

Kalamov, Zarko; Staal, Klaas

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Public Debt, Bailouts, and Common Bonds

Zarko Kalamov*

Klaas Staal†

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Abstract

We look at a model where countries of different size provide local public goods with positive spillovers. Matching grants can induce socially-efficient expenditure levels, but countries can induce bailouts. We consider the characteristics of these bailouts in a subgame-perfect Nash equilibrium and how these characteristics are affected by the introduction of common bonds. Partial substitution of common for sovereign bonds has two implications. First, it lowers the average and marginal borrowing costs of countries, which may be eligible for bailouts. This effect leads to higher borrowing in these countries irrespective of their bailout expectations. Second, the lower borrowing costs mitigate the incentives of countries to induce a bailout and, therefore, constrain parameter set for which a soft budget constraint equilibrium exists.

Key Words: bailouts, spillovers, public debt

JEL Codes: H4, H7, R1

*TU Berlin, Germany.

†IAAK, University of Bonn, Regina-Pacis-Weg 5, 53117 Bonn, Germany. kstaal@uni-bonn.de

1 Introduction

Jurisdictions occasionally fall into serious crises in which drastic cuts in expenditure and increases in taxes are necessary. Such crises can also imply that jurisdictions lose access to the capital market, as in, for example, Saarland and Bremen in Germany or, more recently, Greece. When such a crisis occurs, a federation (in the case of Saarland and Bremen, see, e.g. Seitz 1999 or Rodden 2003) or other countries (the European Union in the case of Greece) may intervene, for example by making transfers or by taking over a part of the debt. Another possible intervention to prevent a jurisdiction losing access to the capital market, is the introduction of common bonds.

These interventions can have a negative effect on welfare, as they lead to for example the underprovision of public goods (for a discussion see, e.g., Wildasin 1997 or Crivelli and Staal 2013). There is also a normative and a moral-hazard aspect that goes against these interventions. Nonetheless, institutions can be structured in such a way that governments find them irresistibly attractive, see for example the role the no-bailout clause now plays in the decision making by the European Union.

To our knowledge there is no paper in the theoretical literature on fiscal federalism that discusses the implications of the introduction of common bonds. In the European Union, common bonds are discussed as a solution to the problems several countries are experiencing (see European Commission 2011). It is unclear, however, how the introduction of common bonds will affect for example public good provision, or whether common bonds will make it more or less probable that countries borrow more than they will be able to repay. In this paper, we construct a model using the approaches of Köthenbürger (2007) and Crivelli and Staal (2013) to discuss these questions.

In our model governments can use the revenues of income taxation to provide local public goods with a positive spillover effect, borrow money, and service public debt. When in a country an insufficient amount of local public goods is provided, the governments of other countries may find it in the interest of their citizens to make transfers to increase public good provision and

so increase its (positive) spillover effect. This is the 'classical' soft-budget constraint problem discussed in the existing literature. A policy intervention that might mitigate the soft-budget problem is the introduction of common bonds. The introduction of common bonds reduces the interest rate of countries that are most vulnerable to the soft-budget constraint problem. This mitigates the adverse effect of serving public debt on public good provision; reducing the marginal benefits of these countries from receiving transfers and also making it less likely that other countries will make transfers to increase public good provision. Hence the introduction of common bonds mitigates the moral hazard problem implied by the 'classical' soft-budget problem.

The remainder of the paper is organized as follows. Section 2 introduces the model, while section 3 compares decentralized decision making with the socially optimal outcome. Section 4 introduces a corrective policy to mitigate the inefficiencies in decentralized decision making and discusses how such a policy can lead to bailouts. In section 5 we show that these bailouts can occur in a subgame-perfect Nash equilibrium. In section 6 we present the implications of the introduction of common bonds, and section 7 concludes.

2 The model

Consider a union of I countries with different population sizes, denoted by $i, i = 1, \dots, I$. Country i has population n_i and total population is denoted by N , where $\sum_i n_i = N$. Furthermore, it is assumed that $I - 1$ countries have the same population size n_j , while country i is inhabited by $n_i < n_j$ residents. Lastly, no country is inhabited by more than half of the total population, i.e. $n_i \leq N/2, i = 1, \dots, I$. The representative household of country i lives for two periods and is endowed with exogenous income y in each period. The government of country i collects a lump sum tax at the rate $t_{i\tau}$ each period. Thus, private per capita consumption c in country i in period τ is

$$c_{i\tau} = y - t_{i\tau}. \tag{1}$$

The local government in i uses tax revenues to provide public goods $g_{i\tau}$. It may also borrow in period one; it then has to service public debt in the second period. Public per capita debt of government i is denoted as b_i . The interest rate $r_i(b_i)$ charged by capital markets depends on the size of the public debt as a higher debt implies a bigger credit risk and thus higher interest rates.¹² Hence, $\partial r_i(b_i)/\partial b_i > 0 \wedge \partial^2 r_i(b_i)/\partial b_i^2 > 0$. Moreover, $r_i(b_i)$ consists of two components: a debt-dependent interest rate function $r(b_i), r', r'' > 0$, which is common to all countries and, following Herz and Hohberger (2013), an exogenous positive “risk premium” ρ , which is charged only on countries with small population sizes. This additional cost of borrowing of small countries captures their larger susceptibility to negative shocks as well as the lower liquidity of small country debt markets (European Commission, 2011). Therefore, the interest rate functions for the small country i and big countries j are given by

$$r_i(b_i) = \rho + r(b_i),$$

$$r_j(b_j) = r(b_j).$$

Moreover, if a soft budget equilibrium prevails, i.e. countries $j \neq i$ are willing to bailout country i and it, on the other hand, is willing to induce a bailout, then the capital markets view bonds issued by i and j as perfect substitutes and do not demand the “risk premium” ρ from the small country. Thus, the governmental budgets are

$$g_{i1} = t_{i1} + b_i, \tag{2}$$

$$g_{i2} = t_{i2} - (1 + r_i(b_i))b_i. \tag{3}$$

Lastly, utility U_i of the representative agent in country i consists of the linear benefit $c_{i\tau}$ of private consumption and a benefit $\ln(g_{i\tau})$ from the public good provided by the government in i in period τ . The individual also benefits from a positive spillover effect of the public good

