S}\Theta\psi$	$-\frac{\delta_3}{\alpha}\Theta\psi$

Note: For any variable, say w_t, the outcome can be stated as follows: $w_t = \phi_{\overline{x}_2}\overline{x}_2 + \phi_{\overline{g}_2^c}\overline{g}_2^c + \phi_{\overline{x}_1}\overline{x}_1 + \phi_{\overline{g}_1^c}\overline{g}_1^c + \phi_{\overline{g}_1^i}\overline{g}_1^i$. Also note that $S = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{k}{\mu_1}$, $S^* = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{\delta_1}{\mu_1^2}$, $\widehat{\beta}_G = \beta_G\frac{S^*}{S}$, $\Theta = 1/(1 + \delta_3 S + \widehat{\beta}_G\psi^2)$, $\Phi = 1 - \Theta > 0$, $\Xi = 1 - \Theta\widehat{\beta}_G\psi^2 > 0$, $\Xi^* = 1 - \Theta\delta_3 S > 0$ and $\Theta^* = 1 - \frac{1/\delta_2}{S}\Phi > 0$.

We now turn to some of the issues arising from these outcomes.

2.2 Composition of public spending and macroeconomic performance

If non-distortionary lump-sum taxes were available to the policymaker, taxes would be set in such a way to attain policy targets, $\overline{x}_t$ and $\overline{g}_t^{c,i}$. Then, bliss points for π, x and g would be achieved in equilibrium with $\pi_t = 0$, $x_t = \overline{x}_t$ and $g_t^{c,i} = \overline{g}_t^{c,i}$. In the absence of lump-sum taxes, both inflation and revenue taxes are used as sources of finance towards achieving policy targets, $\overline{x}_t$ and $\overline{g}_t^{c,i}$, which thus become the sources of distortions. Table 1 reveals that all equilibrium values are determined by current and future distortions, $\overline{x}_1$ and $\overline{g}_1^{c,i}$ and $\overline{x}_2$ and $\overline{g}_2^c$, respectively.

Reading the entries in the second and the third columns corresponding to the first-period variables (first six rows) highlights the fact that the only link between the two periods under the balanced budget rule is through the productivity enhancing role of public investment. Indeed, when $\psi = 0$ future distortions play no role in determining the first period outcomes. In this case, policymakers play a one-period Nash game between themselves and against the public. Similarly, when $\psi = 0$ current policy has no impact on future outcomes and thus first period inflation and spending are chosen to attain current policy targets only, as is seen from the first three rows.

The positive role of public investment on future output, $\psi > 0$, enables the policymaker to improve the inflation-output trade-off he faces in the second period by expanding capital spending in the first period. However, given the existence of the balanced budget rule, public investment has to be paid for by current revenues with obvious distortionary consequences. Equilibrium values presented in Table 1 clearly indicate these two opposing effects of public investment. The first is a favourable *inter*temporal effect working through the productivity enhancing role of public investment. The second is an *un*favourable *intra*temporal effect arising from the fact that only current revenues can be used to pay for public outlays under the balanced budget rule. As can be seen from the last column in Table 1, the higher the public investment spending target in the first period the lower the contemporaneous public consumption spending and thus the greater the gap between actual and targeted consumption.[10] Similarly, there is an intratemporal trade-off between public investment and output in the first-period. This trade-off also arises from the financing requirement. A rise in public investment (and/or consumption) spending leads to an increase in taxes in $t = 1$, which, in turn, lowers output. As is evident from the last column, the higher the public spending targets (both $\overline{g}_1^i$ and $\overline{g}_1^c$) the higher the output gap in the same period.

As a result of the intertemporal benefits of public investment, as discussed above, its impact on future macroeconomic performance is favourable as opposed to that of public consumption. However, both types of spending have a detrimental contemporaneous effect on macroeconomic outcome since higher spending requires both higher inflation and higher taxes and thereby lower output in the current period. Following two propositions formalize the effects of public consumption and investment expenditure.

Proposition 1 *The higher the public investment (consumption) in the first period, the lower (higher) is inflation and public consumption spending and output gaps; hence, the better (worse) is macroeconomic performance in the final period. That is, the higher is* $\overline{g}_1^i$ *(*$\overline{g}_1^c$*), the lower (higher) is* π_2*,* $[\overline{g}_2^c - g_2^c]$ *and* $[\overline{x}_2 - x_2]$*.*

Proof. The derivative of π_2 with respect to $\overline{g}_1^i$ is $-\frac{\delta_3}{\mu_1}\Theta\psi$, which is unambiguously negative given that δ_3, μ_1, Θ and ψ are all non-negative. Similarly, the derivative of π_2 with respect to $\overline{g}_1^c$ is $\frac{1/\mu_1}{S}\Theta\psi$, which is unambiguously positive. Also, the derivatives of $(\overline{g}_2^c - g_2^c)$ with respect to $\overline{g}_1^i$ and $\overline{g}_1^c$ are $-\frac{\delta_3}{\delta_2}\Theta\psi$ and $\frac{1/\delta_2}{S}\Theta\psi$, which are negative and positive, respectively. In addition, $\partial(\overline{x}_2 - x_2)/\partial\overline{g}_1^i$ is $-\frac{\delta_3}{\alpha}\Theta\psi$ and $\partial(\overline{x}_2 - x_2)/\partial\overline{g}_1^c$ is $\frac{1/\alpha}{S}\Theta\psi$. It is straightforward to establish that the former is negative and the latter is positive. ■

Proposition 2 *The higher the public investment and/or consumption in* $t = 1$*, the higher is contemporaneous inflation, output gap, and public consumption spending gap. As a result, the worse is current macroeconomic performance. That is, the higher is* $\overline{g}_1^i$ *and/or* $\overline{g}_1^c$*, the higher is* π_1*,* $(\overline{g}_1^c - g_1^c)$ *and* $(\overline{x}_1 - x_1)$*.*

Proof. The derivative of π_1 with respect to $\overline{g}_1^i$ and $\overline{g}_1^c$ are $\frac{\delta_3}{\mu_1}\Theta$ and $\frac{1/\mu_1}{S}\Phi$, respectively, which are unambiguously positive given that μ_1, δ_3, S, Φ and Θ are all non-negative.

