Postprint

# A Note on Public Goods in a Decentralized Fiscal Union: Implications of a Participation Constraint[*]

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## Abstract

This paper re-examines the question of whether federal ex-post redistribution in terms of public funds leads to under-provision of public goods when member states may leave the economic federation. We show that federal ex-post redistribution under a binding participation constraint does not necessarily mean under-provision of local and federal public goods.

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# 1  Introduction

The question of how ex-post redistribution by a central (or federal) government affects the incentives for public good provision at lower levels of government has been addressed in several previous studies. These studies focus on economic federations with decentralized leadership, where ex-post redistribution means that the higher level of government redistributes across lower level jurisdictions *after* it observes the policies decided upon by the lower level governments. This scenario might be exemplified by the fiscal structure in a given country, where cities and other municipalities levy local taxes and supply public services to their respective residents, and the central government redistributes public funds through an intergovernmental transfer system (and possibly also provides national public goods).[1] If the redistribution policy aims at accomplishing (reasonably) equivalent living conditions in the country as a whole according to constitutional (or other) requirements, there is a commitment problem for the central government through an incentive to adjust the transfer payments after the lower level governments have made their policy choices. In turn, this creates an incentive for the lower level governments to act strategically in order to gain from this redistribution policy. Another example is the European Union (EU), which plays an important fiscal role in Europe by redistribution between the member states and provision of certain public goods like services. Since the EU is still in its infancy as a fiscal union, and (at least some of) the member countries may have had the opportunity to commit to their own tax policies or expenditure programs, the EU most likely shares the characteristics of an economic federation with decentralized leadership. Earlier research shows that ex-post redistribution in terms of private consumption across citizens in different regions may under certain conditions lead to efficient provision of public goods (Caplan, Cornes and Silva, 2000; Caplan and Silva, 2011), whereas ex-post redistribution in terms of public funds typically leads to under-provision of local public goods as it undermines the local incentive to collect tax revenue (Köthenbürger, 2004, 2007).[2]

Yet, these previous studies assume that the number of local jurisdictions in the economic federation is fixed and does not depend on the redistribution (or other) policy chosen by the federal government. The present paper re-examines the effects of federal ex-post redistribution in terms of public funds under the assumption that membership in the economic federation is voluntary by adding a participation constraint to the decision-problem faced by the higher level government. This change of assumption is clearly relevant from the perspective of the EU, where each member state is (at least in principle) free to leave the union,[3] but may also be relevant from the perspective of a single country. For instance, regional movements of

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[1] Sweden may serve as an example here, where the municipalities supply a variety of public services such as child care, education, and elderly care, and where the central government redistributes public funds through an intergovernmental redistribution system.

[2] A good overview of decentralized leadership models is found in Akai and Sato (2008). See also the related literatures on environmental policy (e.g., Silva and Caplan, 1997; Caplan and Silva, 1999; Aronsson, Jonsson and Sjögren, 2006), and soft budget constraints and bailouts (e.g., Qian and Roland, 1998; Fink and Stratmann, 2011; Crivelli and Staal, 2013).

[3] This is further emphasized by the recent financial crisis in the Euro-area, where the option of leaving the European Monetary Union (which is part of the EU) has been discussed in some of the member states.

autonomy or independence (such as in northern Spain and northern Italy) may induce national governments to change their redistribution and other policies in response to the outside options faced by the residents in these regions. The same argument applies to urban and rural secession movements, where cities or rural areas strive to form their own regional jurisdictions (or enter into other regional jurisdictions) instead of settling with the existing fiscal structure.[4] This paper attempts to address the consequences of such threats for redistribution policy and public good provision, based on the assumption that the higher level government wants to avoid secession.[5] As such, our study is also important from a theoretical point of view, i.e., for our understanding of policy incentives, by showing that federal ex-post redistribution in terms of public funds may have implications different from those presented in earlier studies. This will be discussed more thoroughly below.

