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THE POLITICAL ECONOMY OF PUBLIC INVESTMENT[°]

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Abstract

The political distortions in public investment projects are investigated within the context of a bipartisan political economy framework. The role of scrapping and modifying projects of previous governments receives special attention. The party in government has an incentive to overspend on large ideological public investment projects in order to bind the hands of its successor. This leads to a bias for excessive debt, especially if the probability of being removed from office is large. These political distortions have implications for the appropriate format of a fiscal rule. A deficit rule, like the Stability and Growth Pact, mitigates the overspending bias in ideological investment projects and improves social welfare. The optimal second-best restriction on public debt exceeds the level of public debt that would prevail under the socially optimal outcome. Social welfare may be boosted even more by appropriate investment restrictions: with a restriction on (future) investment in ideological projects, the current government perceives a large benefit of a debt reduction. However, debt and investment restrictions are not needed if investment projects only have a financial return.

Keywords: political economy, bipartisan, public investment, ideological projects, market projects, scrapping public investment, golden rule, investment restriction, deficit rule.

JEL codes: E6, H6, H7.

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1. Introduction

Conventional wisdom holds that political incentives cause public consumption to crowd out public investment. Deficit rules, such as the Europe's Stability and Growth Pact (SGP), are generally expected to worsen this crowding out effect. It may be easier to adhere to the Pact by cutting public investment, the benefits of which are less visible and usually do not directly affect specific interest groups, than to reduce public consumption. Some therefore recommend giving more leeway to public investment in the SGP (e.g., Blanchard and Giavazzi, 2004). However, this bypasses the fact that not only public consumption, but also public investment is often politically motivated. This may lead to over-investment in public projects. For example, the parties in government may want to please specific groups that benefit from particular projects and earn the political credits associated with creating such projects. An infamous case is the Dutch 'Betuwelijn', which is being built for railway transport of goods from the Rotterdam harbour into Germany and was heavily lobbied for by the employers of the Rotterdam harbour. Independent assessments unambiguously show that the project will never earn its costs back. The project may not even be able to cover its operating costs. Another example concerns the plan for a magnetic suspension High Speed Railway to the North of the Netherlands. No independent expert expects this project to earn back its costs either. Clearly, the political dimension of public investment cannot be ignored.¹

The main objective of our paper is to show that in a partisan setup, there is an incentive to over-invest in ideologically motivated public investment projects. We therefore distinguish between ideologically and financially motivated public investment projects. We thus investigate how elections and the political system distort the incentives to invest in public investment projects. We employ a bipartisan framework with political parties that have preferences for different types of public investment projects (e.g., roads versus railways). This yields outcomes with excessive government debt.² Also, an incentive to overspend on such projects arises from the desire to bind the hands of possible rival political parties that may gain office in the future, especially if the probability of the incumbent government being removed from office is high. While such overspending is beneficial for the governing party

¹ Peletier, Dur and Swank (1999) show that under a balanced budget rule public investment may be too low. However, they do not discuss the partisan nature of public investment.

² An alternative approach to explaining deficit and debt bias is based on a domestic common pool problem, where the minister of finance has insufficient credibility, no backing of the prime minister or lacks other institutional safeguards to resist the demands from the multitude of spending ministers and the pressure groups that push them (e.g., Von Hagen and Harden, 1994, 1995; Hallerberg and Von Hagen, 1999; Velasco, 1999, 2000; Krogstrup and Wyplosz, 2006).

given its chances of losing office, it is harmful for society at large. The obvious question then arises how this overspending incentive can be eliminated.

Another objective of our paper is to show that a deficit rule, such as the one prescribed in the Stability and Growth Pact, weakens the incentive for over-investment in ideological investment projects and increases social welfare. However, we also show that a deficit rule can be dominated in social welfare terms by appropriate public investment restrictions. In particular, with a restriction on the (future) investment in ideological projects, the current government perceives a large benefit of debt reduction, as the resources that are freed up for the future cannot be wasted on a project that yields no ideological return to this government. Debt will be thus lower and current ideological investment smaller. Moreover, less of the current investment will be scrapped in the future, while the time profile of government consumption is improved.

Earlier justifications of deficit rules rely on a multi-country, bipartisan framework with a common pool problem for the issue of government debt as well as time inconsistency problems arising from the erosion of the real value of nominal government debt (Beetsma and Uhlig, 1999). Our analysis abstracts from monetary policy and inflation targets, and offers an alternative rationale for deficit rules based on the political economy of investment in a bipartisan framework (cf., Persson and Svensson, 1989; Alesina and Tabellini, 1990; Tabellini and Alesina, 1990). Even though we abstract from money and central bank behaviour, we conjecture that our rationale holds even for a single country where the central bank pre-commits to pre-announced inflation targets.

Section 2 discusses the apolitical outcome, which serves as our benchmark. Section 3 sets up the main premises of our bipartisan framework of analysis, where political parties have polarised preferences about their preference for the type of investment goods and do not scrap past investment. The set-up allows for both ideological and financial returns on public investment projects. Future governments can modify the public capital accumulated by their predecessors to their liking. Hence, their investment is more productive as they can use more of the existing stock of public capital. We characterise the political outcome and also offer some numerical results with respect to changes in crucial coefficients such as the interest rate, the elasticity of demand for public consumption and the degree of polarisation of political preferences. We also explore how optimal debt management, public consumption and public investment respond to temporary and future changes in exogenous revenue. Section 4 contrasts the political and apolitical outcomes if governments can scrap past investment and a second-hand market for public capital exists. Section 5 analyses optimal restrictions on public

investment and government debt and argues that these mitigate political distortions and improve social welfare. The optimal restrictions are looser than the levels chosen by the social planner. Section 6 concludes with a summary and suggestions for further research. This section also elaborates on our analysis by discussing the implications of rent seeking and corruption for public investment. In particular, ministers with transport and infrastructure in their portfolios may gang up together with interested parties and project developers to give a flattered picture of the costs and benefits of projects. We thus argue that government may benefit from engaging in public-private partnerships with consortiums of banks, developers, planners and users. This requires careful design of risk-sharing contracts. Finally, all derivations are found in an appendix that is available directly from the authors or on www.eui.eu/Personal/RickvanderPloeg/.

2. Apolitical outcome in the absence of scrap

To have a benchmark for comparison, we first characterise the apolitical outcome that prevails in the absence of elections. There are three periods and two possible investment projects. Fraction λ of the population favours investment project K and fraction $1-\lambda$ favours project L. Investment in project K, i.e., I , occurs in the first period and comes to fruition in the second period. Investment in project L, i.e., J , takes place in the second period and pays off in the third period. Investments in project K may benefit project L.

The government is utilitarian and thus adds the preferences of its citizens and maximises the social welfare function presented in the first panel of Table 1 subject to the present-value budget constraint given in the second panel. We use italics to denote variables and roman capitals to indicate functions. Social welfare equals the discounted value of present and future government consumption, G_1 and G_2 , plus the discounted value of the immaterial return on investment in project K, i.e., I , and in project L, i.e., J . We assume separable preferences and set the social rate of discount to the market rate of interest $\phi = 1/(1+r)$. The excess of present government consumption plus investment in project K over first-period revenues, i.e., G_1+I-R_1 , must be financed by issuing government debt, B_1 . The excess of debt service, government consumption and investment in project L over public revenue in the second period, $rB_1+G_2+J-R_2$, is financed by additional government debt, B_2-B_1 . In the final period the financial return on project L must cover principal and interest on accumulated debt.

The first set of optimality conditions in the third panel of Table 1 states that the marginal utility of consumption in each period must equal the cost of public funds η_U . Demand for

public consumption in each period thus declines with the cost of public funds. Furthermore, public consumption is smoothed over time, i.e., $G_1 = G_2 = G(\eta_U)$, $G' < 0$, where from now on subscript “ U ” denotes the apolitical outcome. Since it is optimal to smooth public consumption, the present-value budget constraint implies the following level of public debt:

$$B_1 = \frac{R_2 - R_1 + I - J + \rho_K K + \rho_L L / (1+r)}{2+r} = (R_p - R_1) + (I - LOSSK) - LOSSL,$$

where $R_p \equiv \frac{(1+r)R_1 + R_2}{2+r}$, $LOSSK \equiv \left(\frac{1+r}{2+r}\right)(I - \phi\rho_K K)$ and $LOSSL \equiv \left(\frac{1}{2+r}\right)(J - \phi\rho_L L)$ are the permanent levels of exogenous public revenues and losses on public investment project K and L, respectively. Hence, if there is a temporary fall in public revenues ($R_1 < R_p$), government debt is used to contain the fall in government consumption today in such a way that it matches the fall in future government consumption (cf., Barro, 1979). Similarly, the incumbent government runs up a government debt for public investment in as far as the project earns its initial outlays back in the future. Government debt is thus used to finance temporary increases in government consumption and investment with a market rate of return. Governments thus only borrow for that part of a public investment project that eventually earns itself back. This has been coined the ‘golden rule’.