[10] In what follows, we analyze the qualitative effects of a rise in g_1^i by working out the implications of a rise in $\overline{g}_1^i$ as $\partial g_1^i / \partial \overline{g}_1^i$ is always positive.

Similarly, the derivatives of $(\overline{g}_1^c - g_1^c)$ with respect to $\overline{g}_1^i$ and $\overline{g}_1^c$ are $\frac{\delta_3}{\delta_2}\Theta$ and $\frac{1/\delta_2}{S}\Phi$, respectively, which are positive. In addition, the derivatives of $(\overline{x}_1 - x_1)$ with respect to $\overline{g}_1^i$ and $\overline{g}_1^c$ are $\frac{\delta_3}{\alpha}\Theta$ and $\frac{1/\alpha}{S}\Phi$. It is straightforward to establish that both of these derivatives are positive. ■

Propositions 1 and 2 imply that expanding public investment makes the policymaker worse off in the short term but better off in future. It follows from the proofs of Propositions 1 and 2 that whether the improvement in performance in $t = 2$ outweighs the deterioration in $t = 1$ is determined by the productivity coefficient. If $\psi > 1$, a rise in public investment delivers a net rise in output and public consumption and thus a fall in their respective gaps between actual and targeted values over the whole period and *vice versa*, if $\psi < 1$.[11] Similarly, when $\psi > 1$, the undesirable contemporaneous effect on inflation (a rise in inflation in $t = 1$) is smaller than the desirable effect in future (a fall in inflation in $t = 2$).

This relationship is formally established by Proposition 3.

Proposition 3 *Under the balanced budget rule, the net effects of a rise in current public investment on inflation, public consumption and output gaps over the whole period are determined by the productivity of public investment, ψ. More formally, if $\psi > 1$, then $\partial(\overline{g}_1^c - g_1^c)/\partial\overline{g}_1^i < |\partial(\overline{g}_2^c - g_2^c)/\partial\overline{g}_1^i|$, $\partial\pi_1/\partial\overline{g}_1^i < |\partial\pi_2/\partial\overline{g}_1^i|$ and $\partial(\overline{x}_1 - x_1)/\partial\overline{g}_1^i < |\partial(\overline{x}_2 - x_2)/\partial\overline{g}_1^i|$ and vice versa otherwise.*

Proof. *Follows from Propositions 1 and 2.* ■

Proposition 3 suggests that under the balanced-budget rule, the net effects of a rise in current public investment on macroeconomic outcome are determined by the productivity of public investment, ψ. If $\psi > 1$, a rise in public investment is beneficial for macroeconomic performance and *vice versa*, when $\psi < 1$.

3 Public Investment and Public Debt under Discretion

The balanced budget rule considered above is rarely adhered to in practice.[12] Governments routinely resort to public borrowing to finance their expenditures. Sometimes this is done too frequently that raises the issue of fiscal sustainability, as discussed above. This section analyzes the consequences of public investment spending and borrowing decisions on macroeconomic performance as well as their interactions under a discretionary policymaking framework. In this regime, the fiscal and monetary authorities choose their instruments -τ_t, g_t^c, g_t^i and d_t for the former and π_t for the latter- to minimize their respective welfare losses as given by (1) and (2) in the absence of any policy rules. We now allow public outlays, both consumption spending and investment, to be financed by

[11] $\psi > 1$ would be the case when a dollar's worth of public investment spending today creates more than a dollar's worth of output tomorrow. A similar definition is used by Pritchett (1997) in comparing the costs of public investment with the value it creates.

[12] Most balanced budget rules in existence are formulated to function at subnational levels such as those in Canada, Switzerland and the US (see, Kopits, 2001).

public borrowing as well as current fiscal revenues. The resulting model, thus, features two intertemporal links between the first and second periods. The first of these is through the capital spending's productivity enhancing role on future output. The second is through the debt servicing obligations arising from current public borrowing. Obviously, the former is favourable as opposed to the latter.

In the presence of public debt the budget constraint takes the following form

$$g_t^c + g_t^i + (1 + r_{t-1})d_{t-1} = k\pi_t + \tau_t + d_t \tag{5}$$

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 re-paid 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 all the other variables are as defined before.[13]

On the left in equation (5) 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; taxes, seigniorage and the new issues of debt.

3.1 Characterization of equilibrium

Similar to the above, the model is solved recursively starting from $t = 2$. The fiscal and monetary authorities minimize their in-period losses in $t = 2$ with respect to their choice variables, for given values of borrowing and public investment in $t = 1$; d_1 and g_1^i.[14]

When the policymaker has access to borrowing from the public, it has two intertemporal instruments at its disposal, public investment and public debt. The first can be utilized to improve future output prospects and the second to spread the cost of financing public spending over time. In effect, optimization now requires balancing the intertemporal consequences of both g_1^i and d_1 in addition to equalizing the marginal welfare losses from different sources of taxation (τ and π).

In order to provide intuition for the asymmetric effects of public borrowing and public investment on future macroeconomic performance, Table 2 presents the second period outcomes, π_2, $(\overline{x}_2 - x_2)$ and $(\overline{g}_2^c - g_2^c)$, in terms of the first period's public investment (g_1^i) and borrowing (d_1).

Tables 2 highlights the opposing effects of public borrowing and public investment; a rise in the previous period's public borrowing (public investment) has an *un*favourable (favourable) effect on the current period's macroeconomic performance. More specifically, the higher the public borrowing (public investment) in the first period, the higher (lower)

[13] As in Beetsma and Bovenberg (1997 and 1999) all debt is indexed. In the presence of non-indexed debt, however, surprise inflation would erode the real value of the government's obligations and provide a further incentive for surprise inflation. We are excluding this possibility by focusing on indexed debt. One justification for this is the increasing reliance on indexed debt instruments in emerging market countries where this incentive has been traditionally more important. In 2001, for instance, the ratio of indexed bonds -including foreign currency denominated ones- in the total domestically issued government bonds was 90 per cent in Chile, 86 per cent in Turkey, 81 per cent in Brazil and 79 per cent in Mexico (see, for example, Borensztein *et al*, 2004).