We consider a scenario where (i) the lower level jurisdictions are heterogenous, (ii) the participation constraint may bind for a certain group of such jurisdictions without being binding for others, and (iii) the ability to commit vis-a-vis the federal/central level may also differ across lower level jurisdictions. Although the earlier theoretical literature on decentralized leadership referred to above assumes that all lower level governments are first movers vis-a-vis the higher level, empirical evidence suggests that the expectations of additional resources in case of failure may, nevertheless, differ among local jurisdictions.[6] This suggests to us that it might be useful to consider a model where the lower level governments are allowed to differ in

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[4] An example taken from the Italian experience can illustrate this possibility. Italy is administratively divided into 20 regions, 110 provinces and 8057 municipalities, with each of these lower-level governmental bodies having some specific responsibilities for revenue collection and public good provision. Five of these regions are granted special autonomy under the Italian Constitution, which also means that they keep at their disposal most of the revenue from central government taxes collected within their borders. Two of these five regions, Trentino-Alto Adige and Friuli-Venezia Giulia, share borders with Austria, whereas the Veneto region, which is located between Trentino-Alto Adige and Friuli-Venezia Giulia and also shares borders with Austria, does does not enjoy special autonomy. In the past decade, several small municipalities in the northern and mountainous part of the Veneto region have either threatened or taken concrete steps to leave the province of Belluno, to which they still belong, with the goal of being incorporated in neighboring provinces located in either Trentino-Alto Adige or Friuli-Venezia Giulia. Even though these attempts were often officially motivated by appealing to linguistic reasons, it is clear that another real issue at stake was the possibility to benefit from the fiscal privileges associated with special autonomy.

[5] We do not attempt to explain why secession occurs; only its policy implications as described above. In the literature on country formation, the break up of jurisdictions is typically driven by a tradeoff between efficiency gains of large jurisdictions and costs due to preference heterogeneity in the population (see the seminal papers by Alesina and Spolaore, 1997, and Bolton and Roland, 1997).

[6] This question has been addressed in the related literature on soft local public budget constraints, where excessive deficits may lead to a bailout by the federal level. Although our study does not contain public debt, it contains the analogous incentive of raising too little tax revenue in anticipation of additional funds from the federal government. Based on German data, Fink and Stratmann (2011) find that states with a stronger bargaining power vis-a-vis the federal government, measured by over-representation of seats (relative to the state population) in the upper chamber of the parliament, tend to run higher budget deficits than other states, ceteris paribus, suggesting higher bailout expectations. Similarly, Atlas et al. (1995) find that over-representation of seats in the U.S. senate leads to more federal spending in these states; similar results for the EU are presented in Rodden (2002). See also Crivelli and Staal (2013), who argue that the ability of a local government to induce a federal bailout is negatively associated with the size of the local jurisdiction.

such commitment power, and also compare the results with those that follow if all lower level governments are first movers.

We show that if the group of lower level governments for which the participation constraint does not bind is acting first mover vis-a-vis the central level, while the group of lower level governments where the participation constraint binds instead treats the central level as a Nash-competitor, there will be efficient provision of local public goods as well as efficient provision of federation-wide public goods. On the other hand, if the participation constraint binds for the group of lower level governments which is acting first mover, then the outcome will not in general be efficient. As such, it is not just the ability to commit by the lower level of government that is important for the outcome; the threat of secession also matters.

Section 2 presents the model, while the main results are discussed in Section 3. Proofs are presented in the Appendix.

# 2    The Model

To simplify the analysis as much as possible, we consider an economic federation comprising two groups of local jurisdictions; denoted by 1 and 2, respectively, and referred to as "states" in what follows. Since the number of states in each such group is of no importance for the qualitative results derived below, it will be normalized to one. Also, each state is populated by identical and immobile residents, whose number is normalized to one.[7] In state $i$ $(i = 1, 2)$, a state government collects tax revenue to finance a local (i.e., state-specific) public good, the benefits of which are only enjoyed by the residents of state $i$, while the higher level government for the economic federation as a whole - referred to as "federal government" - redistributes between the states in terms of public funds as well as provides a federal public good (whose benefits are enjoyed by all residents of the economic federation).