¹The positive relationship between public debt and interest rates is supported by early empirical research by Edwards (1984) and more recently by Chung and Turnovsky (2010).

²The cost of financing usually depends on the debt-to-GDP ratio. However, due to the exogenous per capita income y , b_i can be interpreted as a proxy for debt-to-GDP of country i , which is given by $n_i b_i / n_i y = b_i / y \propto b_i$.

provided in country j ($j \neq i$), where the degree of this spillover effect is denoted by κ ($\kappa > 0$).

U_i is thus given by

$$U_i = \sum_{\tau=1}^2 \delta^{\tau-1} \left[\ln(g_{i\tau}) + \sum_{j \neq i} \kappa \ln(g_{j\tau}) + c_{i\tau} \right], \quad (4)$$

where $\delta \in]0, 1[$ is a time discount factor.

3 The optimal levels of public good provision and decentralized decision making

The public goods provided in a country also benefit the citizens of other countries. We first consider the public good levels that maximizes the aggregate payoff from public good provision, taking this spillover effect into account. We use these optimal levels of public goods as a benchmark for the normative evaluation in the rest of our analysis. The optimal levels of t_{i1}, t_{i2} and b_i that maximize aggregate social welfare, are given by the maximization of

$$\sum_{\tau=1}^2 \delta^{\tau-1} \left[n_i \ln(g_{i\tau}) + \sum_{j \neq i} n_j \kappa \ln(g_{j\tau}) + n_i c_{i\tau} \right], \quad (5)$$

with respect to t_{i1}, t_{i2} and b_i for each government i . The first order conditions can be simplified to

$$\frac{1}{\hat{g}_{i\tau}} = \frac{n_i}{n_i + (N - n_i)\kappa}, \quad \tau = 1, 2, \quad (6)$$

$$\frac{1 - \delta}{\delta} = r_i(b_i)(1 + \varepsilon_i), \quad (7)$$

where $\hat{g}_{i\tau}$ denotes the optimal levels of public good provision and $\varepsilon_i \equiv \frac{b_i}{r_i} \frac{\partial}{\partial b_i} r_i(b_i)$ the public debt elasticity of the interest rate function.

Assume that the governments of each country choose the public good levels. Since the individuals in a country have similar preferences, this decision making leads to the same outcome, independent of whether a government's objective is to maximize the aggregate payoff of

the individuals in the country, or whether the individuals in the government maximize their own payoffs, or whether the government applies direct democracy, organizing referendums with pairwise comparisons of public good levels. The government of country i thus maximizes (4) over t_{i1}, t_{i2} and b_i . Rewriting the first-order conditions leads to

$$\frac{1}{g_{i\tau}} = 1, \quad \tau = 1, 2, \quad (8)$$

$$\frac{1 - \delta}{\delta} = r_i(b_i)(1 + \varepsilon_i). \quad (9)$$

The condition (9) coincides with (7), while a comparison of condition (8) with (6) shows that the tax rate is inefficiently low, i.e., $t_{i\tau} < \hat{t}_{i\tau}$.

4 A corrective policy

The underprovision of public goods under decentralized decision making can be corrected by a system of corrective grants, where the matching grants $m_{i\tau}$ to country i depend on taxes $t_{i\tau}$ of that country. We model such a system of matching grants to mimic the policy that is implemented in the European Union. First, income distribution is a contentious issue in the Union, so we focus on the spillover effects as the only motivation for a system of matching grants. The per-capita contributions T_i that are necessary to finance this system are provided by tax increases implemented by the governments of the member states. Thus, $T_i \equiv \sum_j n_j m_j / N$, which represents the per-capita contribution of one individual to the grant system, reduces consumption. Second, following Köthenbürger (2007), the per-capita grant m_i , received in region i , is added to local public revenues and is a function of the tax rate t_i . The amount of per capita public good provision thus becomes

$$g_{i1} = t_{i1} + m_{i1}(t_{i1}) + b_i, \quad (10)$$

$$g_{i2} = t_{i2} + m_{i2}(t_{i2}) - (1 + r(b_i))b_i \quad (11)$$

and per capita consumption becomes

$$c_{i\tau} = y - t_{i\tau} - T_{i\tau}, \tau = 1, 2. \quad (12)$$

Maximizing (4) over $t_{i\tau}$ and b_i and rewriting the first-order conditions leads to

$$\frac{1}{g_{i\tau}} = \frac{1 + \frac{n_i}{N} \frac{\partial m_{i\tau}}{\partial t_{i\tau}}}{1 + \frac{\partial m_{i\tau}}{\partial t_{i\tau}}}, \quad \tau = 1, 2, \quad (13)$$

$$\frac{1 - \delta}{\delta} = r_i(b_i)(1 + \varepsilon_i). \quad (14)$$

A matching grant, which induces the optimal level of public good provision, must thus satisfy the following condition:

$$\frac{\partial \hat{m}_{i\tau}(t_{i\tau})}{\partial t_{i\tau}} = \frac{\kappa N}{(1 - \kappa)n_i} > 0. \quad (15)$$