[14] Equilibrium outcomes in both $t = 1$ and $t = 2$ can be derived as in the Appendix by incorporating the relevant budget constraint. Due to space limitations, the details are not provided in the paper. All results are available from the authors upon request.

the inflation rate, current spending gap and output gap; hence, the worse (better) is macroeconomic performance in the final period.

Table 2. Output gap, public spending gap and inflation rate in $t = 2$

Variable	Equilibrium values
$(\overline{x}_2 - x_2)$	$\frac{1/\alpha}{S}[\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c + (1 + r_1)d_1 - \psi g_1^i]$
$(\overline{g}_2^c - g_2^c)$	$\frac{1/\delta_2}{S}[\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c + (1 + r_1)d_1 - \psi g_1^i]$
π_2	$\frac{1/\mu_1}{S}[\frac{1}{\alpha}\overline{x}_2 + \overline{g}_2^c + (1 + r_1)d_1 - \psi g_1^i]$

Once the equilibrium values are known for $t = 2$, it is straightforward to solve the policymakers' loss minimization problem in $t = 1$. In this case, the government's choice variables are public spending (both g_1^i and g_1^c), borrowing and the tax rate while the central bank's is inflation. The fiscal authority in making spending and borrowing decisions in $t = 1$ takes into account the implications of d_1 and g_1^i on the economic outcome in $t = 2$. Table 3 presents equilibrium outcomes for both $t = 2$ and $t = 1$.

Table 3 Macroeconomic outcomes under discretion

Variable	$\phi_{\overline{x}_2}$	$\phi_{\overline{g}_2^c}$	$\phi_{\overline{x}_1}$	$\phi_{\overline{g}_1^c}$	$\phi_{\overline{g}_1^i}$
d_1	$\frac{1}{\alpha}\frac{1}{(1+r_1)}Z^*$	$\frac{1}{(1+r_1)}Z^*$	$\frac{1}{\alpha}Z$	Z	Γ
g_1^i	$\frac{1}{\alpha}\frac{1}{(1+r_1)}O$	$\frac{1}{(1+r_1)}O$	$\frac{1}{\alpha}O$	O	O^*
g_1^c	$-\frac{1}{\alpha}\frac{\delta_3}{\delta_2}\frac{1}{\psi_N}O$	$-\frac{\delta_3}{\delta_2}\frac{1}{\psi_N}O$	$-\frac{1}{\alpha}\frac{\delta_3}{\delta_2}\frac{(1+r_1)}{\psi_N}O$	$\widehat{O}$	$\frac{\delta_3}{\delta_2}O$
π_1	$\frac{1}{\alpha}\frac{\delta_3}{\mu_1}\frac{1}{\psi_N}O$	$\frac{\delta_3}{\mu_1}\frac{1}{\psi_N}O$	$\frac{1}{\alpha}\frac{\delta_3}{\mu_1}\frac{(1+r_1)}{\psi_N}O$	$\frac{\delta_3}{\mu_1}\frac{(1+r_1)}{\psi_N}O$	$-\frac{\delta_3}{\mu_1}O$
$(\overline{g}_1^i - g_1^i)$	$-\frac{1}{\alpha}\frac{1}{(1+r_1)}O$	$-\frac{1}{(1+r_1)}O$	$-\frac{1}{\alpha}O$	$-O$	$\frac{\psi_N}{(1+r_1)}O$
$(\overline{g}_1^c - g_1^c)$	$\frac{1}{\alpha}\frac{\delta_3}{\delta_2}\frac{1}{\psi_N}O$	$\frac{\delta_3}{\delta_2}\frac{1}{\psi_N}O$	$\frac{1}{\alpha}\frac{\delta_3}{\delta_2}\frac{(1+r_1)}{\psi_N}O$	$\frac{\delta_3}{\delta_2}\frac{(1+r_1)}{\psi_N}O$	$-\frac{\delta_3}{\delta_2}O$
$(\overline{x}_1 - x_1)$	$\frac{1}{\alpha}\frac{\delta_3}{\alpha}\frac{1}{\psi_N}O$	$\frac{\delta_3}{\alpha}\frac{1}{\psi_N}O$	$\frac{1}{\alpha}\frac{\delta_3}{\alpha}\frac{(1+r_1)}{\psi_N}O$	$\frac{\delta_3}{\alpha}\frac{(1+r_1)}{\psi_N}O$	$-\frac{\delta_3}{\alpha}O$
π_2	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\frac{1}{(1+r_1)}\Omega$	$\frac{1/\mu_1}{S}\frac{1}{(1+r_1)}\Omega$	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\Omega$	$\frac{1/\mu_1}{S}\Omega$	$-\frac{1/\mu_1}{S}\frac{\psi_N}{(1+r_1)}\Omega$
$(\overline{g}_2^c - g_2^c)$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\frac{1}{(1+r_1)}\Omega$	$\frac{1/\delta_2}{S}\frac{1}{(1+r_1)}\Omega$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\Omega$	$\frac{1/\delta_2}{S}\Omega$	$-\frac{1/\delta_2}{S}\frac{\psi_N}{(1+r_1)}\Omega$
$(\overline{x}_2 - x_2)$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\frac{1}{(1+r_1)}\Omega$	$\frac{1/\alpha}{S}\frac{1}{(1+r_1)}\Omega$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\Omega$	$\frac{1/\alpha}{S}\Omega$	$-\frac{1/\alpha}{S}\frac{\psi_N}{(1+r_1)}\Omega$