## 2.1    Consumers and Firms

The utility function faced by the residents in state $i$ is given by

$$U_i = U_i(c_i, g_i, G) = u_i(c_i) + \phi_i(g_i) + \Phi_i(G) \tag{1}$$

for $i = 1, 2$, where $c_i$ denotes private consumption, $g_i$ a local public good provided by the state government, and $G$ a federal public good provided by the federal government. We assume that the functions $u_i(\cdot)$, $\phi_i(\cdot)$ and $\Phi_i(\cdot)$ are increasing in their respective argument and strictly concave. Notice that equation (1) implies that the preferences for private and public consumption may differ between consumers in different states. The separable structure facilitates signing key comparative statics associated with the choices made by the federal government, i.e., the choices underlying equations (6a) and (6b) below. Since none of the results to be

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[7]Allowing for differences between the member states in terms of the number of residents does not change the qualitative results derived below.

derived below refer to work hours, we assume that each consumer supplies one unit of labor inelastically. As such, the consumers are passive agents; they consume their income net of local income taxation, $c_i = y_i - t_i$, where $y_i$ denotes the before-tax income and $t_i$ the tax payment, while treating the two public goods, $g_i$ and $G$, as exogenous.

Output is produced by a linear technology such that the before-tax wage rate is fixed. Since the labor supply is inelastic by assumption, this also implies that the before-tax income, $y_i$, is fixed.

## 2.2 State-Specific and Federal Policy Objectives and Constraints

We assume that the objective function faced by each level of government is a social welfare function. Since the residents in each state are identical, the objective of the government in state $i$ is given by $U_i$ in equation (1), while the objective of the federal government is a utilitarian utility sum, i.e., $U = \sum_i U_i$.[8] The budget constraints faced by the government in state $i$ and the federal government can be written as

$$g_i = t_i - s_i, \tag{2}$$

$$G = \sum_i s_i, \tag{3}$$

respectively, where $s_i$ denotes a fee (positive or negative) paid by the government in state $i$ to the federal government.

A novelty here is that we allow the states to leave the economic federation, which means that the federal redistribution and provision must be carried out subject to participation constraints. Our main result below is derived under the assumption that secession is a realistic option for one of the states. As such, we are concerned with the case where a participation constraint may bind for this state, while the corresponding constraint for the other state is always slack. This may reflect differences in preferences such that the residents in one of the states attach a higher utility to the federal public good than the residents in the other state, differences in the value attached to local public consumption (which is influenced through federal redistribution policy), or differences in income. Therefore, if we assume that the participation constraint may bind for state 2 (an arbitrary choice of no significance for the qualitative results), this constraint may be written as

$$U_2 = u_2(y_2 - t_2) + \phi_2(t_2 - s_2) + \Phi_2(G) \geq \widehat{U}_2 \tag{4}$$

where $\widehat{U}_2$ denotes the reservation utility that will follow if the state leaves the economic federation. To be useful in the analysis below, (4) necessitates two additional assumptions regarding (i) the true outside option for state 2, and (ii) the federal government's belief about this outside option. We assume that state 2, if leaving the economic federation, will act independently and implement a tax and expenditure policy to maximize $u_2(y_2 - t_2) + \phi(g_2)$ subject to $g_2 = t_2$, which represents the utility attainable for the resident

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[8]None of the qualitative results derived below would change if we generalize the federal welfare function such that $U = \sum_i \alpha_i U_i$, where $\sum_i \alpha_i = 1$. We will, therefore, use the simpler utilitarian formulation in the text.

if state 2 is not part of the federal arrangement (meaning that the benefits of the federal public good as well as the fee to the federal government would vanish). Let $\widehat{t}_2$ denote the tax payment that solves this decision-problem. We also assume that $\widehat{t}_2$ corresponds to the federal government's best guess about the policy that state 2 would implement if it chooses to leave the economic federation. We can then specify the right hand side of (4) such that

$$\widehat{U}_2 = u_2(y_2 - \widehat{t}_2) + \phi_2(\widehat{t}_2). \tag{4a}$$

A comparison between (4) and (4a) suggests that the participation constraint may bind only if $s_2 > 0$.