Only the first derivative of the grant system matters for the optimality of public good provision in the case of hard budget constraints, the matching grant is thus given by

$$\hat{m}_{i\tau}(t_{i\tau}) = \frac{\kappa N t_{i\tau}}{(1 - \kappa)n_i}. \quad (16)$$

4.1 A bailout

Consider now the decision that is taken by the governments to bailout a country. We use the the following timing of events:

- **Stage 0:** Before the beginning of period 1, the central government sets the corrective policy rule $m_i(t_i)$.
- **Period 1:** Governments choose t_{i1}, b_i in order to maximize the utility of their residents.

After that, the central government observes the t_{i1} 's and makes the matching grants to each region and collects the funds needed to finance the grants.

- **Period 2:** Governments choose t_{i2} in order to maximize the utility of their residents.

After that, the central government observes the t_{i2} 's and makes the matching grants to each region and collects the funds needed to finance the grants. Simultaneously, the central government decides whether to augment the funds provided to each region.

Note that due to the simultaneity of decisions, local governments cannot induce a bailout in period one, but can do so in period two, by appropriately choosing b_i and t_{i2} . Furthermore, the central government takes the public debt level and second period taxes of all regions as given and, thus, conditions a potential bailout to the government in i on b_i and t_{i2} .

We assume that the bailout is paid for by tax increases and denote the bailout as \underline{m}_i (on a per-capita basis) and the additional costs of it as $T_{BO} = (n_i \underline{m}_i (1 + \underline{m}_i)) / (N - n_i)$. Note that the costs of the bailout are borne by $N - n_i$ individuals, as the country i in the EU that gets a bailout does not pay contributions to finance it. Additionally, the cost of providing \underline{m}_i Euros of bailout is expressed by $\underline{m}_i + \underline{m}_i^2$. The first term denotes the direct cost of the bailout. The quadratic term captures the fact that the bailout decision is made ex-post, i.e. after the taxation and spending policies have been fixed, which makes the financing of the bailout more costly than the financing of other expenditures. Such additional costs arise, if the governments have used the least distortive taxes to finance public spending and must rely on more distortive taxes to provide the bailout.

4.2 Central government bailout policy

We start with the decision of governments to bailout another government. These governments maximize the utility of their citizens (who are located outside the country receiving the bailout), net of the costs of a bailout. Period two per capita private consumption c_{j2} of individuals living in the countries that are giving a bailout is given by

$$c_{j2} = y - t_{j2} - T_{j2} - T_{BO}. \quad (17)$$

On the other hand, the receiving country faces the following new period-two government budget constraint

$$g_{i2} = t_{i2} + m_{i2}(t_{i2}) - (1 + r(b_i))b_i + \underline{m}_i. \quad (18)$$

When a bailout is given, the objective of the governments giving this bailout is

$$\max_{\underline{m}_i} \kappa \ln(g_{i2}) + c_{j2}, \quad (19)$$

where g_{i2} and c_{j2} are given by (18) and (17), respectively. The first order derivative with respect to \underline{m}_i is given by

$$\frac{\partial}{\partial \underline{m}_i} : \quad \frac{\kappa}{g_{i2}} - \frac{n_i(1 + 2\underline{m}_i)}{(N - n_i)}, \quad (20)$$

where the first term of (20) denotes the spillover effect (i.e., the marginal benefits) and the second term the marginal costs of the bailout. A bailout is thus characterized by the following

$$\begin{cases} \underline{m}_i = 0, & \text{if } \left[\frac{\kappa}{g_{i2}} - \frac{n_i(1+2\underline{m}_i)}{(N-n_i)} \right]_{\underline{m}_i=0} < 0, \\ \frac{\kappa}{g_{i2}} = \frac{n_i(1+2\underline{m}_i)}{(N-n_i)}, & \text{if } \left[\frac{\kappa}{g_{i2}} - \frac{n_i(1+2\underline{m}_i)}{(N-n_i)} \right]_{\underline{m}_i=0} > 0. \end{cases} \quad (21)$$

The above equation shows two possible values for the bailout. First, $\underline{m}_i = 0$, if the marginal benefits of changing the transfers to region i are less than the marginal costs. In this case there is no incentive for the rest of the federation to provide a bailout. Second, $\underline{m}_i > 0$ exists, when the positive externalities of public good provision that a bailout would entail are strong enough. This case results in a soft budget constraint.

Now consider the soft budget constraint outcome. Such a bailout takes place when the marginal benefits of increasing the bailout above zero exceed the marginal costs. Looking at Expression (21), the marginal costs are increasing in regional size n_i , while the marginal benefits are independent of n_i . This implies the following result.