Note: The outcome for any variable can be stated as in Table 1. Also note that $\psi_N = \psi - (1 + r_1)$, $\Upsilon = 1 + (1+r_1)^2\widehat{\beta}_G > 0$, $\Lambda = \psi_N^2\widehat{\beta}_G + \delta_3 S\Upsilon > 0$, $O = [(1+r_1)\widehat{\beta}_G\psi_N]/\Lambda \gtreqless 0$ if $\psi_N \gtreqless 0$, $\frac{1}{\psi_N}O$ or $\psi_N O > 0$, $O^* = 1 - \frac{\psi_N}{(1+r_1)}O > 0$, $\widehat{O} = 1 - \frac{(1+r_1)\delta_3}{\psi_N\delta_2}O > 0$, $Z = (1/S)(\psi\psi_N\beta_G S^* + \delta_3 S^2)/\Lambda$, $Z^* = \widehat{\beta}_G(1 + r_1)[\psi_N - \delta_3 S(1 + r_1)]/\Lambda$, $\Gamma = [\delta_3 S(1 + \psi(1 + r_1)\widehat{\beta}_G)]/\Lambda > 0$, $\Omega = [\delta_3 S(1 + r_1)]/\Lambda > 0$ and S, S^* and $\widehat{\beta}_G$ are as defined in Table 1.

As can be seen from Table 3, the nature of the effects of policy targets in all cases is determined by the gap between the benefits of public investment (ψ) and the costs of public borrowing $(1+r_1)$ in $t=2$. In what follows, we use ψ_N to denote the net benefit of public investment spending, $\psi-(1+r_1)$, for notational simplicity. Clearly, there are three cases to consider;

(1) $\psi > 1+r_1$ or $\psi_N > 0$; when the net benefit of capital spending is positive in the next period; or there is a favourable net effect;

(2) $\psi = 1+r_1$ or $\psi_N = 0$; when the net benefit of productive spending is nil in the next period and

(3) $\psi < 1+r_1$ or $\psi_N < 0$; when the net benefit of productive spending is negative; or there is an *un*favourable net effect.

The following sub-sections analyze the equilibrium outcomes in each of these three cases as contained in Table 3.

3.2 Public investment and macroeconomic performance

We now examine the effects of public investment when the policymaker no longer faces the constraint of having to raise all the financing in the current period. The last column of Table 3 clearly shows that the impact of public investment on future as well as current macroeconomic performance crucially depends on the net return from capital spending, ψ_N (all Γ, O and O^* are functions of ψ_N). As is shown by the last three entries in this column, $\frac{\partial\pi_2}{\partial\overline{g}_1^i}$, $\frac{\partial(\overline{g}_2^c-g_2^c)}{\partial\overline{g}_1^i}$ and $\frac{\partial(\overline{x}_2-x_2)}{\partial\overline{g}_1^i}$ are all negatively related to ψ_N. This suggests that a rise in public investment only benefits future performance, in terms of a reduction in inflation and public consumption and output gaps, when the net return from capital spending is positive. Intuitively, when $\psi_N > 0$ the policymaker has the ability to raise capital spending in the first period by borrowing and this will create more than enough resources in the second period to honour the debt service.

More interestingly, the ability to borrow directly impacts the contemporaneous effects of public investment. A closer look at Table 3 indicates that, when $\psi_N > 0$ (and thus $O > 0$) raising capital spending actually improves current performance, in contrast to the case under the balanced budget rule. As is seen from the last column, when $\psi_N > 0$ all $\frac{\partial\pi_1}{\partial\overline{g}_1^i}$, $\frac{\partial(\overline{g}_1^c-g_1^c)}{\partial\overline{g}_1^i}$ and $\frac{\partial(\overline{x}_1-x_1)}{\partial\overline{g}_1^i}$ are negative -higher public investment target leads to lower contemporaneous inflation, public consumption and output gaps. This arises from the fact that public borrowing enables the policymaker to spread the cost of spending over time and thus eliminates the intratemporal trade-offs. When $\psi_N > 0$, the positive net return from public investment increases the scope of borrowing in the first period due to the improved ability to repay the debt in the second period. However, note that the effect on macroeconomic performance is positive only when public investment is sufficiently productive. Indeed, the case of $\psi_N < 0$ re-establishes the unfavourable in-period effects as the long-term benefits of public investment in this case is not large enough to offset its short term costs ($\frac{\partial\pi_1}{\partial\overline{g}_1^i}$, $\frac{\partial(\overline{g}_1^c-g_1^c)}{\partial\overline{g}_1^i}$ and $\frac{\partial(\overline{x}_1-x_1)}{\partial\overline{g}_1^i}$ are all positive when $\psi_N < 0$).

These arguments are formalized by the following proposition.

Proposition 4 *Under the discretionary policy regime, the effects of current public investment on the overall macroeconomic performance are determined by the net benefit of public investment spending,* $\psi_N = \psi \; - (1 + r_1)$.

i) The higher is public investment in the first period the lower is inflation rate, public consumption spending gap and output gap; hence, the better is overall macroeconomic performance, if $\psi_N > 0$.

ii) A change in public investment in the first period does not affect the overall macroeconomic performance, if $\psi_N = 0$.

iii) The higher is public investment in the first period the worse is overall macroeconomic performance, if $\psi_N < 0$.

Proof. The relevant partial derivatives are given by $\partial(\overline{g}_1^c - g_1^c)/\partial\overline{g}_1^i = -\frac{\delta_3}{\delta_2}O$, $\partial(\overline{g}_2^c - g_2^c)/\partial\overline{g}_1^i = -\frac{1/\delta_2}{S}\frac{\psi_N}{(1+r_1)}\Omega$, $\partial\pi_1/\partial\overline{g}_1^i = -\frac{\delta_3}{\mu_1}O$, $\partial\pi_2/\partial\overline{g}_1^i = -\frac{1/\mu_1}{S}\frac{\psi_N}{(1+r_1)}\Omega$, $\partial(\overline{x}_1 - x_1)/\partial\overline{g}_1^i = -\frac{\delta_3}{\alpha}O$ and $\partial(\overline{x}_2 - x_2)/\partial\overline{g}_1^i = -\frac{1/\alpha}{S}\frac{\psi_N}{(1+r_1)}\Omega$. It is clear that all partial derivatives are unambiguously negative/zero/positive when $\psi_N > 0$ / $\psi_N = 0$ / $\psi_N < 0$, respectively. ∎