An alternative to equation (4a) would be to assume that the reservation utility is "truly" exogenous, i.e., represents a fixed number irrespective of the choices made by the government of state 2 in case of secession. This might be the case if state 2 would have the option of entering another economic federation if leaving the current arrangement. Yet, this change of assumption would have no influence on the qualitative results derived below, since the right hand side of equation (4a) is also exogenous when state 2 decides on whether to remain in the economic federation (it just represents the maximum utility attainable outside the economic federation if state 2 acts independently).

# 3 Redistribution and Provision of Public Goods

The policy problem analyzed here is characterized by decentralized leadership. It is analogous to similar policy problems examined in earlier literature on federal redistribution under decentralized leadership (see the introduction) with two important exceptions: (a) the federal government carries out the redistribution policy subject to a participation constraint, and (b) the state governments may differ with respect to commitment power vis-a-vis the federal level (as explained above). The order of decision-making is as follows: (i) either one or both states move first by deciding upon their tax revenue while recognizing how this choice will affect the fee that both states pay to the federal government; (ii) the remaining non-leader state (if any) decides upon its tax revenue, and the federal government decides upon its redistribution policy, while treating the policy instruments chosen by all other policy-makers as exogenous. Following earlier comparable literature (see the introduction), we also assume that the state governments treat one another as Nash-competitors, i.e., the government in state 1 treats the policy variables of state 2 as exogenous and vice versa (irrespective of whether they are first movers vis-a-vis the federal level).

## 3.1 Federal Government

The federal government redistributes lump-sum in terms of public funds through the fees levied on the state governments and provides the federal public good, $G$, while treating the tax revenue collected by the state governments, $t_1$ and $t_2$, as exogenous. As such, the federal government chooses $s_1$, $s_2$ and $G$ to maximize $U = \sum_i U_i$ subject to the state and federal public budget constraints given in equations (2) and

(3), respectively, and the participation constraint given in equation (4). By substituting equations (2) and (3) into the objective function to obtain a decision-problem only in $s_1$ and $s_2$, we get

$$\underset{s_1, s_2}{Max} \ \sum_i U_i(y_i - t_i, t_i - s_i, s_1 + s_2) \ \text{ s.t. } \ u_2(y_2 - t_2) + \phi_2(t_2 - s_2) + \Phi_2(G) \geq \widehat{U}_2.$$

If the participation constraint binds, the first order conditions can be written as (in addition to equation (4))

$$s_1 \ : \quad -U_{1,g} + U_{1,G} + (1 + \lambda)U_{2,G} = 0 \tag{5a}$$

$$s_2 \ : \quad (U_{2,G} - U_{2,g})(1 + \lambda) + U_{1,G} = 0 \tag{5b}$$

where $\lambda$ denotes the Lagrange multiplier attached to the participation constraint, while $U_{i,g} = \partial U_i / \partial g_i$ and $U_{i,G} = \partial U_i / \partial G$ are the marginal utilities of local and federal public goods, respectively, in state $i$. Equations (5a) and (5b) can be combined to imply $U_{1,g} = (1 + \lambda)U_{2,g}$, i.e., the effect of the participation constraint is to put extra weight on state 2 such that the redistribution goes beyond the point of equalization of marginal utilities of public consumption.[9] Note that the participation constraint will always bind as long as $\widehat{U}_2$ is sufficiently large. In what follows, we both discuss the case where the participation constraint binds (which is the case of main interest here), and the case where it does not bind. In the Appendix (under the headline "Binding participation constraint"), we present an example based on simplified utility functions showing that an equilibrium with a binding participation constraint is, indeed, possible.