Lemma 1 *There exists a regional size \overline{n}_C such that the central government never provides country i a bailout if $n_i > \overline{n}_C$.*

Proof of Lemma 1: $\overline{n_C}$ is implicitly defined by

$$\frac{1}{g_{i2}} \Big|_{\underline{m}_i=0} \kappa = \frac{\overline{n_C}}{N - \overline{n_C}}. \quad (22)$$

The left-hand side of expression (22) gives the benefits of providing a bailout marginally above zero and n_i does not have a first-order effect on this benefit. The right-hand side of expression (22) gives the marginal costs, and the first-order effect of n_i on these costs is positive. Given the continuity of the expressions it follows that only countries of $n_i < \overline{n_C}$ can receive a bailout which results in a soft budget constraint. \square

Country i anticipates that its borrowing and taxes affect the optimal bailout. Totally differentiating the second row of (21), it follows that

$$\frac{\partial \underline{m}_i}{\partial b_i} = \frac{(1 + r_i(b_i^*)(1 + \varepsilon_i^*)) (1 + 2\underline{m}_i)}{(1 + 2\underline{m}_i + 2g_{i2})} > 0, \quad (23a)$$

$$\frac{\partial \underline{m}_i}{\partial t_{i2}} = - \left(\frac{n_i + \kappa(N - n_i)}{(1 - \kappa)n_i} \right) \frac{(1 + 2\underline{m}_i)}{(1 + 2\underline{m}_i + 2g_{i2})} < 0. \quad (23b)$$

In the above expression, we have used a superscript $*$ to denote a soft budget constraint outcome. Also, we used Equation (21) to simplify the denominator. Note that (23a) shows that b_i has an expected positive effect on \underline{m}_i , which leads to more borrowing by country i than optimal when this country induces a bailout. Furthermore, (23b) shows that country i has incentives to cut its taxes in period two in order to induce a higher bailout.

Now consider the first-order conditions of the country that receives a bailout. They are identical to Eq. (13) and (14) with the only difference that country i also takes into consideration how its borrowing and taxation decisions affect the expected bailout. Therefore, the equilibrium

t_{i1}, t_{i2} and b_i are determined by

$$\frac{1}{g_{i1}^*} = \frac{n_i}{n_i + (N - n_i)\kappa}, \quad (24)$$

$$\begin{aligned} \frac{1}{g_{i2}^*} &= \frac{n_i}{n_i + (N - n_i)\kappa} \left(1 + \frac{1 + 2\overline{m}_i}{2g_{i2}^*} \right) \\ &= \frac{n_i}{n_i + (N - n_i)\kappa} \left[1 - \frac{n_i}{n_i + (N - n_i)\kappa} \frac{1 + 2\overline{m}_i}{2} \right]^{-1}, \end{aligned} \quad (25)$$

$$\frac{1 - \delta}{\delta} = r_i(b_i^*)(1 + \varepsilon_i^*). \quad (26)$$

Expression (25) implies that the amount of public good provided in period 2 in relation to period 1 and in relation to the efficient level gets smaller when there is a bailout. Equation (26) coincides with (14). The reason is that borrowing not only induces increases in the bailout, but also reduces second period public good provision. Due to the underprovision of g_{i2} , the marginal value of the second effect is augmented. In equilibrium, the two effects cancel each other out. However, because financial markets view country i debt as a perfect substitute for country j borrowing, the interest rate function $r_i(b_i)$ has shifted downwards and $b_i^* > \hat{b}_i$.

Lastly, the first order conditions of countries j do not change, because they cannot act strategically and influence the optimal bailout by their taxes or borrowing.

The proof of Lemma 1 can be recalculated now. From Eq. (25), it can be seen that the equation determining $\overline{n_C}$ becomes

$$\frac{2\kappa\overline{n_C}}{\overline{n_C} + 2\kappa(N - \overline{n_C})} - \frac{\overline{n_C}}{N - \overline{n_C}} = 0. \quad (22')$$

Even though the derivative of the marginal benefits of the bailout with respect to n_i is positive, the derivative of the whole expression is negative, i.e.,³

$$\frac{\partial}{\partial n_i} \left(\frac{\kappa}{g_{i2}^*} - \frac{n_i}{N - n_i} \right) \Big|_{\underline{m}_i=0} = - \frac{n_i(4\kappa(N - n_i) + n_i)}{(n_i + 2\kappa(N - n_i))^2(N - n_i)^2} < 0.$$

Therefore, there exists $\overline{n_C}$ above which no bailout is given.

³In calculating the derivative w.r.t. n_i , we take into consideration that $dN/dn_i = 1$.

Moreover, it can be seen from Equations (21) and (25) that the optimal period two public good level in country i is determined both by the local government and the countries giving a bailout. In equilibrium, both equations must be satisfied. Equating the two conditions leads to a quadratic equation in the bailout, which has one positive and one negative root. Since only a positive bailout will ever be accepted by the government of country i , the equilibrium bailout is given by the positive root, i.e.⁴

$$\underline{m}_i = \frac{\kappa(N - n_i) + \sqrt{(\kappa(N - n_i))^2 + n_i^2}}{2n_i}. \quad (27)$$

It is easy to establish that the optimal bailout is increasing in the spillover κ and decreasing in the population size n_i , where

$$\frac{\partial \underline{m}_i}{\partial n_i} = -\frac{\kappa(N - n_i) \left(\sqrt{(\kappa(N - n_i))^2 + n_i^2} + \kappa(N - n_i) \right)}{2n_i^2 \sqrt{(\kappa(N - n_i))^2 + n_i^2}} < 0. \quad (28)$$

4.3 Local government bailout policy

Now consider whether a region, which expects to receive a bailout, is also willing to induce one. To answer that we follow Crivelli and Staal (2013) and compare the equilibrium utility in the absence of a bailout \hat{U}_i and in a soft budget constraint equilibrium U_i^* . If region i expects to receive a bailout, it will be willing to induce one if and only if

$$U_i^* - \hat{U}_i > 0. \quad (29)$$

The above equation can be rewritten as

$$\sum_{\tau=1}^2 \delta^{\tau-1} \left[\ln(g_{i\tau}^*) + \sum_{j \neq i} \kappa \ln(g_{j\tau}^*) + c_{i\tau}^* \right] > \sum_{\tau=1}^2 \delta^{\tau-1} \left[\ln(\hat{g}_{i\tau}) + \sum_{j \neq i} \kappa \ln(\hat{g}_{j\tau}) + \hat{c}_{i\tau} \right]. \quad (29.1)$$

We will use expression 29.1 to show the following

⁴The second order condition with respect to \underline{m}_i is always negative and, thus, satisfied.