Proposition 4 clearly shows that the impact of public investment on macroeconomic outcome depends on the net effect of public investment, ψ_N, which is determined by ψ, the productivity or the quality of public investment and, r_1, the interest rate on public borrowing. Taking r_1 as given, it is obvious that the quality of public investment is a key parameter in determining its impact on macroeconomic outcome. Thus, unless the rate of return on investment projects is sufficiently high -at least to cover the costs of borrowing that is required to finance this investment- there is no *a priori* argument in favour of this type of spending at the expense of others. On the other hand, the presence of productive public investment opportunities, $\psi_N > 0$, enables the policymaker to finance popularity-enhancing public spending in both periods with the help of intertemporal instruments (g_1^i and d_1) without hampering output and inflation performance.

As such our findings highlight the importance of identifying projects with highest returns in committing capital spending.[15] The IMF's recent proposals for providing help to countries under IMF-supported programs in project evaluation is a recognition of this principle. It has also been noted that the strong project appraisal that is a part of the fiscal framework in the UK has been a crucial element in its functioning (Hemming and Ter-minassian, 2004). Likewise, the significance of the productivity of public investment has also been noted by the proponents of reforming the SGP in favour of a golden rule. For example, Blanchard and Giavazzi (2004) point to the need for the institutional design of investment agencies in arguing for 'a proper accounting of public investment'.[16] Thus,

[15] The parameter ψ is affected by other variables such as the level of development of a given country. It is frequently argued that the productivity of public investment is higher in developing countries than in the industrial world (see, for example, Afonso *et al,* 2006 and World Bank, 1994). Similarly, features of the policymaking environment could also play a role in determining the scale of productivity effects. For example, the existence of activities such as corruption and favouritism has been shown to reduce the efficiency of capital spending (Tanzi and Davoodi, 1998, Isham and Kaufmann,1999 and Jain, 2001).

[16] See Blanchard and Giavazzi (2004, p.16) for more details on the institutional design of investment agencies.

our results point to the vital importance of the incorporation of the mechanisms for selection, implementation and monitoring of public investment projects in both developed and developing countries.

3.3 Determinants of Public Borrowing and Public Investment

Having established the effects of public investment on macroeconomic performance, we now turn to exploring the determinants of both public investment and public borrowing. The above analysis suggests that a rise in public investment is only beneficial if its net effect is positive. In this case, capital spending creates additional resources and provides more room for manoeuvre in $t = 2$. Once in $t = 2$, the net benefit of the previous period's public investment helps towards lower inflation, lower taxes, higher current spending and higher output. Therefore, the higher the second period distortions the greater the incentives for capital spending in the first period, that is both $\partial g_1^i/\partial \overline{x}_2$ and $\partial g_1^i/\partial \overline{g}_2^c$ are positive, as exhibited by the second row in Table 3. In addition, the positive net benefit of public investment enables the policymaker to commit capital spending that improves even the current performance. Thus, the relationship between current distortions and public investment is also positive in this case. In terms of the determination of public borrowing, d_1, ψ_N is again a key factor. The first row of Table 3 indicates that, higher in-period distortions unambiguously increase d_1 when $\psi_N > 0$. Higher borrowing, in effect, delays the undesirable consequences of such distortions, transferring the cost of financing to the second period. However, given that the return from capital spending is also due in the second period, which more than compensates for the cost of borrowing, it follows that the greater the scale of current distortions the greater the extent of borrowing. On the other hand, higher future distortions, do not necessarily reduce borrowing as would be the case in the absence of the productivity effect of public investment.[17]

When $\psi_N < 0$, however, public investment cannot generate sufficient resources in future, not even to offset the costs incurred. Thus, the trade-off between public consumption and capital spending in $t = 1$ re-appears. Hence, a rise in any policy target (except $\overline{g}_1^i$) has a negative effect on g_1^i, if $\psi_N < 0$. In this case, a rise in $\overline{g}_1^i$ unambiguously raises d_1, since capital spending generates resources to pay for at least some part of the debt service, and hence creates less distortions in $t = 2$ *vis-a-vis* current spending.

Table 3 also suggests that in-period distortions increase borrowing if $|\psi\psi_N\beta_G S^*| < \delta_3 S^2$ when $\psi_N < 0$ (note that $\partial d_1/\partial \overline{x}_1 = \frac{1}{\alpha}Z$ and $\partial d_1/\partial \overline{g}_1^c = Z$, where $Z = (1/S)(\psi\psi_N\beta_G S^* + \delta_3 S^2)/\Lambda$ and $\Lambda > 0$). This, in turn, implies that the more myopic the government, the lower the β_G, the more likely it is that $\partial d_1/\partial \overline{g}_1^c$ and $\partial d_1/\partial \overline{x}_1$ are positive. Intuitively, the more myopic the government the less significant is the policymaker's perception of future debt servicing costs. In addition, higher δ_3 and k also increase the likelihood of higher borrowing in the face of higher current distortions. This is because greater aversion for public capital spending deviations reduces the scope of reductions in public investment

[17] The first row of Table 3 implies that $\partial d_1/\partial \overline{x}_2$ and $\partial d_1/\partial \overline{g}_2^c > 0$ if $\psi_N > \delta_3 S(1 + r_1)$ (note that $S = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{k}{\mu_1}$). This suggests that, in addition to the key role of the quality of public investment, ψ_N, the policymaker's dislike for the deviations of public consumption and public investment from their targets, δ_2, δ_3, the cost of borrowing, r_1, the scope for seigniorage, k, and the inflation aversion of the central bank, μ_1, all play a role in the determination of public debt. It is also clear that the greater the productivity effect, ψ_N, the greater the possibility of a rise in d_1 in response to higher future distortions.

that would be expected in the case of $\psi_N < 0$. This, in turn, requires financing and thus the rise in d_1. Regarding the role of k, the greater the scope of inflation financing the easier it is to service the debt in the second period. Also, in this case borrowing falls in response to a rise in distortions in $t = 2$; $\partial d_1/\partial \overline{x}_2$ and $\partial d_1/\partial \overline{g}_2^c < 0$ ($Z^* < 0$ when $\psi_N < 0$). The productivity effect in this case is not strong enough to cover the debt servicing costs and thus higher second period distortions induce the policymaker to cut down borrowing.