By using equations (4), (5a) and (5b), we can solve for $\lambda$, $s_1$ and $s_2$ as functions of $t_1$ and $t_2$. Notice first that in the absence of any participation constraint, or when this constraint does not bind (in which case $\lambda = 0$), we would obtain two functions, $s_1 = \check{s}_1(t_1, t_2)$ and $s_2 = \check{s}_2(t_1, t_2)$, with the following comparative statics properties: $\partial s_i / \partial t_i > 0$ and $\partial s_j / \partial t_i < 0$ for $i = 1, 2$ and $j \neq i$. In this case, therefore, each state may reduce its own fee and increase the fee paid by the other state by lowering its own tax collection, ceteris paribus, which is, in turn, the root to the under-provision of local public goods under federal ex-post redistribution (e.g., Köthenbürger, 2007).

On the other hand, with a binding participation constraint for state 2, the comparative statics will be as follows (see the Appendix for technical detail):

$$s_1 \ = \ s_1(\overset{+}{t_1}, t_2) \tag{6a}$$

$$s_2 \ = \ s_2(\overset{+}{t_1}, t_2). \tag{6b}$$

The sign above $t_1$ indicates the sign of the partial derivative with respect to this argument. Notice that an increase in $t_1$ leads to an increase in $s_2$; a consequence of the participation constraint. The intuition is that an increase in $t_1$ leads to an increase in the federal public good via $s_1$: in turn, this relaxes the participation constraint, which means that the federal government can increase $s_2$ up to the point where the

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[9]The result that secession threats may impose fiscal restraint on the non-seceding part is, of course, not novel in itself. See, e.g., Buchanan and Faith (1987).

participation constraint binds without inducing secession. The increase in $s_2$ serves to impose more financial burden on state 2, which is desirable from the point of view of the federal government. In other words, since the participation constraint necessitates an undesirable redistribution in favor of country 2, the federal government has an incentive to increase $s_2$ to come as close as possible to the desired distribution of public funds. This mechanism is crucial for the results to be derived in the next section.

The comparative statics with respect to $t_2$ depend on whether state 2 behaves as Nash-competitor or Stackelberg leader vis-a-vis the federal level. If the government in state 2 treats the federal government as a Nash-competitor, then $\partial s_1 / \partial t_2 > 0$ and $\partial s_2 / \partial t_2 > 0$. The interpretation of the positive partial effect of $t_2$ on $s_1$ is analogous to the effect of $t_1$ on $s_2$ discussed above: a higher $t_2$ tightens the self-selection constraint despite the associated increase in $G$, which necessitates that the federal transfer is rebalanced in favor of state 2. If state 2 acts as Stackelberg leader vis-a-vis the federal level, on the other hand, both $\partial s_1 / \partial t_2$ and $\partial s_2 / \partial t_2$ can be either positive, zero, or negative. This result will be explained in subsection 3.2.

## 3.2   State Governments

As explained above, since the state governments may differ with respect to commitment power vis-a-vis the federal level, we distinguish between a state whose government acts as Stackelberg leader vis-a-vis the federal level, and a state whose government treats the federal government as a Nash-competitor (i.e., moves simultaneously with the federal government). If the government in state $i$ acts as a Nash-competitor towards the federal level, it chooses $t_i$ and $g_i$ to maximize its own welfare function, $U_i$, subject to its own public budget constraint given in equation (2), while treating $s_1$ and $s_2$ (and, therefore, $G$) as exogenous. On the other hand, if the government in state $i$ acts as first mover vis-a-vis the federal level, it will also recognize that $s_1$ and $s_2$ (and, therefore, $G$) are affected by its own choice of tax collection through equations (6a) and (6b). As we indicated above, the state governments are assumed to be Nash-competitors to one another: the government in state 1 treats $t_2$ as exogenous and vice versa, irrespective of whether it behaves as a Stackelberg leader or Nash-competitor vis-a-vis the federal level.