Lemma 2 *There exists a population size \bar{n}_L such that if $n_i > \bar{n}_L$, country i will not induce a bailout, even if it knows it will receive one.*

Proof of Lemma 2: The proof consists of two parts. First, we show that the utility difference can be both positive and negative. We already proved that $g_{j\tau}^* = \hat{g}_{j\tau}$. Therefore, no difference in utility can come through the externalities of foreign public good provision. Second, Eq.'s (24) and (25) show that $g_{i1}^* = \hat{g}_{i1}$ and $g_{i2}^* < \hat{g}_{i2}$. Therefore, utility from public good provision is lower in a soft budget constraint equilibrium than in the first best. As a result, $U_i^* > \hat{U}_i$ if and only if t_{i2}^* is sufficiently smaller than \hat{t}_{i2} , which would augment second period consumption c_{i2}^* relative to \hat{c}_{i2} . However, $t_{i2}^* \gtrless \hat{t}_{i2}$ depends on the reaction of public debt to the bailout. If public debt increases only marginally relative to its first best level, then $t_{i2}^* < \hat{t}_{i2}$ and the possibility exists that country i chooses to induce a bailout. The stronger b_i reacts to the bailout, the larger t_{i2}^* is, and lower the utility difference $U_i^* - \hat{U}_i$. In the extreme, a large difference $b_i^* - \hat{b}_i$ leads to $t_{i2}^* > \hat{t}_{i2}$ and $U_i^* < \hat{U}_i$.

Subsequently, we differentiate the utility difference with respect to n_i . Using the Envelope Theorem, any effect of n_i on the equilibrium $\hat{t}_{i\tau}, \hat{b}_i, t_{i\tau}^*, b_i^*$ has zero effect on \hat{U}_i and U_i^* , respectively. Moreover, the effects through $\hat{t}_{j\tau}, \hat{b}_j, t_{j\tau}^*$ and b_j^* cancel out, which leaves

$$\frac{d}{dn_i} [U_i^* - \hat{U}_i] = \frac{\delta}{g_{i2}^*} \frac{dm_i}{dn_i} < 0. \quad (30)$$

Therefore, there are three cases. Either Eq. (29) is always negative, which means $\bar{n}_L = 0$, or it is always positive and thus $\bar{n}_L = N/2$, or it changes sign as n_i increases. The last case means that by the intermediate value theorem, there exists $\bar{n}_L \in [0, N/2]$, such that Eq. (29) holds if and only if $n_i < \bar{n}_L$. \square

5 Bailouts in equilibrium

In the previous section we discussed the bailout policies. We now argue that bailouts can occur in a subgame perfect Nash equilibrium. The main argument is that the central government does

not have an incentive to change the system of matching grants due to the fact that bailouts are such a rare event.

In the following there is uncertainty what the value of δ_i is in region i . With probability p^H , $\delta_i = \delta_{high}$. With (a small) probability $p^L = 1 - p^H$, however, $\delta_i = \delta_{low}$. The intuition is that when $\delta_i = \delta_{low}$, with δ_{low} small enough, country i borrows more, and that makes a bailout more attractive, given (23a) and the fact that the smaller amount of public goods provided in country i in period 2 is less of a worry for the individuals in country i in period 1. p^L small enough implies that the central government does not have an incentive to change the system of matching grants.

Consider the following timing:

- **Stage 0:** Nature determines the time-preference parameter δ_i of country i in period 1 and the central government (without observing this parameter) sets the corrective policy rule $m_i(t_i)$.
- **Period 1:** The government of country i observes whether $\delta_i = \delta_{high}$ or $\delta_i = \delta_{low}$. Governments choose t_{i1}, b_i in order to maximize the utility of their residents. After that, the central government observes the t_{i1} 's and makes the matching grants to each region and collects the funds needed to finance the grants.
- **Period 2:** Governments choose t_{i2} in order to maximize the utility of their residents. After that, the central government observes the t_{i2} 's and makes the matching grants to each region and collects the funds needed to finance the grants. Simultaneously, the central government decides whether to provide a bailout to country i .

Definition 1 *The strategy set \mathcal{S} is defined as follows:*

1. *The central government sets the corrective policy rule $m_i(t_i)$ as given by (16).*
2. *When $\delta_i = \delta_{low}$ then the government of country i induces a bailout and it chooses tax levels t_{i1}, t_{i2} , and b_i such that (24), (25), and (26) are satisfied, respectively; otherwise its choices satisfy (13), (13), and (14), respectively.*

3. The governments of countries $j \neq i$ choose tax levels and borrowing t_{j1} , t_{j2} , and b_j such that (13), (13), and (14), respectively, are satisfied.
4. When the government of country i induces a bailout, the governments of countries j will provide a bailout characterized by (21).