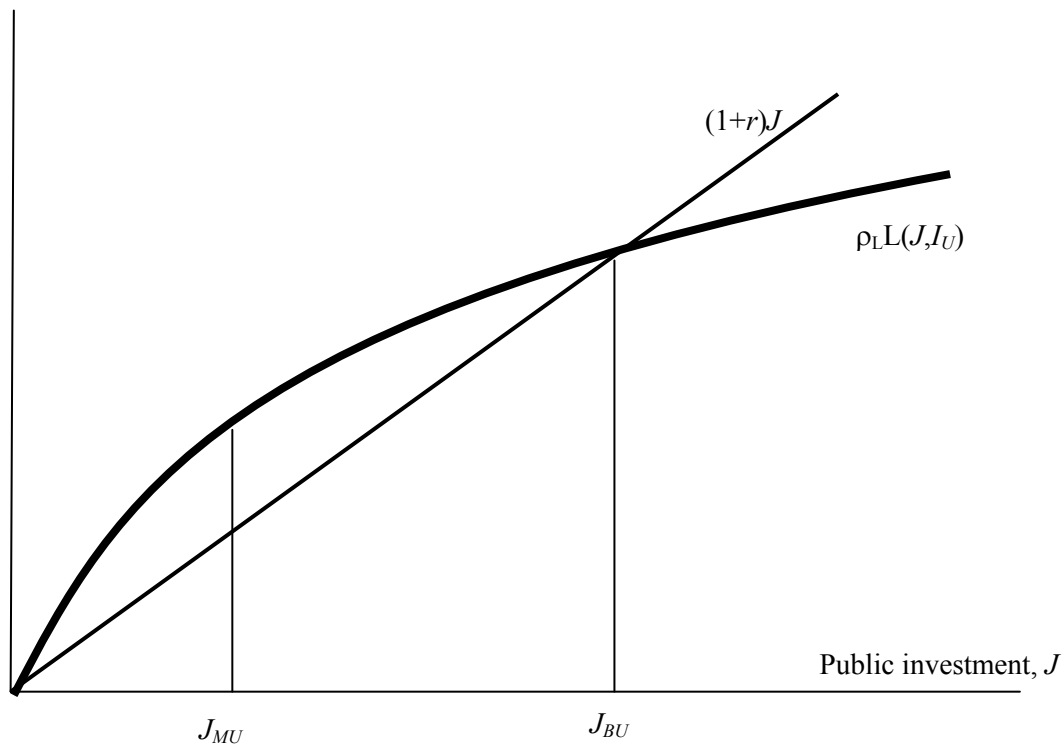
The second optimality condition in the third panel of Table 1 states that the discounted future marginal product of investment in project L times the share of people who care about this project equals the cost of public funds minus the discounted marginal future financial return on project L. Alternatively, the future financial return on investment, i.e., $\rho_L L_J(J_U, I_U)$, plus the immaterial return on project L must equal the return on government debt, $1+r$:

$$(1A) \quad [\rho_L + (1-\lambda) \psi / \eta_U] L_J(J_U, I_U) = 1 + r \Rightarrow J_U = J(\eta_U^-, I_U^{(+)}, r^-, \rho_L^+, \psi^+, \lambda^-).$$

The immaterial return on project L increases, of course, with the fraction of the population that is in favour of this type of investment $1-\lambda$. It also declines with the marginal cost of public funds, η_U . The demand for public investment in the second period J_U thus declines with the cost of public funds and increases with the fraction $1-\lambda$ of people in the population that prefer project L rather than K. It also increases with the financial return (ρ_L). If the marginal return on future investment increases with current investment (i.e., $L_{JI} > 0$), demand for investment in project L rises with past investment in project K.

An interesting special case arises if the political return ψ on the project is zero. In that case, expression (1A) indicates that the financial return on project L must equal the return on government bonds, $\rho_L L_J(J_{MU}, I_U) = 1+r$ where the subscript “*MU*” denotes the ensuing *market level of investment*. The market level of investment in project L, J_{MU} , does not depend on the cost of public funds. In general, the political return on investing in project L is positive, $\psi > 0$, so that the financial return on public investment falls short of the return on financial assets, i.e., $\rho_L L_J(J_U, I_U) < 1+r$. It is helpful to define the *break-even level of investment* as J_{BU} for which $\rho_L L(J_{BU}, I_U) = (1+r)J_{BU}$ and thus $LOSSL=0$ holds. Since $L_{JJ} < 0$, the market level of public investment corresponding to $\psi=0$ is less than the break-even level, i.e., $J_{MU} < J_{BU}$, and the government obtains maximum positive profits on its investment if it chooses $J_U = J_{MU}$. Figure 1 indicates that for all levels of investment less (bigger) than the break-even level of investment, the government makes a financial profit (loss). An increase in ψ makes investment in project L more attractive and, hence, J_U increases in ψ . In fact, there exists a critical value ψ^* such that $J_U < J_{BU}$ for $\psi < \psi^*$ and $J_U > J_{BU}$ for $\psi > \psi^*$.

Figure 1: Break-even level of public investment



The third optimality condition for investment in project K states that the discounted future marginal social value of investing in project K (including any positive effects on project L) must be set to the marginal cost of public funds minus the discounted value of any extra future financial returns on these projects. Alternatively, the financial plus immaterial return on projects K and L should equal the return on government debt:

$$(2A) \quad [\rho_K + \lambda\psi/\eta_U]K'(I_U) + \phi[\rho_L + (1-\lambda)\psi/\eta_U]L_1(J_U, I_U) = 1+r \Rightarrow I_U = I(\eta_U, J_U, r, \rho_K, \rho_L, \psi, \lambda).$$

Hence, public investment in project K, i.e., I_U , declines with the cost of public funds η_U and the cost of borrowing/the rate at which future utility flows are discounted r . Investment I_U increases with its own financial return ρ_K and the political return ψ . If public investment in project K affects project L positively (i.e., $L_I > 0$), I_U also increases with the financial return ρ_L on project L. Further, if the future marginal return on project L is reinforced by investment in project K (i.e., $L_{JI} > 0$), I_U rises with future investment J_U in project L. The effect on I_U of an increase in the fraction of people in the population that prefers project K rather than L (i.e., λ) is ambiguous. On the one hand, a higher λ raises the fraction of the people that directly derives utility from project K. This has a positive effect on investment I_U . On the other hand, a smaller share of the population derives utility from I_U in an indirect way through its positive effect on L. This affects I_U negatively. If the direct effect dominates, then we have $dI_U/d\lambda > 0$.

If the political return ψ on public investment is zero, (2A) states that the direct and indirect financial return on project K equals the return on bonds, $\rho_K K'(I_U) + \phi \rho_L L_1(J_U, I_U) = 1+r$. The solution of this equation yields the market level of investment in project K, i.e., $I_U = I_{MU}$, which clearly does not depend on the cost of public funds η_U . If the political return on project K is positive, $\psi > 0$, (2A) indicates that the total marginal financial return on project K falls short of the market rate of return, $1+r$.

If $L(J, I)$ is separable, investment in project K does not depend on future investment in project L. If $L(J, I)$ is not separable, we solve (1A) and (2A) to give:

$$(3A) \quad I_U = I^U(\eta_U, r, \rho_K, \rho_L, \psi, \lambda) \quad \text{and} \quad J_U = J^U(\eta_U, r, \rho_K, \rho_L, \psi, \lambda).$$

Substituting (3A) together with the demand functions for current and future public consumption into the present-value government budget constraint and solving for the cost of public funds yields:

$$(4A) \quad (1+r)R_1 + R_2 = (2+r)G(\eta_U) + [(1+r)I^U(\cdot) - \rho_K K(I^U(\cdot))] + [J^U(\cdot) - \left(\frac{1}{1+r}\right)\rho_L L(J^U(\cdot), I^U(\cdot))] \\ \Rightarrow \eta_U = \eta(R_1, R_2, r, \rho_K, \rho_L, \psi, \lambda).$$

If the government has more public revenue R_1 or R_2 at its disposal, the cost of public funds is lower. The terms in the two sets of square brackets indicate the financial losses on project K and project L, respectively. If investments are at their break-even levels, these terms in square brackets are zero, public investment can be de-budgeted from the present-value government budget constraint, and the golden rule of public finance is satisfied. Then, if the government needs to issue additional debt to finance government consumption ($R_1 < G_1$), a higher interest rate r pushes up the cost of public funds. Conversely, if $R_1 > G_1$, higher r pushes down η_U .

If the marginal financial return on public investment initially exactly matches the return on government debt, i.e., $\rho_K K'(I) + \rho_L L_I / (1+r) = 1+r$ and $\rho_L L_J(J, I) = 1+r$, a higher financial return on project K or L, i.e., higher ρ_K or ρ_L , always eases the government budget constraint and thus lowers the cost of public funds. If the marginal financial return on investment falls short of the return on bonds, $\rho_K K'(I) + \rho_L L_I / (1+r) < 1+r$ and $\rho_L L_J(J, I) < 1+r$, the effects of higher financial returns on public investment on the cost of public funds are no longer unambiguous. On the one hand, an increase in ρ_K or ρ_L raises available resources for given investments in projects K, respectively L, thereby reducing the cost of funds. On the other hand, higher ρ_K or ρ_L boosts investment in these projects and thus pushes up the cost of funds. Also, if the marginal effect of I on L is large relative to that on K (more precisely, if $L_I > K'$), a higher fraction λ of people that prefers project K lowers the cost of public funds. The higher λ reduces the attractiveness of the project with the higher marginal return in I relative to that with the lower marginal return and, hence, causes a reduction in I . On top of this, investment J in project L becomes less desirable. Both effects imply a fall in the demand for funds. Hence, the cost of funds shrinks. If the marginal effect of I on L is relatively small, the effect of λ on the cost of funds remains ambiguous.

If we substitute the cost of funds (4A) into (3A) and $G(\eta_U)$, we find the optimal levels of government consumption and investment. Alternatively, we can solve the social welfare problem with dynamic programming. The social planner then proceeds by backward recursion. It is easy to show that this yields the same outcome, since optimality requires that the cost of public funds in all periods must be the same, i.e. $\eta_{1U} = \eta_{2U} = \eta_U$.

3. Political outcome in the absence of scrap

3.1. A bipartisan framework with polarised preferences about public investment

Instead of a median voter approach (e.g., Bassetto and Sargent, 2006), we use a two-party partisan approach (cf., Alesina and Tabellini, 1990). The preferences and budget constraints are presented in the top two panels of Table 2. There are two political parties denoted by P and Q , respectively. They differ in their preference for the type of public investment projects (e.g., railroads versus roads). Only party P can obtain an ideological return from investing in project K , while only party Q can obtain an ideological return from investing in project L (if $\psi > 0$). However, both parties obtain the same financial returns from both projects. Subscript P indicates that the incumbent party P secures re-election while subscript Q indicates that party Q gains office in the second period.