Now let us consider the case $\psi_N = 0$. Under this scenario, equilibrium public investment is equal to its target level ($g_1^i = \overline{g}_1^i$) and is fully financed by public borrowing. As a result, all else remains the same; $\partial \pi_1/\partial \overline{g}_1^i = 0$, $\partial(\overline{x}_1 - x_1)/\partial \overline{g}_1^i = 0$, and $\partial(\overline{g}_1^c - g_1^c)/\partial \overline{g}_1^i = 0$, as is seen from the last column of Table 3 (also see Proposition 4). Thus, when $\psi_N = 0$, a rise in public investment does not affect either *current* or *future* values of public consumption, output and inflation. Hence, effects of both current and future policy targets on public investment are nil, in contrast to the case under the balanced budget rule.[18] In the absence of the productivity effect, public borrowing is the only intertemporal instrument available to the policymaker. Since borrowing improves the inflation-output trade-off in $t = 1$ but deteriorates it in $t = 2$; $\partial d_1/\partial \overline{x}_1$ and $\partial d_1/\partial \overline{g}_1^c$ are positive and $\partial d_1/\partial \overline{x}_2$ and $\partial d_1/\partial \overline{g}_2^c$ are negative when $\psi_N = 0$ (note that $Z > 0$ and $Z^* < 0$ when $\psi_N = 0$).

The following two propositions formalize the relationships between policy targets and public investment and borrowing in $t = 1$.

Proposition 5 *The higher the public investment target in $t = 1$ the higher is equilibrium public investment in that period. However, the effects of other policy targets on equilibrium capital spending in $t = 1$ depend on the net benefit of public investment spending, $\psi_N = \psi - (1 + r_1)$, in $t = 2$.*

i) The higher are current and future output and public consumption targets, the higher is equilibrium public investment in the first period, if $\psi_N > 0$.

ii) A change in current and future output and public consumption targets does not affect equilibrium public investment in $t = 1$, if $\psi_N = 0$.

iii) The higher are current and future output and public consumption targets, the lower is equilibrium public investment in the first period, if $\psi_N < 0$.

Proof. While the derivative of g_1^i with respect to $\overline{g}_1^i$ is O^*, which is unambiguously positive for all values of ψ_N, the derivative of g_1^i with respect to $\overline{g}_1^c, \overline{x}_1, \overline{g}_2^c$ and $\overline{x}_2$ are O, $\frac{1}{\alpha}O$, $\frac{1}{(1+r_1)}O$, and $\frac{1}{\alpha(1+r_1)}O$, respectively, and all partial derivatives are unambiguously positive /zero/negative when $\psi_N > 0$ / $\psi_N = 0$ / $\psi_N < 0$, respectively. ■

[18] In the balanced budget case, an increase in g_1^i is only possible by lowering g_1^c and a rise in g_2^c can be made possible by boosting g_1^i. Hence, there is an asymmetry between the effects of current and future policy targets on public investment. This asymmetry disappears in the presence of borrowing where the nature of the effects of all policy targets (except $\overline{g}_1^i$) on g_1^i depends on the sign of ψ_N.

Proposition 6 *The higher the public investment target in $t = 1$, the higher is equilibrium public borrowing in $t = 1$. However, the higher the current spending and output targets in $t = 1$, the higher is the equilibrium public borrowing in $t = 1$, if $\psi_N \geq 0$. In contrast, the higher are the public consumption and output targets in future, the lower is equilibrium public borrowing in $t = 1$, if $\psi_N \leq 0$. That is, while a rise in $\overline{g}_1^i$ raises d_1, increases in $\overline{g}_2^c(\overline{g}_1^c)$ and $\overline{x}_2$ $(\overline{x}_1)$ lower (raise) d_1, if and only if $\psi_N \leq 0$ $(\psi_N \geq 0)$.*

Proof. The derivative of d_1 with respect to $\overline{g}_1^i$ is Γ, which is unambiguously positive. However, the derivative of d_1 with respect to $\overline{g}_2^c$ and $\overline{x}_2$ are $\frac{1}{(1+r)}Z^*$ and $\frac{1}{\alpha(1+r_1)}Z^*$, respectively, which are unambiguously negative, if $\psi_N \leq 0$. Similarly, the derivative of d_1 with respect to $\overline{g}_1^c$ and $\overline{x}_1$ are Z and $\frac{1}{\alpha}Z$, respectively, both of which are unambiguously positive, if $\psi_N \geq 0$. ■

The determinants of public investment and public borrowing as established by both Propositions 5 and 6 indicate two main issues. First, the productive nature of public investment plays a key role in the determination of public borrowing. Such a link between the productivity effects of public investment and public borrowing is due to the intertemporal aspect of both public investment and public borrowing decisions. In principle, it may well be possible for a government to extend public capital spending, to be financed by additional borrowing, with favourable consequences for macroeconomic performance. However, in practice that will only be possible if the projects to be invested in are sufficiently productive. Hence, the availability of productive investment opportunities enables the policymaker to raise borrowing to finance a greater scale of public spending including current expenditure. A second issue highlighted by the above propositions is that given the size of the productivity effect, political and institutional factors -represented by both the current and future distortions as well as the policymaker's time preference and the aversion parameters- play a major role in determining both public investment spending and public debt. The existence of factors such as political instability, fragmented political processes, divided governments have all featured in the explanations of the apparent deficit bias in democratic societies (see for example, Persson and Tabellini, 2002). This aspect of fiscal policy has been put forward as a main rationale for formal fiscal rules including the SGP.