Proposition 1 *The strategies \mathcal{S} can be the strategies of a subgame perfect Nash equilibrium.*

Proof of proposition 1: To show that \mathcal{S} can constitute a subgame perfect Nash equilibrium, we have to show that no actor has an incentive to change its strategy.

First consider (S4). Note that due to the subgame perfectness, the governments of countries j cannot stick to a non-bailout policy, even though from a welfare perspective, they may prefer to do so. Given this restriction, (21) describes their optimal bailout policy.

Then consider (S3). When countries j give a bailout as (21) describes then the previous section shows that (13) and (14) describe the utility maximizing choices, these choices are also maximizing utility of the citizens in countries j if country i does not induce a bailout.

Considering (S2), note that when δ_{high} is large enough, i.e., close to one, it follows from (26) that the government of country i does not borrow money and that it has no incentive to consume more in period 1 at the cost of lower public good provision in country i in period 2. It will thus not induce a bailout in period 2. On the other hand, when $\delta_i = \delta_{low}$ is small enough, i.e. close to zero, it gets more attractive for individuals in country i to consume more in period 1 at the expense of consumption and public good provision in period 2, and choose a b_i big enough to change all period 2 income into period 1 consumption. In addition for a lower δ the period-2 costs associated with a bailout (a lower amount of public goods and less consumption) for the individuals in country i matter less when they take their decision in period 1 on a debt level that implies inducing a bailout in period 2.

Finally, the crucial condition is (S1). Changing the system of matching grants in a way to avoid bailouts leads to public good levels that are too high when country i does not induce a bailout, that is, when $\delta_i = \delta_{low}$. Since δ_i is not known when the system of matching grants is designed, the only way to give the government of country i an incentive to increase its public good

provision enough, is by increasing the size of the matching grant. Let g_i^a denote the amount of public goods in country i when the system of matching grants is adjusted in such a way that the government of country i will never induce a bailout and let T^a denote the additional tax that has to be raised to finance the adjustment in the system of matching grants. The benefits of doing so are the additional spillovers that can be expected when a bailout is avoided: $p^L [\ln(g_i^a) - \ln(g_i^*) - T^a] + (1 - p^L) [\ln(g_i^a) - \ln(\hat{g}_i) - T^a]$. While the first term might be positive, the second term is surely negative, so for p^L small enough, there is no incentive to change the system of matching grants. \square

6 Common bonds

The introduction of common bonds should be modeled in a way similar to what the European Commission (2011) has proposed. It considers three different approaches, of which the third is most feasible politically and modelled in this article.

The first approach considers full substitution of common bonds for national bonds with several and joint guarantees. This is highly unrealistic, because it means that every country will be fully responsible for debt of other members. Thus, any decision about giving a bailout to some problematic country will vanish: whenever a country does not service its debt, all the others will be obliged by the joint guarantees to pay.

The second one is the so-called "blue-red" approach, which assumes partial substitution of common bonds for national bonds with several and joint guarantees (proposed by Delpla and von Weizsäcker 2010). Common bonds are called "blue" and can be issued up to a certain limit (e.g. 60% of GDP) and once this threshold is reached, governments can issue junior, national bonds. This is more feasible politically, because it implies less moral hazard problems. However, the credibility of the "blue" bonds ceiling is questionable. Because of the joint guarantees, there will again be no question whether to bail out one country, if it defaults on its "blue" bonds. The country must be bailed out, which means that there will be large wedge between the interest on common bonds (which we denote by r) and r_i for small countries i . This will put large

political pressures on increasing the ceiling, which can make this approach also unsustainable and politically not feasible.

The third approach is most feasible, because it introduces partial substitution of common bonds for national bonds with several but not joint guarantees. According to it, countries will have to guarantee only a part of the total amount of common bonds issued, according to what their proportion of the total issuance is. As in the second approach, common bonds will be senior to the national bonds. This approach is deemed as most realistic by the Commission.

The introduction of common bonds naturally affects the interest rates. We assume that $r = r_j(b_j)$, which would be the case if common bonds receive the same credit rating as those of countries j .⁵ In the case of the Euro Area it means that the common interest rate converges to the rates of bonds of triple-A countries. Moreover, according to this approach only some of national bonds will be replaced by common bonds, we assume that an amount \bar{b} is the ceiling for common bond issuance (where \bar{b} is, for example, determined by a "60%-of-GDP" rule) with $\bar{b} < b_i, \forall i$, otherwise some countries may be able to achieve full substitution.

Thus, the ceiling will be binding for all countries and their marginal debt will be national at the national rates r_i . Therefore, total borrowing costs of the government in i become

$$(1 + r_i(b_i))(b_i - \bar{b}) + (1 + r)\bar{b} = (1 + r_i(b_i))b_i + (r - r_i(b_i))\bar{b}.$$

As a result, the budget constraints of local governments become

$$g_{j2}^{cb} = t_{j2} + m_{j2}(t_{j2}) - (1 + r_j(b_j))b_j, \quad (31a)$$

$$g_{i2}^{cb} = t_{i2} + m_{i2}(t_{i2}) + \underline{m}_i - (1 + r_i(b_i))b_i - (r_j(b_j) - r_i(b_i))\bar{b}. \quad (31b)$$

where the superscript ^{cb} means common bonds.