Without loss of generality, we assume that party P is in power in the first period and chooses public consumption G_1 and public investment in the infrastructure of its choice I . It leaves a public debt to the next government B_1 equal to the excess of spending $G_1 + I$ over exogenous revenue R_1 . At the end of the first period, there are elections. Whoever gets into office in the second period, must repay the debt incurred during the first period plus interest. The incumbent P is re-elected with probability π and with probability $(1 - \pi)$ party Q gets into office. Since elections may depend on other variables than the type of public investment, the probability of re-election, π , can differ from unity (zero) even if the fraction λ of people in favour of project K is larger (smaller) than 50%.

The party that gets into office in the second period pays off debt including interest, $(1+r)B_1$, cashes the financial return on public investment $\rho_K K(I)$ and uses the remaining funds for public consumption G_2 and investment J in project L . Investment in project L induces more capital, especially if investment has already taken place in the period before. For example, government P may be strong in province K and wish to build a railroad from the capital city to province K . Party Q , however, may have a strong base in province L and want to relay the original rail-track from province K to province L . It then makes sense to have $L_{J1} > 0$. Each party when in office cashes the financial returns from the operation of the railway.

In the closing period the financial return on project L pays for principal and interest on the debt left at the end of the second period. The present-value budget constraint states that the present value of current and future government spending cannot exceed the present value of current and future exogenous government revenue plus the present value of scrap income. We

abstract from distorting taxes.

The two political parties obtain utility from government consumption, $u(G_1)+\phi u(G_2)$, and possibly from their own ideological capital stock as well, $\psi\phi K(I)$ or $\psi\phi^2 L(J,I)$. Ideological projects with no financial returns correspond to $\psi=1$ and $\rho_K=\rho_L=0$. Market projects with only a financial return correspond to $\psi=0$ and $\rho_K>0$ and $\rho_L>0$. In general, an investment project may have both an ideological and a financial return. Note that, even if the incumbent is kicked out of office, it still receives the ideological return $\psi\phi K(I)$ as the project is in existence in that period.

3.2. Strategic investment in face of political uncertainty

The timing of events is crucial for the political outcome. To ensure time consistency, it is necessary to work backwards. We thus start with the policies that have to be chosen after the election. The third panel of Table 2 presents the *post-election* outcomes in this bipartisan framework. The party that gains office in the second period cashes the exogenous revenues plus the financial returns on party P 's earlier investment, pays off principal and interest on the public debt and spends the remaining funds on public consumption and investment in project L. If party i secures office, it chooses consumption G_{2i} and investment J_i to maximise second-period utility V_i subject to the budget constraints of the second and final period, where $i=P,Q$.

First, the marginal utility of public consumption must equal government i 's marginal cost of public funds η_i , $i=P,Q$. This yields the demand for public consumption as a negative function of the cost of public funds, $G_{2i} = G(\eta_i)$, $G'<0$, $i=P,Q$.

Second, if party P gets into office in the second period, it sets investment in project L such that its marginal financial return equals the cost of capital (the purchase price plus the interest rate), i.e., $\rho_L L_J(J_P, I) = 1 + r$. Party Q ensures that the marginal utility of investment in project L equals the marginal cost of public funds times the cost of capital (the purchase price plus the interest rate) minus the marginal future financial return on investment. Alternatively, the total marginal return on investment, i.e., the marginal financial return plus the immaterial political value divided by the cost of funds, must equal the user cost of capital under Q 's reign:

$$(1P) \quad (\rho_L + \psi/\eta_Q) L_J(J_Q, I) = 1 + r.$$

The main difference with condition (1A) for the apolitical outcome is that party Q gives full ideological weight to investment in project L, so ignores the wishes of the people that do not care about investment in project L. Differentiating the first-order conditions for J under party P, respectively Q, we obtain:

$$(5) \quad J_P = J^P(I, r, \rho_L) \quad \text{and} \quad J_Q = J^Q(I, \eta_Q, r, \rho_L, \Psi).$$

Combining these with the second-period budget constraints of the respective parties and differentiating, we obtain the cost of funds in the two cases:

$$(6) \quad \eta_P = \eta_P(\bar{I}, R_2 - (1+r)B_1, r, \rho_K, \rho_L) \quad \text{and} \quad \eta_Q = \eta_Q(\bar{I}, R_2 - (1+r)B_1, r, \rho_K, \rho_L, \Psi).$$

Higher exogenous resources R_2 and a higher return ρ_K on investment in K reduce the cost of funds, while a larger stock of debt, B_1 , raises the cost of funds. Under Q's reign the effect of a higher interest rate r on the cost of funds is ambiguous. It depresses demand for investment in project L and the need for funds and thus lowers the cost of funds. But it also depresses the present value of the financial return on project L and thus pushes up the cost of funds. Also, the effect of a higher financial return on project L on the cost of funds is ambiguous. On the one hand, a higher financial return raises available resources and lowers the cost of funds. On the other hand, it raises the demand for investment in project L, thus pushing up the cost of funds. Similarly, larger investment in K has an ambiguous effect on the cost of funds. With party Q in power, the need for funds and the cost of funds are high if the immaterial value of investment projects (i.e., Ψ) is high and thus the demand for public investment is high.

The fourth panel of Table 2 presents the *pre-election* outcome. The incumbent government maximises its expected utility being fully aware of the after-election consequences of party Q taking over power on the level of government consumption and the capital it has invested in project K. The optimal level of public consumption follows from setting the marginal utility of government consumption $u'(G_I)$ equal to the pre-election marginal cost of public funds, η_I . Investment by the incumbent government follows from:

$$(2P) \quad (\pi\eta_P\rho_K + \Psi) K'(I) + \phi\pi\eta_P \rho_L L_1^P + (1-\pi)\eta_Q [\rho_K K'(I) + (\phi\rho_L L_1^Q - 1)J_1^Q + \phi\rho_L L_1^Q] \xi = (1+r)\eta_I,$$

where

$$0 < \xi \equiv \frac{G'(\eta_Q)}{G'(\eta_Q) + (\phi\psi/\eta_Q)L_J^Q J_\eta^Q} \leq 1$$

and $L_1^P \equiv \partial L(J_P, I)/\partial I$, $J_\eta^Q \equiv \partial J(\cdot)/\partial \eta_Q$, etcetera. The total marginal return of investment to the incumbent government must equal the user cost of capital in the first period times the gross interest rate, i.e., $(1+r)\eta_I$. The total marginal return of investment equals the marginal financial return of investing in public capital plus the marginal immaterial return. The *direct* marginal financial returns are $\pi\eta_P\rho_K K'$ and $(1-\pi)\eta_Q\rho_K K'$ weighted with the respective re-election probabilities and the respective costs of public funds. The present values of the *indirect* marginal financial returns are $\phi\pi\eta_P\rho_L L_1^P$ and $(1-\pi)\eta_Q\phi\rho_L L_1^Q$ due to the positive effect of first period investment on the financial return on project L (under both government types, weighted with the likelihood of their appearance and the relevant cost of public funds). These indirect returns obviously depend on second-period investment. There are two additional indirect components of the marginal financial return. The first of these, $(1-\pi)\eta_Q\phi\rho_L L_J^Q J_1^Q$ captures the positive effect of first-period investment on second-period investment and, thereby, on the financial return on L. The second one is negative and concerns the drain on resources J_1^Q caused by the higher outlay on J . The marginal immaterial return to the incumbent P is $\psi K'$. The future marginal financial returns under government Q are diluted by Q's excessive investment (from P's perspective) in J when it values project L for ideological reasons.

Party Q thus attaches immaterial utility to the project L that is not valued by the incumbent government P and that drives a wedge between the valuation of parties P and Q of this project (i.e., pushes ξ down). This crucial effect thus manifests itself by a value of the key coefficient ξ that is less than one if $\psi > 0$. Consequently, holding all costs of funds constant and assuming that an increase in I has a positive net marginal financial benefit under Q's reign,³ the incumbent party P invests less in project K to discourage a possible future government under the rule of party Q to invest in project L.

Finally, the dynamic efficiency condition for the optimal level of public debt is:

$$(7) \quad \pi \eta_P + (1-\pi) \eta_Q \xi = \eta_I.$$

³ That is, the term in square brackets in (2P) should be positive.

This condition states that the marginal benefit of an extra unit of public debt at the end of the first term must equal the expected marginal cost in the second term (the left-hand side of the equation). In general, the weight given to the future cost of public funds under a possible future rule of party Q is driven below one, because of Q's incentive to invest in a project to which party P does not attach any immaterial value. This political distortion implies $\xi < 1$ and that the incumbent government P cares less about containing debt. Effectively, the current cost of funds is reduced below the expected future cost of funds and this encourages the incumbent government to spend and borrow more.

Proposition 1: *Ideological attachment by a rival successor to investment projects that are not valued by the incumbent drives the cost of funds to the incumbent below the expected future cost of funds. This induces the incumbent to invest more in its pet investment project and to issue more debt, especially if the probability of being removed from office is high.*

3.3. Comparison of planner with partisan government

In the sequel we use the terms 'debt bias' and 'investment bias' when (for given parameters) government debt, respectively public investment, under the partisan government exceeds the corresponding levels chosen by the social planner under the apolitical outcome.