Let $U_{i,c} = \partial U_i / \partial c_i$ such that $MRS_i^{g,c} = U_{i,g}/U_{i,c}$ denotes the marginal rate of substitution between the local public good and private consumption faced by the resident in state $i$, while $MRS_i^{G,c} = U_{i,G}/U_{i,c}$ denotes the corresponding marginal rate of substitution between the federal public good and private consumption. By substituting equations (2) and (3) into the objective function, such that $t_i$ becomes the effective decision-variable for the state government, i.e.,

$$\underset{t_i}{Max}\ U_i(y_i - t_i, t_i - s_i, s_1 + s_2) \text{ for } i = 1, 2,$$

the first order condition can be written as follows if the state government behaves as a *Nash-competitor* vis-a-vis the federal government:

$$MRS_i^{g,c} = 1, \tag{7}$$

which is the well-known Samuelson condition for the local public good examined here (where the public

good only benefits the local residents). Equation (7) follows from the assumption of Nash-competition: the state government treats $s_1$ and $s_2$ as exogenous in that case. Instead, if the state government behaves as *Stackelberg leader* vis-a-vis the federal level (and recognizes that $t_i$ also affects $s_1$ and $s_2$), the corresponding first order condition becomes

$$MRS_i^{g,c} = 1 + \left[ MRS_i^{g,c} - MRS_i^{G,c} \right] \frac{\partial s_i}{\partial t_i} - MRS_i^{G,c} \frac{\partial s_j}{\partial t_i} \tag{8}$$

for $j \neq i$. Therefore, based on equation (8), efficient provision of the local public good requires that the second and third terms on the right hand side sum to zero.

Before we derive the main result, notice that in the absence of any participation constraint (i.e., if the constraint does not bind), the second and third term on the right hand side of equation (8) sum to a positive number. In turn, this means $MRS_i^{g,c} > 1$, in which case it also follows from equations (5a) and (5b) that $\sum_i MRS_i^{G,c} > 1$. As such, in the absence of a binding participation constraint, a first mover state government always under-provides the local public good, and there will also be under-provision of the federal public good, relative to the Samuelson condition.

We are now ready to derive the main result:

**Proposition 1** *Suppose that the participation constraint binds for state 2. (a) If the government in state 1 acts as Stackelberg leader vis-a-vis the federal level, while the government in state 2 behaves as a Nash-competitor towards the federal level, a subgame perfect equilibrium satisfies*

$$MRS_i^{g,c} = 1 \ \ for \ \ i = 1, 2 \quad and \quad \sum_i MRS_i^{G,c} = 1.$$

*(b) If the government in state 2 is Stackelberg leader vis-a-vis the federal level, while the government in state 1 either behaves as a Nash-competitor or Stackelberg leader towards the federal level, the subgame perfect equilibrium instead satisfies*

$$MRS_1^{g,c} = 1, \quad MRS_2^{g,c} \gtreqless 1 \quad and \quad \sum_i MRS_i^{G,c} \gtreqless 1.$$

Proof: see the Appendix.

The most interesting aspect of the proposition is that the outcome in terms of efficiency depends on in which state (or group of states) the government is first mover vis-a-vis the federal level. More specifically, if the government in the state for which the participation constraint does not bind is first mover, while the government in the state for which the participation constraint is binding engages in Nash-competition with the federal level, the outcome is efficient: $g_1$, $g_2$ and $G$ are all provided in accordance with the Samuelson condition. This is clearly different from the outcome that would follow in the absence of the participation constraint, which always implies under-provision of the local public good by the strategic leader state and under-provision of the federal public good, respectively.