The introduction of common bonds does not influence the local first order conditions with respect to taxes. It also has no impact on the optimal borrowing of country j . On the other

⁵Since countries $j \neq i$ are identical, b_j measures the per-capita debt of all countries $j \neq i$ and, therefore, the common interest rate.

hand, country i will issue common bonds, if it benefits from their introduction, i.e. if $\text{sgn}\{r_i(\hat{b}_i) - r_j(\hat{b}_j)\} = \text{sgn}\{r_i(b_i^*) - r_j(b_j^*)\} > 0$. We are able to show that this result holds under very general assumptions. First, we derive the first order condition with respect to b_i :

$$\frac{1 - \delta}{\delta} = r_i(b_i) \left(1 + \varepsilon_i \left(1 - \frac{\bar{b}}{b_i} \right) \right), \quad (32)$$

where $r_i(b_i) = \rho + r(b_i)$ in the case of hard budget constraints and $r_i(b_i) = r(b_i)$ in a soft budget constraint equilibrium.⁶ Assume furthermore that $r(b_i)$ is homogeneous of degree $h > 1$ (homogeneity of degree between 0 and 1 would violate the assumption that r'' is positive). This means that $r(b_i) - r'(b_i)b_i = (1 - h)r(b_i)$. Using this assumption and the first order conditions of country j (given by (14)) and of country i (given by (32)), we calculate the interest rate difference in the cases of hard and soft budget constraints, respectively

$$(r_i(\hat{b}_i) - r_j(\hat{b}_j)) = \frac{r'(\hat{b}_i)\bar{b} + h\rho}{(h + 1)} > 0, \quad (33a)$$

$$(r_i(b_i^*) - r_j(b_j^*)) = \frac{r'(b_i^*)\bar{b}}{(h + 1)} > 0. \quad (33b)$$

The above results can be summarized by the following Lemma

Lemma 3 *If the supply of debt function is homogenous of degree $h > 1$, the government in country i always finds it advantageous to issue common bonds.*

Therefore, in the following we assume that country i always issues the full amount of common bonds possible \bar{b} .

We can now derive the following proposition regarding the effects of common bonds on the soft budget constraint equilibrium:

Proposition 2 *(i) the equilibrium borrowing of a small country i is larger in the presence of common bonds, (ii) the equilibrium bailout is unchanged by the presence of common bonds, (iii) \bar{n}_C is unaffected from the introduction of common bonds, (iv) \bar{n}_L declines unambiguously with*

⁶Eq. (32) holds both in a soft and hard budget constraint case, as the optimal bailout decision remains given by (21), while $\partial \underline{m}_i / \partial b_i$ becomes $\partial \underline{m}_i / \partial b_i = (1 + r_i(b_i^*) (1 + \varepsilon_i^* (1 - \bar{b}/b_i^*))) (1 + 2\underline{m}_i) / (1 + 2\underline{m}_i + 2g_{i2}) > 0$.

the introduction of common bonds. This effect is declining in the common bond ceiling level \bar{b} and vanishes, when full substitution is reached.

Proof of proposition 2: The first result states that equilibrium borrowing in a bailout equilibrium increases with the introduction of common bonds. This result vindicates the concerns that common bonds will lead to larger indebtedness of countries with soft budget constraints. It exists both in the cases of hard and soft budget constraints. Totally differentiating Eq. (32) with respect to b_i and \bar{b} , we get

$$\frac{db_i}{d\bar{b}} = \frac{r'_i(b_i)}{2r'_i(b_i) + b_i r''_i(b_i) - \bar{b} r''_i(b_i)}. \quad (34)$$

Moreover, taking into consideration that $r'(b_i)$ is homogenous of degree $h - 1$ and, therefore, $r''(b_i)b_i = (h - 1)r'(b_i)$, we get

$$\begin{aligned} \frac{db_i^*}{d\bar{b}} &= \frac{1}{2 + (h - 1) \left(1 - \bar{b}/b_i^*\right)} > 0, \\ \frac{d\hat{b}_i}{d\bar{b}} &= \frac{1}{2 + (h - 1) \left(1 - \bar{b}/\hat{b}_i\right)} > 0. \end{aligned}$$

The second result shows that the equilibrium bailout does not change. This can be directly seen by Eq. (27), which determines the optimal bailout and is independent of \bar{b} . The intuition of this result is that the bailout depends only on the externalities from public good provision in country i (denoted by κ) and the relative size of country i , which influences the costs of providing the bailout (determined by n_i and N).

The third result states that the introduction of common bonds does not influence the critical value \bar{n}_C . This result is related to the previous one. Since both the bailout and g_{i2}^* are determined only by κ, n_i and N , common bonds and the borrowing of region i do not influence the incentive of the remaining countries to increase the bailout above zero.

The fourth result states that the second critical value goes down. It is the case if the introduction of common bonds lowers the value of $U_i^* - \hat{U}_i$ for any n_i . In this case, either \bar{n}_L

declines (if an interior value for it exists), or it remains at 0 or $N/2$. Therefore, showing that

$$\frac{d}{d\bar{b}}(U_i^* - \hat{U}_i) < 0$$

suffices to prove this result. We can show that it always holds. First, due to the independence of $g_{i\tau}^*, \hat{g}_{i\tau}, g_{j\tau}^*$ and $\hat{g}_{j\tau}$ of common bonds, the utility difference is not affected by \bar{b} through the public good consumption. Nevertheless, since common bonds lead to an increase in borrowing in each equilibrium, optimal taxes decline in period one and rise in period two. Using Eq.'s (13), (14), (24), (25) and (34), we can show that