3.3.1. Special case: party P faces no electoral uncertainty ($\pi=1$)

It is instructive to study first the special case in which party P faces no electoral uncertainty ($\pi=1$). If in the Alesina and Tabellini (1990) framework electoral uncertainty vanishes, the debt bias also vanishes. Knowing that future resources can no longer be 'lost' to a type of public good that the current government does not value, the governing party no longer faces the incentive to overspend now at the cost of future spending. In our set-up, the situation is more complicated. With $\pi=1$, the two conditions (2P) and (7) that determine investment I and public debt B_I simplify to:

$$(8) \quad (\rho_K + \psi / \eta_P) K'(I) + \phi \rho_L L_1^P = 1+r \quad \text{and} \quad \eta_P = \eta_I.$$

The second of these conditions implies that public consumption will be the same in both periods, just like under a social planner. Equation (2P) needs to be compared with (2A). Holding the cost of funds equal in the two cases ($\eta_P = \eta_U$), then if $\lambda=1$, the investment outcomes under the partisan and the planner case are equal. However, in general, debt and

also first-period investment differ from the apolitical outcome. With $0 < \lambda < 1$, the comparison between party P's investment in K and the planner's investment in K becomes ambiguous. The partisan government attaches a higher ideological weight to project K than the planner, inducing it to invest more (higher I). However, the lower ideological weight that the partisan incumbent attaches to future investment L induces it to invest less (lower I).

3.3.2. Numerical comparison between planner and partisan government

To gain a better understanding of the political economy of public investment, we present some numerical results in Table 3. We adopt an iso-elastic utility function for government consumption. Parameter ε is the coefficient of relative risk aversion while δ regulates the welfare share of public consumption relative to investment. This generates demand functions for public consumption with elasticity with respect to the cost of funds equal to $-1/\varepsilon = -0.67$. We must ensure that before- and post-election investment projects reinforce each other, but are not perfect substitutes in order to avoid a degenerate solution. An easy way of achieving this is to use the specified Cobb-Douglas production function, which creates future capital out of past and present investment. We set the interest rate and the rate of time preference at 0.2. Preferences are completely polarised ($\lambda = \pi = 0.5$). Table 3 presents the results, assuming decreasing returns to scale of project L in past and future investment (i.e., $\sigma + \theta < 1$).⁴ In the apolitical case, there is no uncertainty and social welfare is given in Table 1. However, in the political case, utilitarian social welfare aggregates all individual utilities and is calculated as:

$$u(G_I) + \phi\pi u(G_{2P}) + \phi(1-\pi) u(G_{2Q}) + \lambda \phi\psi K(I) + (1-\lambda)\phi^2\psi[\pi L(J_P, I) + (1-\pi)L(J_Q, I)].$$

The first three terms capture current and expected future discounted utility from public consumption and are common to all individuals. The fourth term stands for the ideological benefit from project K and is only valued by a share λ of the population. The final term captures the ideological benefit from project L and is only valued by a share $1-\lambda$ of the population. This final term consists of two components, which capture the probability-weighted outcomes of L under the two possible types of government in the second period.

We now turn to an interpretation of the results presented in Table 3. We first compare the apolitical (planner's) and the partisan outcomes. In all cases debt is higher under the partisan government. Also first-period investment is always higher than under the planner. The reason

⁴ We avoid a constant returns specification (as is often used), because if we introduce scrap in section 4 and $\sigma + \theta = 1$, the cost of funds η_Q will be fixed by party Q's first-order conditions and thus becomes independent of party P's actions in the first period. In fact, numerical comparison of outcomes under constant and decreasing returns to scale did not reveal any qualitative differences.

is that the partisan government gives full weight to investment I , while the planner only attaches a weight that corresponds to the population share in favour of project K.

We now discuss the effects of perturbations in the various parameters of the model:

- A higher relative utility weight attached to public spending δ raises public spending and reduces investment. Because public spending is not subject to a partisan bias, the debt level falls with a higher δ .
- A higher elasticity of demand for public consumption with respect to the cost of funds (higher $1/\varepsilon$) marginally raises demand for public consumption by the incumbent P in period 1. Also, it is more attractive for P to invest in project K. These two effects result in higher public debt. Under both parties second-period consumption is lower than under the baseline, while investment in project L is higher, reflecting the positive effect that the higher level of first-period investment has on the marginal contribution of investment J to project L.
- A lower interest rate r boosts investment by the incumbent P. The reason is that the market interest rate also corresponds to the subjective discount rate of party P. Since the returns on P's investment in project K only materialise in the second period and a lower discount rate raises the relative weight of future utility terms, P will make a bigger investment in K.
- A lower interest rate r also makes debt issuance less expensive and thus leads to an increase in public debt. It also leads to a drop in public consumption (under the social planner and in the partisan case of party P in both periods and party Q in period 2). This may seem surprising, but the reason is that the drop in public consumption is necessary to make possible the increase in investment engendered by the lower interest rate. The drop in public consumption in the second period under P is the result of higher debt servicing costs that are only partly offset by more financial return on project K. In case of party Q taking over in the second period, the drop in consumption is reinforced by the higher investment in project L.
- Higher government revenue R_1 or R_2 raises party P's public consumption in both periods as well as investments in projects K and L. Higher revenue during P's first reign of office R_1 corresponds to a temporary increase in public revenue, so it is optimal to save for the next period of government by reducing debt. However, the reduction in the public debt is rather small compared to the rise in investment I . While consumption under party P is higher in the second period, consumption under party Q is actually (slightly) lower than under the baseline,

the reason being that the due to the reinforcing character of investments I and J , investment J is so much higher that this dominates the effect of the higher financial return on K and the lower debt servicing costs in period 2. Similar results obtain when R_2 is raised, although in that case public debt goes up substantially in order to smooth public consumption.

- A lower ideological return on government investment projects (i.e., $\psi=0.1$) leads to less investments in both projects while government consumption is boosted. As a result, there is less accumulation of government debt. Interestingly the polarisation becomes less severe and thus the level of government consumption is no longer that much affected by whether party P or party Q gains office in the second period. The welfare loss arising from the partisan bias is much less than before.

4. Analysis with scrap

We now allow the government to scrap part of investment in project K in the second period. We denote the amount of scrap by S . Scrapping yields βS at the second-hand market, which can be used for public consumption or investment in Q 's own favourite project. The capital production function for project L is now written $L(J, I-S)$. Think of a road that at extra cost can be converted into a railway. If part of the original road is dismantled and the land on which it was built is sold, the railway will be shorter, which reduces the size of L . We first analyse the outcomes under the planner and then turn to the case of the partisan government.

4.1. Social planner with scrap

Again, the planner smoothes consumption over time, $G_1 = G_2 = G(\eta_U)$, $G' < 0$, and thus:

$$B_1 = (R_p - R_1) + (I - LOSSK) - LOSSL + \beta S / (2 + r).$$

The final term is new and shows that the government borrows more if it anticipates more scrap revenue. This way the revenues from scrap are smoothed over time. The first-order condition for investment in project L is still given by (1A), with the term $I_U - S_U$ replacing I_U . In addition, the planner sets the marginal drop in social utility of scrapping equal to the cost of public funds times the scrap price of public capital (including interest) minus the forsaken financial return of scrapping. Alternatively, the marginal financial plus ideological losses of scrapping should equal the scrap price times the rate of interest:

$$(9A) \quad [\rho_L + (1-\lambda) \psi/\eta_Q] L_I(J_U, I_U - S_U) = (1+r) \beta.$$

The planner weighs the marginal ideological loss by the share $1-\lambda$ of the population that attaches value to project L. Combining (1A) and (9A), we see that the marginal rate of substitution between past and future investment must equal the scrap price of past investment, $L_I/L_J=\beta$. Conditions (1A) and (9A) can be solved together for scrapping and investment:

$$(10A) \quad J = J^{US}(\eta_Q^-, r^-, \beta^-, \rho_L^-, \psi^+, \lambda^+) \text{ and } S = S(I^+, \eta_Q^+, r^+, \beta^-, \rho_L^-, \psi^+, \lambda^+) = I + S^{US}(\eta_Q^+, r^+, \beta^-, \rho_L^-, \psi^+, \lambda^+).$$

Higher past investment I leads one-for-one to scrapping in the second period. A higher cost of public funds, a higher interest rate and a lower financial or immaterial return on project L reduces the demand for investment by government Q and induces more scrapping. A higher scrap price β implies it is more attractive to scrap past investments of government P. As a result, if investments in the two projects reinforce each other (i.e., $L_{IJ} > 0$), the productivity of investment J falls and thus there is a decline in investment in project L.

The first-order condition for investment in the first period is still given by (2A), with the term $L(J_U, I_U - S_U)$ replacing $L(J_U, I_U)$, so that the sum of the present discounted marginal financial plus ideological returns (directly via K and indirectly through the effect of I on J and, hence, on L) should equal the cost of funds. If we use (9A), condition (2A) becomes:

$$(2A') \quad [\rho_K + \lambda \psi/\eta_U] K'(I_U) + \beta = 1+r.$$

Hence, the marginal return in the second period of an additional unit of investment in project K consists of the marginal financial and ideological return plus the marginal revenue of scrapping one unit (recall that one additional unit of I leads to one more unit of scrap).

4.2. The partisan outcome with scrap

The parties trade off scrap value against the marginal return on investment in project L. For party P, the marginal return on investment in project L only involves a financial return, but for party Q it is both a financial and an ideological return. In the second period both parties choose government consumption, investment in project L and now also the amount of scrap. The first-order conditions for public spending are again $u'(G_{2i}) = \eta_i$, $i = P, Q$. The optimality conditions for investment in L by parties P and Q are changed to, respectively:

$$(1P') \quad \rho_L L_I(J_P, I-S_P) = 1+r \quad \text{and} \quad (\rho_L + \psi/\eta_Q) L_I(J_Q, I-S_Q) = 1+r.$$

The first-order conditions for scrapping are, respectively, for P and Q:

$$(9P) \quad \rho_L L_I(J_P, I-S_P) = (1+r) \beta \quad \text{and} \quad (\rho_L + \psi/\eta_Q) L_I(J_Q, I-S_Q) = (1+r) \beta.$$

Given that the ideological returns on project L are zero for party P, this party sets the marginal revenue β of one more unit of scrap equal to the discounted marginal financial cost associated with the fall in public capital L. Party Q gives full weight to the ideological return while the planner attaches only a weight $1-\lambda$ to the ideological return – compare (9P) with (9A). Combining (1P') and (9P), we obtain for party P, respectively party Q:

$$(10P) \quad S_P = I + S^{\text{PS}}(r, \beta, \rho_L) \quad \text{and} \quad J_P = J^{\text{PS}}(r, \beta, \rho_L)$$

$$S_Q = I + S^{\text{QS}}(\eta_Q, r, \beta, \rho_L, \psi) \quad \text{and} \quad J_Q = J^{\text{QS}}(\eta_Q, r, \beta, \rho_L, \psi).$$

As under the planner, scrap increases one for one with the investment made in the first period. Also the signs of the partial derivatives of scrap with respect to the interest rate, the second-hand price of scrap and the marginal financial return on L are the same as under the planner. Since P only scraps for financial reasons, only scrap under party Q depends on the cost of funds and the ideological value it attaches to capital L, where the signs of the partial derivatives are under the social planner.