4 Golden rule

As is suggested earlier, one major criticism of the SGP has been related to its implications for public investment in eurozone countries. It has been argued that the debt and the deficit rules of the SGP may seriously restrict policymakers' willingness and ability to commit public investment in member countries. Central to these arguments have been the notion that public investment should be treated differently than public consumption in public borrowing decisions. This view is mainly based on the premise 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. The popular policy suggestion from the proponents of this argument is a capital borrowing rule -frequently referred to as the 'golden rule' of public borrowing- which enables the policymaker to run a deficit equal to the level of public investment committed. Such a rule allows only public investment to be financed by additional borrowing and hence imposes a balanced budget condition on current spending. A capital borrowing rule has been implemented in the UK since 1997, and has been in place in many US states and Dutch municipalities (Dur *et al,* 1997). A number of proposals have been put forward in favour of adopting a golden rule in eurozone instead of the framework specified by the SGP (see, for example, Blanchard and Giavazzi, 2004, Le Cacheux, 2002 and Fitoussi and Creel, 2002).[19]

In what follows we examine the effects of public investment on macroeconomic performance under the golden rule arrangement. Table 4 contains the equilibrium outcomes for both $t = 2$ and $t = 1$, when the fiscal authority follows this rule in setting its instruments (equilibrium outcomes under this policy regime are obtained by imposing the condition $g_1^i = d_1$).

Table 4. Macroeconomic outcomes under the golden rule ($g_1^i = d_1$)

Variable	$\phi_{\overline{x}_2}$	$\phi_{\overline{g}_2^c}$	$\phi_{\overline{x}_1}$	$\phi_{\overline{g}_1^c}$	$\phi_{\overline{g}_1^i}$
π_1	0	0	$\frac{1}{\alpha}\frac{1/\mu_1}{S}$	$\frac{1/\mu_1}{S}$	0
$g_1^i = d_1$	$\frac{1}{\alpha}\Psi F$	ΨF	0	0	Ψ
$(\overline{g}_1^i - g_1^i)$	$-\frac{1}{\alpha}\Psi F$	$-\Psi F$	0	0	Ψ^*
$(\overline{g}_1^c - g_1^c)$	0	0	$\frac{1}{\alpha}\frac{1/\delta_2}{S}$	$\frac{1/\delta_2}{S}$	0
$(\overline{x}_1 - x_1)$	0	0	$\frac{1}{\alpha}\frac{1/\alpha}{S}$	$\frac{1/\alpha}{S}$	0
π_2	$\frac{1}{\alpha}\frac{1/\mu_1}{S}\Pi$	$\frac{1/\mu_1}{S}\Pi$	0	0	$-\frac{1/\mu_1}{S}\psi_N\Psi$
$(\overline{g}_2^c - g_2^c)$	$\frac{1}{\alpha}\frac{1/\delta_2}{S}\Pi$	$\frac{1/\delta_2}{S}\Pi$	0	0	$-\frac{1/\delta_2}{S}\psi_N\Psi$
$(\overline{x}_2 - x_2)$	$\frac{1}{\alpha}\frac{1/\alpha}{S}\Pi$	$\frac{1/\alpha}{S}\Pi$	0	0	$-\frac{1/\alpha}{S}\psi_N\Psi$

Note: $F = \frac{1}{\delta_3 S}\psi_N\widehat{\beta}_G \gtreqless 0$ if $\psi_N \gtreqless 0$, $\Psi = 1/(1+\psi_N F) > 0$, $\Psi^* = 1 - \Psi > 0$, $\Pi = 1 - \psi_N F \Psi > 0$ and S, S^*, $\widehat{\beta}_G$ and ψ_N are as defined in Tables 1 and 3.

As is suggested by Table 4, public investment has no contemporaneous effect on macroeconomic performance under the capital borrowing rule since it is fully financed by public borrowing. More formally, $\partial(\overline{g}_1^c - g_1^c)/\partial\overline{g}_1^i = 0$, $\partial\pi_1/\partial\overline{g}_1^i = 0$ and $\partial(\overline{x}_1 - x_1)/\partial\overline{g}_1^i = 0$ (see the last column in Table 4). Since the balanced budget constraint still applies to the financing of public consumption spending both in $t = 1$ and $t = 2$, public consumption has an u*n*favourable contemporaneous effect on macroeconomic performance due to the intratemporal trade-offs between public spending and output, as noted in Section 2. Table 4 also reveals that, although public investment has no effect on contemporaneous equilibrium values of inflation, output and public consumption, its impact on the second period values of these variables is directly related to the net productivity effect, as above.

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

The three values in the last column corresponding to $\pi_2, (\overline{g}_2^c - g_2^c)$ and $(\overline{x}_2 - x_2)$ are all unambiguously negative functions of ψ_N, suggesting a favourable effect in the presence of positive net productivity. Due to the nature of the golden rule, the intertemporal link between the first period distortions and the second period equilibrium values and the second period distortions and the first period values is broken. In terms of the determination of public investment spending in $t = 1$ (and thus of public borrowing), the second period distortions induce a greater public investment only when the net productivity effect is positive ($\partial g_1^i / \partial \overline{x}_1$ and $\partial g_1^i / \partial \overline{g}_2^i > 0$ if $F > 0$ which holds when $\psi_N > 0$). Proposition 7 establishes these relationships.

Proposition 7 *Under the capital borrowing rule, the effect of public investment committed in $t = 1$ on the macroeconomic performance in $t = 2$ depends on the net benefit of public spending, ψ_N.*

i) The higher is public investment in the first period the lower is the inflation rate, public consumption gap and output gap; hence, the better macroeconomic performance in the final period, if $\psi_N > 0$.

ii) A change in public investment in the first period does not affect the macroeconomic performance in the final period, if $\psi_N = 0$.

iii) The higher is public investment in the first period the worse is macroeconomic performance in the final period, if $\psi_N < 0$.