$$\frac{dt_{i1}^*}{d\bar{b}} = -\frac{(1-\kappa)n_i}{n_i + \kappa(N-n_i)} \frac{db_i^*}{d\bar{b}} < 0, \quad (35a)$$

$$\frac{d\hat{t}_{i1}}{d\bar{b}} = -\frac{(1-\kappa)n_i}{n_i + \kappa(N-n_i)} \frac{d\hat{b}_i}{d\bar{b}} < 0, \quad (35b)$$

$$\frac{dt_{i2}^*}{d\bar{b}} = \frac{(1-\kappa)n_i}{n_i + \kappa(N-n_i)} \left[r_j(b_j^*) - r_i(b_i^*) + \left(1 + r_i(b_i^*) \left(1 + \varepsilon_i^* \left(1 - \frac{\bar{b}}{b_i^*} \right) \right) \right) \frac{db_i^*}{d\bar{b}} \right] > 0, \quad (35c)$$

$$\frac{d\hat{t}_{i2}}{d\bar{b}} = \frac{(1-\kappa)n_i}{n_i + \kappa(N-n_i)} \left[r_j(\hat{b}_j) - r_i(\hat{b}_i) + \left(1 + r_i(\hat{b}_i) \left(1 + \hat{\varepsilon}_i \left(1 - \frac{\bar{b}}{\hat{b}_i} \right) \right) \right) \frac{d\hat{b}_i}{d\bar{b}} \right] > 0. \quad (35d)$$

Using the above Equations, we can derive

$$\begin{aligned} \frac{d}{d\bar{b}}(U_i^* - \hat{U}_i) &= -\frac{1}{1-\kappa} \left[\frac{dt_{i1}^*}{d\bar{b}} - \frac{d\hat{t}_{i1}}{d\bar{b}} + \delta \left(\frac{dt_{i2}^*}{d\bar{b}} - \frac{d\hat{t}_{i2}}{d\bar{b}} \right) \right] \\ &= \frac{-\delta n_i}{n_i + \kappa(N-n_i)} \left[\rho + r(\hat{b}_i) - r(b_i^*) \right] \end{aligned}$$

Using the first order conditions of local governments, given by Eq. (32), we can present the above utility difference change as

$$\frac{d}{d\bar{b}}(U_i^* - \hat{U}_i) = \frac{-\delta n_i h}{n_i + \kappa(N-n_i)} \left[(r(b_i^*) - r(\hat{b}_i)) + \left(\frac{r(\hat{b}_i)\bar{b}}{b_i^*} - \frac{r(b_i^*)\bar{b}}{\hat{b}_i} \right) \right] \leq 0. \quad (36)$$

The first term in the square brackets is positive $(r(b_i^*) - r(\hat{b}_i)) > 0$, while the last term is negative and increasing in the amount of common bonds. The whole term in the square brackets is

multiplied by a negative number and we can conclude that the change in the utility difference attains its largest value when \bar{b} approaches its upper limit b_i . In this case, full substitution of sovereign for common debt is achieved and both b_i^* and \hat{b}_i equal \bar{b} . In this case we can show that

$$\left. \frac{d}{d\bar{b}}(U_i^* - \hat{U}_i) \right|_{\text{full substitution}} = 0. \quad (37)$$

Therefore, the marginal effect of common bonds on the incentives to induce a bailout is always negative, except for full substitution of national for common bonds. Thus, the impact of a discrete introduction of common bonds from $\bar{b} = 0$ to $\bar{b} > 0$ is also negative. The intuition behind this result is that common bonds have a larger positive effect on second period taxes in a SBC equilibrium than in a HBC case. Therefore, the possible negative tax differential $t_{i2}^* - \hat{t}_{i2}$, which is responsible for the inducement of a bailout, declines in absolute value. Lastly, $d(U_i^* - \hat{U}_i)/d\bar{b}$ is most negative when $\bar{b} = 0$, because the positive effect vanishes. Therefore, the marginal effect on \bar{n}_L is strongest at the lowest possible common bond ceiling. It vanishes at full substitution of national for common bonds. \square

7 Concluding remarks

The defining characteristic of bailouts and soft-budget constraints is that governments are not able to stick to pledges not to interfere when another government gets into financial troubles. Even when a government bears sole responsibility for its troubles, other governments can find it irresistible to intervene in favor of this governments, as it could otherwise dramatically reduce its supply of goods and services (Seitz 1999). Another important observation is that bailouts of jurisdictions occur to the relatively small districts - both attributes of bailouts are captured by our model.

The existing literature on bailouts draws on three motivations (see von Hagen et al. 2000) prompting bailouts: (1) a high vertical fiscal imbalance restricting the possibilities of subnational governments to respond to adverse developments; (2) an electorate responding positively to bailouts; and (3) the externalities caused by a reduction in public good provision. Stein (1999),

for example, bases his model upon (1), while, e.g., Goodspeed (2002) concentrates on (2). We follow Wildasin (1997) and Crivelli and Staal (2013) and use (3). To our knowledge, our paper is the first to introduce debt into a model based on (3), considering jurisdiction of different size, and to subsequently study how the introduction of common bonds affect bailouts. Our analysis shows four effects of the introduction of common bonds: (i) that public debt levels increase; (ii) that the size of bailouts is not affected; (iii) that the set of governments eligible for bailouts does not change; and (iv) that the incentives to induce bailouts are reduced. While (i) can be seen as a negative, (ii) and (iii) as neutral consequences of the introduction of common bonds, (iv) on the contrary shows that the introduction of common bonds can mitigate the problems that are caused by bailouts.

8 References

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