Substituting demand for government investment and scrapping (10P) as well as demand for government consumption into the post-election budget constraints of the two parties and solving for the cost of funds yields:

$$(6') \quad \eta_P = \eta_P^S(\bar{I}, R_2, -(1+r)B_1, r, \beta, \rho_K, \rho_L) \text{ and } \eta_Q = \eta_Q^S(\bar{I}, R_2, -(1+r)B_1, r, \beta, \rho_K, \rho_L, \Psi).$$

The cost of public funds is high if the debt plus interest inherited from party P is high, exogenous revenues are low, and the scrap value of party P's investment project is low. Not surprisingly, the cost of funds is also high if the financial return on project K is low as available resources are comparatively low. However, with party Q in power, the need for revenue and the cost of funds are high if the immaterial value it attaches to project L (i.e., ψ) is high and thus the demand for public investment is high. Also, under Q, the effect of a higher interest rate r on the cost of funds is ambiguous. The interest rate affects the cost of funds in three ways. It reduces the present value of the financial return on a project L of given size. This pushes up the cost of funds. It also depresses demand for investment in project L. The resulting cash saving exceeds the resulting fall in the financial return on L, because, when evaluated at its equilibrium outcome, the marginal return on J is dominated by the market interest rate. The third effect is that an increase in the interest rate raises scrap. The marginal cash revenue on the second-hand market for scrap exceeds the induced reduction in the financial revenue on L. The second and third effects contribute to a negative effect of the interest rate on the cost of funds. These two effects disappear if P is in power, so that under P an increase in r has an unambiguous positive effect on the cost of funds. Finally, under Q the consequences of a higher marginal return on L are ambiguous. On the one hand, a higher value of ρ_L raises the financial return for given values of scrap and investment J . On the other hand, the increase in ρ_L induces more investment J , which at the margin fails to earn back its cash outlay, and less scrap, for which the foregone cash revenue dominates the financial return on the increased capital stock L. With P in power these last two effects are zero, and the effect of a change in ρ_L on the cost of funds is unambiguous.

The fourth panel of Table 2 presents the *pre-election* outcome in this bipartisan framework. The incumbent government maximises its expected utility being fully aware of the after-election consequences of party Q taking over power on the level of government consumption and the capital it has invested in project K. The optimal level of public consumption follows from setting the marginal utility of government consumption $u'(G_I)$ to the pre-election cost of public funds, η_I . Investment by the incumbent follows from:

$$(11) \quad (\rho_K + \psi / \eta_I) K'(I) + \beta = 1 + r.$$

The marginal ideological plus financial return (payback plus scrap) on investment should equal the user cost of capital.

Finally, the dynamic efficiency condition for the optimal level of public debt is:

$$(7') \quad \pi \eta_P + (1-\pi) \eta_Q \xi^S = \eta_I, \text{ where}$$

$$0 < \xi^S \equiv \frac{G'(\eta_Q)}{G'(\eta_Q) + (\phi\Psi/\eta_Q)(L_1^Q J_\eta^{QS} - L_1^Q S_\eta^{QS})} \leq 1.$$

Again, the marginal benefit of public debt equals the expected future marginal cost. The weight given to the future cost of public funds under a possible future rule of party Q is now driven more severely below one due to the extra term in the denominator than when there is no scrapping, again provided that Q has an incentive to invest in a project to which party P does not attach any immaterial value (cf., the definition of ξ after equation (2P)). If the ideological return on project L is positive, the optimal scrapping condition (9P) implies that the scrap value exceeds the discounted value of future financial returns. With scrapping, the current cost of funds is therefore driven even more below the expected future cost of funds and this encourages the incumbent government to invest and borrow even more.

Proposition 2: *With scrapping, there is an extra reason for the current cost of public funds to fall short of the expected future cost of funds in the partisan outcome. As a result, there is an extra strategic reason for the incumbent government to invest and borrow.*

4.3. Comparison of planner with partisan government when there is scrapping

4.3.1. Special case: party P faces no electoral uncertainty ($\pi=1$)

If there is no electoral uncertainty, the dynamic efficiency condition for public debt under party P becomes $\eta_P = \eta_I$. We thus have equal government consumption in the two periods. Holding first-period government consumption constant across the planner's and partisan cases (thus, $\eta_U = \eta_I$), the partisan case will be characterised by over-investment and a debt bias.

4.3.2. Numerical comparison between planner and partisan government

For our numerical comparison between the planner and the partisan government with scrapping, we use the same specifications and parameter choices as before. The computation of social welfare takes now account of the effect of scrapping on project L. A couple of the

results reported in panel (b) of Table 3 stand out. First, as long as there are full ideological returns, the planner finds it optimal not to scrap any of the investment done in the first period,⁵ thereby making optimal use of the complementary nature of earlier investment with the new investment in project L. Only if the ideological return becomes small ($\psi=0.1$), scrapping turns positive as the benefit from investment in project L gets small. The extra return from scrapping induces party P to substantially increase investment (compared to the case without scrapping). Indeed, if party P remains in office in the second period, it scraps virtually all earlier investment as the benefit from leaving some of the investment in place only results in some additional financial return on project L. Investment in project K is thus always higher under party P than under the planner. Moreover, as suggested by Proposition 1, government debt is also always larger than under the planner. Furthermore, in line with Proposition 2, investment in project K and government debt is for each case higher when the government is allowed to scrap than when scrapping is not permitted (compare with panel (a) in Table 3). This is not necessarily true for government consumption, although in a big majority of cases government consumption is higher if scrapping is allowed.

5. Fiscal restrictions

The partisan allocation rarely coincides with that under the social planner. In this section, we examine whether appropriate fiscal rules and constraints are able to bring the partisan solution “closer” to that under the planner. In particular, we explore the benefits of restrictions on public investment and a deficit rule. Throughout this section we allow for scrapping (part of) the investment in project K during the second period.

5.1. Restrictions on public investment

Let us turn to the partisan outcomes if investments by both parties are restricted to some values $I = I^R > 0$ and $J = J^R > 0$. The demand function for public consumption if Q gets into office is given by $G_{2Q} = G(\eta_Q)$, $G' < 0$ and optimal scrapping conditions are as before, except that investments in those conditions are restricted to the indicated levels. Hence, we have:

$$(10P') \quad S_p = I^R + S^{PR}(J^R, r^+, \beta^+, \rho_L^-) \text{ and } S_Q = I^R + S^{QR}(J^R, \eta_Q^+, r^+, \beta^+, \rho_L^-, \psi).$$

Also, the costs of funds if P, respectively Q, gains office in the second period are:

⁵ Solving the model yields a negative solution for the optimal level of scrapping. As we rule out

$$(6'') \quad \eta_P = \eta_P^R(I^R, J^R, R_2 - (1+r)B_1, r, \beta, \rho_K, \rho_L) \quad \text{and} \quad \eta_Q = \eta_Q^R(I^R, J^R, R_2 - (1+r)B_1, r, \beta, \rho_K, \rho_L, \Psi).$$

The main difference is that a more binding restriction on investment (a lower I^R) by the current administration P raises the cost of public funds during the second period, because the financial return on project K is smaller (while investment in L is given and, hence, independent of the restriction on I). The dynamic efficiency condition for the optimal level of public debt (7') and the demand function for consumption by government P are unaffected, but the wedge between the valuation of parties P and Q of project L becomes:

$$0 < \xi^R = \frac{G'(\eta_Q)}{G'(\eta_Q) - (\phi\Psi / \eta_Q) L_1^Q S_\eta^{QR}} \leq 1.$$

Again, if public investment is ideologically motivated, there is a wedge between the valuations of parties P and Q of project L (i.e., $0 < \xi^R < 1$). More importantly, *ceteris paribus*, the wedge with investment restrictions is smaller than without such restrictions (i.e., $\xi^R > \xi^S > 0$). Effectively, the investment restriction brings the current cost of funds more in line with the expected future cost of funds and thus weakens the strategic incentive to borrow. With future investment at its restricted level, the future resources that are freed by debt reduction will be channelled towards higher future public consumption. The incumbent is therefore induced to issue less debt for a given level of future investment. This is the key channel by which investment restrictions remove a political distortion and increase welfare.

Panel (a) in Table 4 reports, for the same baseline and parameter perturbations as before, the outcomes with restrictions on public investment. Investments are restricted to the levels chosen by the planner. Debt levels are still higher (reflecting the expected revenue from scrapping if P returns to power in period 2) and welfare levels are lower than under the planner. However, compared with the partisan solution in the absence of restrictions (see panel (b) of Table 3), debt is lower and welfare is higher under these investment restrictions. Social welfare is maximised by relaxing the restriction on I somewhat and tightening the restriction on J – see the final line of panel (a) in Table 4. If financial returns on public investment become relatively more important than ideological returns, the investment restrictions need to be less tight. In the absence of ideological returns, no investment restrictions are needed at all.

negative scrapping as economically meaningless, we resolve the model restricting scrapping to zero.