Proof. The derivative of π_2 with respect to $\overline{g}_1^i$ is $-\frac{1/\mu_1}{S}\psi_N \Psi$, and this derivative is unambiguously negative/zero/positive when $\psi_N > 0$ / $\psi_N = 0$ / $\psi_N < 0$, respectively. Similarly, the derivative of $(\overline{g}_2^c - g_2^c)$ with respect to $\overline{g}_1^i$ is $-\frac{1/\delta_2}{S}\psi_N \Psi$, which is again negative/zero/positive when $\psi_N > 0$ / $\psi_N = 0$ / $\psi_N < 0$, respectively. The derivative of $(\overline{x}_2 - x_2)$ with respect to $\overline{g}_1^i$ is $-\frac{1/\alpha}{S}\psi_N \Psi$, which is also unambiguously negative/zero/positive when $\psi_N > 0$ / $\psi_N = 0$ / $\psi_N < 0$, respectively. ■

Proposition 7 highlights an important aspect of public spending and borrowing decisions. It suggests that even in the presence of a capital borrowing rule which eliminates all other sources of public borrowing, there is no guarantee that public investment will improve macroeconomic performance. This is because the impact of public capital spending on the economic outcome is still determined by the net productivity effect under the golden rule. It, therefore, follows that in countries where return from investment is low relative to the cost of public borrowing expanding public investment is likely to deteriorate the overall macroeconomic environment. This possibility clearly highlights the importance of the mechanisms in choosing the appropriate projects to invest in. Our results, therefore, provide strong support for recent calls for the need for proper investment agencies that would provide such mechanisms (see, for example, Blanchard and Giavazzi, 2004).

5 Concluding Remarks

This paper has explored the implications of public investment for macroeconomic performance under three fiscal policy regimes; a balanced-budget rule, discretion, and a capital borrowing rule. This is done by utilizing a simple two-period policymaking model that explicitly incorporates the productivity enhancing role of public investment as opposed to current consumption spending that has no such effect. Our main results are as follows. First, under a balanced budget rule the contribution of public investment to future output plays a key role in determining its effects on macroeconomic performance. More specifically, we show that public investment enhances overall performance under a balanced budget rule when a unit of public capital spending today raises future output by more than one unit. Second, when policymakers resort to debt issue in financing expenditures, the attractiveness of public investment crucially depends on the return from capital spending relative to the cost of public borrowing. Third, we consider the case of a capital borrowing rule where only public investment could be financed by additional borrowing. We find that even under the golden rule there is no guarantee that public investment will be productive and raising capital spending may even worsen macroeconomic outcome if returns from public investment is not sufficiently large.

As such our results provide two distinct policy implications. First, our findings suggest that the composition of public spending matters greatly not just for better inflation and output performance but also for fiscal balances. Our analysis has shown that public investment could be a flexible fiscal instrument that could potentially improve both contemporaneous and future macroeconomic environment. However, we have also shown that such beneficial effects crucially depend upon the scale of productivity effects associated with public investment. Thus, second, 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. In the absence of properly identified projects, raising public investment may well be self-defeating with serious consequences for public debt sustainability.

Appendix

Derivation of the equilibrium solution in $t = 2$

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

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

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

Re-arranging the first-order condition (FOC)s for π_2 yields the following reaction function of the central bank:

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

Likewise, the fiscal authority 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 is not among the choice variables 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

$$\begin{aligned} \pounds_2 \;=\; & \frac{1}{2}[\delta_1\pi_2^2 + (\alpha(\pi_2 + \psi g_1^i - \pi_2^e - \tau_2) - \overline{x}_2)^2 + \delta_2(g_2^c - \overline{g}_2^c)^2] \\ & +\lambda_2(g_2^c - \tau_2 - k\pi_2) \end{aligned} \tag{A3}$$

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 :

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

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

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

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

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

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

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, the equilibrium values of g_2^c and x_2 are arrived at by using the budget constraint and output supply function. Thus the results for the second period outcomes, π_2, $(\overline{x}_2 - x_2)$ and $(\overline{g}_2^c - g_2^c)$, in terms of the first period's public investment (g_1^i) can be written as follows:

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

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

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

where $S = \frac{1}{\alpha^2} + \frac{1}{\delta_2} + \frac{k}{\mu_1}$.

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 $\frac{1}{2}[\mu_1\pi_1^2 + (x_1 - \overline{x}_1)^2]$, taking government's action and expectations as given. Re-arranging the FOCs for π_1 yields the following reaction function of the central bank,

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

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

$$\begin{aligned} \pounds_1 &= \frac{1}{2}[\delta_1\pi_1^2 + (\alpha(\pi_1 - \pi_1^e - \tau_1) - \overline{x}_1)^2 + \delta_2(g_1^c - \overline{g}_1^c)^2 + \delta_3(g_1^i - \overline{g}_1^i)^2] \\ &\quad +(1/2)\beta_G\frac{S^*}{S^2}(\overline{x}_2/\alpha + \overline{g}_2 - \psi g_1^i)^2 + \lambda_1(g_1^c + g_1^i - \tau_1 - k\pi_1) \end{aligned} \tag{A12}$$

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

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

$$-\alpha(\alpha(\pi_1 - \pi_1^e - \tau_1) - \overline{x}_1) = \lambda_1 \quad \text{(A13)}$$

$$\delta_2(\overline{g}_1^c - g_1^c) = \lambda_1 \quad \text{(A14)}$$

$$\delta_3(\overline{g}_1^i - g_1^i) + \psi\beta_G \frac{S^*}{S^2}(\overline{x}_2/\alpha + \overline{g}_2^c - \psi g_1^i) = \lambda_1 \quad \text{(A15)}$$

In order to derive the equilibrium outcome in $t = 1$, initially, λ_1 is eliminated from the above three-equation system and, then, rational expectations condition (i.e. $\pi_1^e = \pi_1$) is imposed on the results. Finally, combining the resulting equations with the budget constraint and output supply function (as well as considering the the first period reaction function of the central bank, as in $t = 2$), yields the equilibrium outcome in the first period appearing in Table 1.

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