Proposition 3: *In a partisan framework, restrictions on public investment bring the current cost of funds more in line with the expected future cost of funds and thus diminish the strategic incentive to borrow too much. Investment restrictions therefore raise social welfare. Such restrictions are not needed if projects only have financial returns, since then the partisan and planner outcomes coincide.*

5.2. A debt restriction

Now we consider a debt (or deficit) restriction. A special case arises if the debt/deficit level is restricted to zero. A more general rule requires that debt should not exceed a certain fraction of government revenues R_1 . We simply assume that debt is restricted to some level B_1^R . Conditional on this debt level, the after-election outcomes are the same as without the restriction. The dynamic efficiency condition for the optimal public investment becomes:

$$(12) \quad \pi (\eta_p/\eta_l)[\rho_K K'(I) + \beta] + (\psi/\eta_l) K'(I) + (1-\pi)(\eta_Q/\eta_l)[\rho_K K'(I) + \beta] \xi^B = 1+r,$$

where ξ^B is given by the same expression as ξ^S , but evaluated at the equilibrium obtained at the restricted debt level. At the optimum, the expected discounted marginal return of investment in the second period should equal the cost of investment. The former consists of a probability-weighted average of the marginal returns under each of the two possible future governments. In turn, the future marginal return on I under party P is the sum of the marginal financial return on K , the marginal increase in scrap (both suitably modified by the relative costs of funds) and the marginal ideological return (transformed in terms of the single good by dividing by the cost of funds). The latter component is also present under party Q in the second period. The future marginal return on I under party Q further consists of the sum of the marginal financial return on K and the additional scrap (both suitably modified by the relative costs of funds), taking account of the fact that the additional financial return is diluted by ideologically motivated overspending on J , resulting in $\xi^B < 1$.

Panel (b) of Table 4 reports, for the same baseline and parameter perturbations as before, the outcomes if public debt is restricted to the level chosen by the social planner. Because party Q in period 2 would optimally choose negative scrap, we resolve the model under the additional restriction $S_Q=0$. In all cases, social welfare is higher than without this debt restriction (compare with panel (a)). However, even under the optimal debt restriction (see the final line in the panel), the partisan case is inferior to the planner's case. With full ideological returns

($\psi=1$), first-period government consumption under party P is too high, while the investment in project K is too low, reflecting that party Q may profit from investment I by boosting the investment in project L. Investment in project L under party Q exceeds the planner's investment in L, which reflects the larger ideological weight that party Q attaches to this project than the planner does. Debt under the optimal restriction exceeds the debt level selected by the social planner, since it makes a trade-off between over-investment in K and over-investment in L. By setting debt above the planner's level, party P is induced to invest somewhat more in K. However, the additional debt-servicing costs in the second period restrain investment in L and bring it closer to the planner's level when party Q comes to power. Social welfare under the optimal debt restriction is also lower than social welfare under the optimal investment restriction (compare with the final line in panel (a) of Table 4).

Proposition 4: *The optimal restriction on public debt exceeds the planner's optimal debt level, because it needs to make a trade-off between over-investment in the two different public investment projects. Although restrictions on public debt are welfare improving, they are dominated by the optimal investment restrictions. Again, restrictions on public debt are not necessary if investment projects only have financial returns.*

5.3. Discussion of deficit rules and the golden rule

The golden rule is often advocated as a helpful guide to running public deficits. It says that the government should be allowed to borrow for public investment projects as long as they have a market rate of return. The future returns will then be able to pay interest and principal. Most US states follow this rule and also many governments elsewhere followed this rule in the eighteenth and nineteenth centuries. Although the golden rule is simple, it gives strong incentives for majorities in democracies to choose an efficient mix of public goods in democratic economies with growing populations of overlapping generations of finitely-lived agents (Bassetto and Sargent, 2006). In the limiting case where Ricardian debt neutrality prevails, the golden rule does not enhance efficiency at all. Empirical evidence from the US suggests that the golden rule does affect government policies (Bohn and Inman, 1996; Poterba, 1995; Poterba and Rueben, 2001).

Our political economy approach departs from the median voter setting of Bassetto and Sargent (2006) and focuses on the implications of bipartisan politics with parties having differences in preferences about the type of public investment rather than differences in, say, the type of public consumption or the size of the public sector. We find that there may be a bias for too much public investment and government borrowing. It may thus be more desirable to have a

deficit rule, which can yield higher social welfare than under the unrestricted political economy outcome. This does not mean that the specific deficit and debt rules of the Stability and Growth Pact improve welfare. They are ad hoc and have the disadvantage of being the same for all economies of the EMU irrespective of their size or starting conditions (see the critique of Buiter (1985, 2003) and fail to recognise that reform of budgetary institutions is required (e.g., Wyplosz, 2002; Fabrizio and Mody, 2006).

Restrictions on public investment and deficit rules can correct for a bias towards over-investment and excessive government debt. However, it is crucial how tight the restrictions are set. If they are too tight, one ends up with too little public investment, especially if countries attempt to meet the targets by cutting government investment and forsaking future returns. Indeed, the Stability and Growth Pact may have the undesirable effect of reducing public investment relatively more than unproductive government spending (e.g., Blanchard and Giavazzi, 2004; Beetsma and Debrun, 2004, 2006), but the empirical evidence that the Pact has crowded out public investment is not very convincing (Galí and Perotti, 2003; Turrini, 2004). With the Stability and Growth Pact countries are also tempted to shift expenditure below the line and use creative accounting, fiscal gimmickry, privatisation and other one-off operations to meet the fiscal targets especially if the deficit is in danger of rising above its target (e.g., Dafflon and Rossi, 1999; Easterly, 1999; Milesi-Ferretti, 2003; Milesi-Ferretti and Moriyama, 2004; Alt and Lassen, 2005; von Hagen and Wolf, 2005; Koen and van den Noord, 2006; Buti, Martins and Turrini, 2006). Of course, there may be good efficiency grounds for privatisation but meeting tough deficit targets is a bad rationale for privatisation. If the targets are too loose and make an exception for public investment, countries will try to push all kinds of so-called investment projects with dubious financial returns under this heading. In that case, an independent fiscal council or a committee of wise persons may be called to take on the task of a more comprehensive fiscal surveillance comprising both government assets and liabilities and to reduce the incentives to manipulate the data to meet the targets. It also helps if the minister of finance is given the power to set the agenda (e.g., Hallerberg and von Hagen, 1999).

6. Concluding remarks

We have four main conclusions. First, in a bipartisan political economy framework the incumbent government has an incentive to borrow excessively and overspend on large public investment projects in order to bind the hands of its successor, especially if the probability of being removed from office is large and the scrap value of public investment is considerable. The point is that ideological attachment by a rival successor to investment projects that are

not valued by the incumbent drives the cost of funds to the incumbent below the expected future cost of funds. This induces the incumbent to invest more in its pet investment project and to issue more debt, especially if the probability of being removed from office is high. With scrapping, there is an extra reason for the current cost of public funds to fall short of the expected future cost of funds in the partisan outcome. As a result, there is an extra strategic reason for the incumbent government to invest and borrow.

Second, restrictions on public investment bring the current cost of funds more in line with the expected future cost of funds and thus diminish the strategic incentive to borrow too much. Investment restrictions therefore raise social welfare, especially if the probability of a change in government is high. The optimal restrictions on public investment are a bit looser than the levels of investment that prevail in the first-best apolitical outcomes. Any additional resources left for the future are thus no longer channelled into investments that benefit only part of the population, but will be transformed into public consumption goods that are valued by everyone. This induces the incumbent to restrain debt accumulation, which in turn leads to lower scrap in equilibrium and a more balanced time profile of public consumption.

Third, the political economy outcome with restrictions on public debt dominates the unconstrained political economy outcome. The political distortions can thus also be curbed with a deficit rule such as the one prescribed by the Stability and Growth Pact of the European Union. The optimal restriction on public debt exceeds the planner's optimal debt level, because it needs to make a trade-off between over-investment in the two different public investment projects. Although restrictions on public debt are welfare improving, they are dominated by the optimal investment restrictions.

Fourth, restrictions on public investment or debt are not needed if projects only have financial returns, since then the partisan and planner outcomes coincide.

Our results are obtained in a partial equilibrium framework with exogenous wages and interest rates, and a rudimentary private sector. In future work on the potential merits of golden rules, investment restrictions and debt restrictions it is important to model private behaviour (labour supply, saving, etc.) and extend our results to a general equilibrium setting. It would also be important to allow for the effects of government investment on productivity and the rate of economic growth along the lines of Barro (1990) and Barro and Sala-i-Martin (1995). Although we expect taxes to adversely affect private saving and labour supply and to increase the marginal cost of public funds, we do not expect that the qualitative nature of our conclusions will be much affected.

It is interesting to investigate how the political economy of public investment projects impacts on the optimal budget window (cf., Auerbach, 2004). Governments tend to choose public investment projects with immediate benefits over projects with delayed benefits (Rogoff and Sibert, 1988; Rogoff, 1990). The budget window should therefore not be too short, since otherwise the benefits of public investment are not fully taken account of or the costs are shifted beyond the window. However, the budget window should not be too long either for otherwise it includes future years for which current legislation is meaningless. At the same time, budget windows should be designed in such a way to ensure solvency and long-term budget commitments.

It is also worthwhile to allow for the possibility that the party in government invests in a small public project that is finished within its period of government. This addresses the distinction between small, but sensible, projects and large projects with meagre benefits. The political economy probably works out in favour of large, possibly non-productive public investment projects. The main issue here is that spending on small investment projects, especially maintenance, is not visible to the electorate. Big projects are visible and earn more political credits. The local politicians of an isolated region and their representatives in the national parliament and government would earn huge political credits from the local population if they succeed in their lobby for a high speed railway to their region, especially if the fraction paid by the national government (the general tax payer) is large. Clearly, big unprofitable projects generate huge rents and thus stimulate strong lobbying efforts and possibly even fraud. The benefits are concentrated among the supporters of the politicians that initiate and realise the project, while the costs are borne by the whole population. If there are only limited public funds and individual politicians can propose only a limited number of projects, political credits and visibility are maximised by proposing large projects.

Future research should thus investigate a normative and a positive question. The normative question is what is the optimal risk sharing contract between government and project developers and to what extent would this include the government participating in convertible bonds and project developers sharing in the losses and the costs of overrunning budgets. Such risk-sharing contracts may reduce the bias towards big projects. By focusing on desirable characteristics of the project rather than writing down all the technical specifications, the creativity of the private contractors in achieving these characteristics is stimulated. Although there are some good experiences with public-private partnerships in Hong Kong and the UK, many horror stories exist as well. In particular, most big projects are budgeted too low in order to get political support. Once the project is underway, it is difficult to turn back and

more money will be thrown at it. Often, a too low initial budget is followed by revisions that still understate true costs.

The positive puzzle is why such an optimal contract is often not implemented. The answer may derive from unlikely coalitions between short-sighted politicians wanting to be the first to start a grand project and rent-seeking project developers who want to shift commercial risks to (future) governments. Both of them can get locked into continuing the project, even if it makes losses and the principle ‘bygones are foregones’ is violated. Sometimes these political distortions are exacerbated if politicians are sitting on big pots of money (e.g., sales of national assets or windfall profits on gas due to higher oil prices, as in the case of the Netherlands), especially if there is a tendency for over-investment arising from the need to be quick to propose projects before the ‘common pool’ is depleted. The so-called voracity effect may be relevant here (Tornell and Lane, 1999). A deeper understanding of these intricate political economy issues requires one to allow for project developers seeking influence by giving bribes, so the analysis of Grosman and Helpman (2002) will prove useful. A possible solution is to delegate the responsibility of planning and controlling large-scale public investment projects to independent experts away from politicians (cf., Alesina and Tabellini, 2004).

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Table 1: Apolitical benchmark

Preferences	
$U = u(G_1) + \phi [u(G_2) + \lambda \psi K(I) + (1-\lambda)\psi \phi L(J, I-\zeta S)]$	
where $u', K', L_J, L_I, L_{II} > 0$, $u'', K'', L_{JJ}, L_{II} < 0$ and $K(0) = L(0, I-\zeta S) = 0$	
Budget constraint	
First period:	$B_1 = G_1 + I - R_1$
Second period:	$B_2 = (1+r) B_1 + G_2 + J - R_2 - \beta \zeta S - \rho_K K(I)$, $0 < \beta \leq 1$
Final period:	$(1+r) B_2 = \rho_L L(J, I-\zeta S)$
Present value:	$G_1 + I + \phi(G_2 + J) = R_1 + \phi[R_2 + \rho_K K(I) + \beta \zeta S] + \phi^2 \rho_L L(J, I-\zeta S)$
Smoothing of public consumption	
$u'(G_{1U}) = u'(G_{2U}) = \eta_U \Rightarrow G_{1U} = G_{2U} = G(\eta_U)$	
Demand for investment in second period (project L) – case of no scrap	
$(1-\lambda) \phi \psi L_J(J_U, I_U) = \eta_U [1 - \phi \rho_L L_J(J_U, I_U)] \Rightarrow J_U = J(\eta_U^-, I_U^+, r^-, \rho_L^+, \psi^+, \lambda^-)$	
Scrapping and demand for investment in second period (project L) – case of scrap	
$(1-\lambda) \phi \psi L_I(J_U, I_U - S_U) = \eta_U [\beta - \phi \rho_L L_I(J_U, I_U - S_U)] \Rightarrow S_U = S(I_U^+, \eta_U^+, r^+, \beta^-, \rho_L^-, \psi^+, \lambda^+) = I_U + S^{US}(\eta_U^+, r^+, \beta^-, \rho_L^-, \psi^+, \lambda^+)$	
$(1-\lambda) \phi \psi L_J(J_U, I_U - S_U) = \eta_U [1 - \phi \rho_L L_J(J_U, I_U - S_U)] \Rightarrow J_U = J^{US}(\eta_U^-, r^-, \beta^-, \rho_L^+, \psi^+, \lambda^-)$	
Demand for investment in first period (project K) – case of no scrap	
$\phi \psi [\lambda K'(I_U) + (1-\lambda) \phi L_I(J_U, I_U)] = \eta_U [1 - \phi \rho_K K'(I_U) - \phi^2 \rho_L L_I(J_U, I_U)]$	
$\Rightarrow I_U = I(\eta_U^-, J_U^+, r^-, \rho_K^+, \rho_L^+, \psi^+, \lambda^-)$	
Demand for investment in first period (project K) – case of scrap	
$\phi \psi [\lambda K'(I_U) + (1-\lambda) \phi L_I(J_U, I_U - S_U)] = \eta_U [1 - \phi \rho_K K'(I_U) - \phi^2 \rho_L L_I(J_U, I_U - S_U)]$	
$\Rightarrow I_U = I^{US}(\eta_U^-, r^-, \rho_K^+, \rho_L^+, \psi^+, \lambda^-)$	
Notation	
$\zeta =$ indicator function ($\zeta = 0$ in absence of scrap, $\zeta = 1$ with scrap),	
$\lambda =$ fraction of population in favour of project K, $1-\lambda =$ fraction in favour of project L,	
$\rho =$ financial return on public investment, $\psi =$ ideological return on public investment,	
$r =$ interest rate, $\phi = 1/(1+r) =$ discount factor, $U =$ utility, $u =$ felicity function,	
$B =$ public debt, $G =$ government consumption, $I =$ investment in project K,	
$J =$ investment in project L, $S =$ investment in K that is scrapped, $\eta =$ cost of public funds,	
$\beta =$ scrap value of investment done in project K, $R =$ exogenous government revenue.	
Subscript ‘‘U’’ denotes the apolitical outcome.	

Table 2: Political economy of public investment

Preferences:	
Party P – before election:	$U = u(G_I) + \phi [\pi u(G_{2P}) + (1-\pi) u(G_{2Q}) + \psi K(I)]$
Parties P and Q, respectively – after election:	$u(G_2) + \psi K(I)$ and $u(G_2) + \phi \psi L(J, I-\zeta S)$
Budget constraints:	
First period:	$B_I = G_I + I - R_I$
Second period party $i=P, Q$:	$B_2 = (1+r) B_I + G_{2i} + J_i - R_2 - \beta \zeta S_i - \rho_K K(I), \quad 0 < \beta \leq 1$
Final period party $i=P, Q$:	$(1+r) B_2 = \rho_L L(J_i, I-\zeta S_i)$
Present value $i=P, Q$:	$G_I + I + \phi (G_{2i} + J_i) = R_I + \phi [R_2 + \rho_K K(I) + \beta \zeta S_i] + \phi^2 \rho_L L(J_i, I-\zeta S_i)$
AFTER ELECTION	
Demand for public consumption, $i=P, Q$: $u'(G_{2i}) = \eta_i \Rightarrow G_{2i} = G(\eta_i), \quad G' = 1/u'' < 0$	
Demand for public investment by parties P and Q, respectively – no scrap:	
$\rho_L L_J(J_P, I) = 1 + r \Rightarrow J_P = J^P(I, r, \rho_L)$ and $\psi L_J(J_Q, I) = \eta_Q [(1+r) - \rho_L L_J(J_Q, I)] \Rightarrow J_Q = J^Q(I, \eta_Q, r, \rho_L, \psi)$	
Scrapping and demand for public investment by parties P and Q, respectively – scrap:	
$\rho_L L_I(J_P, I-S_P) = (1+r) \beta$ and $\rho_L L_J(J_P, I-S_P) = 1+r \Rightarrow S_P = I + S^{PS}(r, \beta, \rho_L)$ and $J_P = J^{PS}(r, \beta, \rho_L)$	
$\psi L_I(J_Q, I-S_Q) = \eta_Q [(1+r) \beta - \rho_L L_I(J_Q, I-S_Q)]$ and $\psi L_J(J_Q, I-S_Q) = \eta_Q [(1+r) - \rho_L L_J(J_Q, I-S_Q)] \Rightarrow$	
$S_Q = I + S^{QS}(\eta_Q, r, \beta, \rho_L, \psi)$ and $J_Q = J^{QS}(\eta_Q, r, \beta, \rho_L, \psi)$	
Cost of public funds under parties P and Q, respectively – case of no scrap:	
$\eta_P = \eta_P(\bar{I}, R_2 - (1+r)B_I, r, \rho_K, \rho_L)$ and $\eta_Q = \eta_Q(\bar{I}, R_2 - (1+r)B_I, r, \rho_K, \rho_L, \psi)$	
Cost of public funds under parties P and Q, respectively – case of scrap:	
$\eta_P = \eta_P^S(\bar{I}, R_2 - (1+r)B_I, r, \beta, \rho_K, \rho_L)$ and $\eta_Q = \eta_Q^S(\bar{I}, R_2 - (1+r)B_I, r, \beta, \rho_K, \rho_L, \psi)$	
BEFORE ELECTION	
No scrap: $U_P = u(G_I) + \phi [\pi u(G(\eta_P(I, R_2 - (1+r)B_I, r, \rho_K, \rho_L))) + (1-\pi)u(G(\eta_Q(I, R_2 - (1+r)B_I, r, \rho_K, \rho_L, \psi)))] + \psi K(I)$	
Scrap: $U_P = u(G_I) + \phi [\pi u(G(\eta_P^S(I, R_2 - (1+r)B_I, r, \beta, \rho_K, \rho_L))) + (1-\pi)u(G(\eta_Q^S(I, R_2 - (1+r)B_I, r, \beta, \rho_K, \rho_L, \psi)))] + \psi K(I)$	
Demand for public consumption: $u'(G_I) = \eta_I \Rightarrow G_I = G(\eta_I), \quad u'' < 0, \quad G' < 0$	
Investment by party P – no scrap: $(\pi \eta_P \rho_K + \psi)K' + \phi \pi \eta_P \rho_L L_I^P + (1-\pi) \eta_Q [\rho_K K' + (\phi \rho_L L_J^Q - 1)J_1^Q + \phi \rho_L L_I^Q] \xi = (1+r) \eta_I$	
Investment by party P – scrap: $(\rho_K + \psi / \eta_I)K' + \beta = 1+r$	
Dynamic efficiency debt – no scrap: $\pi \eta_P + (1-\pi) \eta_Q \xi = \eta_I, \quad 0 < \xi \equiv G'(\eta_Q) / [G'(\eta_Q) + (\phi \psi / \eta_Q) L_J^Q J_1^Q] \leq 1$	
Dynamic efficiency debt – scrap: $\pi \eta_P + (1-\pi) \eta_Q \xi^S = \eta_I, \quad 0 < \xi^S \equiv G'(\eta_Q) / [G'(\eta_Q) + (\phi \psi / \eta_Q) (L_J^Q J_1^{QS} - L_I^Q S_1^{QS})] \leq 1$	
Notation: π = probability that P wins election. Other notation: see Table 1.	

Table 3: Results for planner and bipartisan outcomes

<p>Utility of government consumption $u(G) = \delta G^{1-\varepsilon} / (1-\varepsilon)$, $\varepsilon \neq 1$ and $u(G) = \delta \ln(G)$, $\varepsilon = 1$</p> <p>Capital production in projects K and L $K(I) = I^\sigma \gamma^{1-\sigma}$ and $L(J, I) = J^\sigma I^\theta$, $0 < \sigma + \theta < 1$</p> <p>Base parameters: $\psi = 1$, $r = \delta = 0.2$, $\lambda = \pi = \sigma = \gamma = 0.5$, $\beta = \theta = 0.4$, $\varepsilon = 1.5$, $R_1 = R_2 = 2$, $\rho_K = \rho_L = 0.25$</p>
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(a) Without scrap:

	Planner						Partisan							
	G_1	G_2	I	J	B_I	Ω	G_1	G_{2P}	G_{2Q}	I	J_P	J_Q	B_I	Ω
Baseline	0.836	0.836	1.574	1.164	0.410	0.017	1.002	0.903	0.398	2.145	0.0200	0.725	1.147	-0.174
$\pi = 1$	0.836	0.836	1.574	1.164	0.410	0.017	0.958	0.958	0.410*	2.143	0.0200	0.778*	1.101	-0.251
$\delta = 0.25$	0.954	0.954	1.436	1.035	0.390	-0.177	1.126	1.013	0.484	1.916	0.0183	0.744	1.042	-0.345
$\varepsilon = 1.25$	0.809	0.809	1.605	1.193	0.414	-0.715	1.007	0.868	0.337	2.170	0.0202	0.758	1.177	-0.908
$r = 0.15$	0.806	0.806	1.642	1.194	0.449	0.065	0.986	0.889	0.383	2.230	0.0224	0.741	1.215	-0.146
$R_1 = 3$	0.881	0.881	2.145	1.717	0.026	0.268	1.119	1.013	0.391	2.980	0.0260	0.902	1.099	-0.00322
$R_2 = 3$	0.874	0.874	2.050	1.623	0.924	0.227	1.101	0.996	0.392	2.839	0.0250	0.874	1.939	-0.0300
$\psi = 0.1$	1.962	1.962	0.108	0.026	0.070	-0.512	1.951	1.918	1.848	0.182	0.00277	0.101	0.133	-0.513

(b) With scrap:

	Planner							Partisan									
	G_1	G_2	I	J	S	B_I	Ω	G_1	G_{2P}	G_{2Q}	I	J_P	J_Q	S_P	S_Q	B_I	Ω
Baseline	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.717	0.532	0.385	4.214	0.000	0.101	4.214	4.012	2.930	-0.336
$\pi = 1$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.704	0.704	0.407*	4.007	0.000	0.201*	4.007	3.605	2.711	-0.284
$\delta = 0.25$	0.954	0.954	1.436	1.035	0.000	0.390	-0.177	0.813	0.607	0.450	3.961	0.000	0.108	3.961	3.746	2.775	-0.515
$\varepsilon = 1.25$	0.809	0.809	1.605	1.193	0.000	0.414	-0.715	0.680	0.472	0.320	4.350	0.000	0.105	4.350	4.140	3.030	-1.082
$\beta = 0.35$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.730	0.537	0.373	3.926	0.000	0.114	3.926	3.664	2.656	-0.350
$r = 0.15$	0.806	0.806	1.642	1.194	0.000	0.449	0.065	0.699	0.518	0.372	4.469	0.000	0.101	4.469	4.267	3.168	-0.323
$R_1 = 3$	0.881	0.881	2.145	1.717	0.000	0.026	0.268	0.794	0.581	0.393	5.605	0.000	0.129	5.605	5.348	3.399	-0.200
$R_2 = 3$	0.874	0.874	2.050	1.623	0.000	0.924	0.227	0.782	0.574	0.392	5.372	0.000	0.124	5.372	5.123	4.154	-0.221
$\psi = 0.1$	1.970	1.970	0.173	.0014	0.170	0.143	-0.510	1.827	1.682	1.635	0.861	0.000	0.0335	0.861	0.794	0.688	-0.526

* These values never materialise as party Q never comes to power if party P is sure to be re-elected. They are the values Q would choose as the probability of Q coming to power approaches zero.

Table 4: Results under fiscal restrictions

<p>Utility of government consumption $u(G) = \delta G^{1-\varepsilon} / (1-\varepsilon)$, $\varepsilon \neq 1$ and $u(G) = \delta \ln(G)$, $\varepsilon = 1$</p> <p>Capital production in projects K and L $K(I) = I^\sigma \gamma^{1-\sigma}$ and $L(J, I-S) = J^\sigma (I-S)^\theta$, $0 < \sigma + \theta < 1$</p> <p>Base parameters: $\psi=1$, $\rho_K=\rho_L=0.25$, $r=\delta=0.2$, $\lambda = \pi = \sigma = \gamma = 0.5$, $\beta = \theta = 0.4$, $\varepsilon = 1.5$, $R_1=R_2=2$</p>
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(a) Investments restricted at planner level and optimal investment restrictions

	Planner							Partisan								
	G_1	G_2	I	J	S	B_1	Ω	G_1	G_{2P}	G_{2Q}	I	J	S_P	S_Q	B_1	Ω
Baseline	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.904	1.163	0.753	1.574	1.164	1.491	0.000	0.478	-0.104
$\pi=1$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	1.022	1.022	0.612	1.574	1.164	1.491	0.000	0.596	-0.217
$\delta=0.25$	0.954	0.954	1.436	1.035	0.000	0.390	-0.177	1.020	1.249	0.874	1.436	1.035	1.361	0.000	0.456	-0.284
$\varepsilon=1.25$	0.809	0.809	1.605	1.193	0.000	0.414	-0.715	0.881	1.142	0.724	1.605	1.193	1.520	0.000	0.485	-0.837
$\beta=0.35$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.895	1.100	0.764	1.574	1.164	1.470	0.000	0.469	-0.102
$r=0.15$	0.806	0.806	1.642	1.194	0.000	0.449	0.065	0.877	1.147	0.725	1.642	1.194	1.551	0.000	0.520	-0.0686
$R_1=3$	0.881	0.881	2.145	1.717	0.000	0.0259	0.268	0.967	1.335	0.778	2.145	1.717	2.030	0.000	0.111	0.0959
$R_2=3$	0.874	0.874	2.050	1.623	0.000	0.924	0.227	0.957	1.307	0.775	2.050	1.623	1.940	0.000	1.007	0.0640
$\psi=0.1$	1.970	1.970	0.173	.0014	0.170	0.143	-0.510	1.970	1.970	1.968	0.173	.0014	0.173	0.166	0.143	-0.510
Optimal (I^R, J^R)	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.968	1.247	0.806	1.617	0.966	1.546	0.000	0.585	-0.101

(b) Debt restricted at planner level and optimal debt restriction

	Planner							Partisan									
	G_1	G_2	I	J	S	B_1	Ω	G_1	G_{2P}	G_{2Q}	I	J_P	J_Q	S_P	S_Q	B_1	Ω
Baseline	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.895	2.332	0.577	1.514	0.000	1.444	1.514	0.000	0.410	-0.142
$\pi=1$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.845	2.355	0.574	1.564	0.000	1.456	1.564	0.000	0.410	-0.284
$\delta=0.25$	0.954	0.954	1.436	1.035	0.000	0.390	-0.177	1.008	2.293	0.670	1.382	0.000	1.345	1.382	0.000	0.390	-0.315
$\varepsilon=1.25$	0.809	0.809	1.605	1.193	0.000	0.414	-0.715	0.876	2.338	0.523	1.538	0.000	1.502	1.538	0.000	0.414	-0.870
$\beta=0.35$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.897	2.255	0.577	1.513	0.000	1.444	1.513	0.000	0.410	-0.144
$r=0.15$	0.806	0.806	1.642	1.194	0.000	0.449	0.065	0.880	2.333	0.556	1.568	0.000	1.464	1.568	0.000	0.449	-0.115
$R_1=3$	0.881	0.881	2.145	1.717	0.000	0.0259	0.268	0.991	3.035	0.598	2.035	0.000	2.016	2.035	0.000	0.0259	0.0349
$R_2=3$	0.874	0.874	2.050	1.623	0.000	0.924	0.227	0.977	2.917	0.595	1.948	0.000	1.919	1.948	0.000	0.924	0.00682
$\psi=0.1$	1.970	1.970	0.173	.0014	0.170	0.143	-0.510	1.856	2.038	1.835	0.286	0.000	0.139	0.286	.0092	0.143	-0.514
$B_1 = B_1^{R*}$	0.836	0.836	1.574	1.164	0.000	0.410	0.017	0.931	2.112	0.512	1.757	0.000	1.180	1.757	0.000	0.688	-0.135

Note: B_1^{R*} is the optimal debt restriction.