Part (a) of Proposition 1 follows from the comparative statics properties with respect to $t_1$ in equations (6a) and (6b) in combination with the behavioral assumptions imposed on state 2. As explained above, the

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policy rule for public provision in state 2 is given by equation (7), since the government in state 2 treats the federal government as a Nash-competitor. For state 1, on the other hand (which is first mover vis-a-vis the federal level), the policy rule is given by equation (8): yet, due to the comparative statics properties of the federal redistribution problem, the second and third terms on the right hand side of equation (8) sum to zero in this case. Also, when the local public good is efficiently provided in both states, efficient provision of the federal public good follows from the federal first order conditions in equations (5a) and (5b).[10]

To provide an interpretation of part (a) of the proposition, suppose that state 1 raises its tax revenue by one dollar. This raises the fee that the government in state 1 pays to the federal government and also the fee that state 2 pays. The increase in $s_2$ is due to that a higher $s_1$ allows the federal government to impose a higher fee on state 2 without violating the participation constraint (since $G$ also increases). As such, this is desirable for the federal government, which attempts to come as close as possible to its preferred distribution of public funds. The intuition behind part (a) is that the locally induced change in federal transfer payments does not generate any externalities when the government in state 1 is Stackelberg leader vis-a-vis the federal government and the participation constraint binds for state 2. This is so because the utility in state 2 is held constant when the federal government rebalances transfer payments, meaning that all utility effects of this policy will be internalized by the first-mover state 1.[11]

In part (b) of the proposition, where state 2 is first mover, this reasoning no longer holds. For state 1, this regime implies that the local public provision satisfies $MRS_1^{g,c} = 1$, irrespective of whether the state government moves simultaneously with or before the federal government (as before). However, for state 2, the outcome in this regime hinges on the observation that when the participation constraint binds, and if the government in state 2 acts as Stackelberg leader vis-a-vis the federal level, the government in state 2 recognizes that the federal government will use the interjurisdictional redistribution system to maintain the equality $U_2 = \widehat{U}_2$ irrespective of its own tax policy. In turn, since the reservation utility is defined by equation (4a), it is a fixed number that state 2 in unable to influence through its policy choice inside the economic federation. As a consequence, there exists no unique solution to the optimal tax problem for the local government in state 2. Since both the federal government and the local government in state 1 condition their respective policies on the observed level of $t_2$, there exist no unique solutions for $s_1$, $s_2$ and $t_1$ either. This also explains why we were not able to sign the comparative statics of the reaction functions for $s_1$ and $s_2$ with respect to $t_2$ when state 2 is first mover vis-a-vis the federal level.[12]

To take the analysis underlying part (b) a bit further, we also discuss the results following a more restrictive assumption, where state 2 implements the same tax policy inside the economic federation as it

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[10] As long as the participation constraint binds, and since $t_1$ does not affect the reservation utility faced by state 2, this result does not depend on the assumption that $\widehat{U}_2$ is defined as the maximum utility attainable to state 2 if acting independently. The same result would follow if $\widehat{U}_2$ is truly exogenous.

[11] We are grateful to a referee for suggesting this interpretation.

[12] On the other hand, when state 2 treats the federal level as a Nash-competitor, its provision of the local public good satisfies $U_{2,c} = U_{2,g}$, meaning that the first term on the right hand side of equation (A5b) and (A5d), respectively, vanishes. In turn, this implies that we can sign equations (A5b) and (A5d) such that $\partial s_1/\partial t_2 > 0$ and $\partial s_2/\partial t_2 > 0$.

would do if leaving the economic federation, and where the federal government expects state 2 to do so. Note that this is consistent with the belief structure discussed earlier: in accordance with the belief of the federal government, state 2 still chooses $t_2$ to maximize $u_2(y_2 - t_2) + \phi(t_2)$ if leaving the economic federation. Yet, since it also implements the same tax policy if remaining inside the economic federation, the participation constraint implied by (4) and (4a) simplifies to read

$$\phi_2(t_2 - s_2) + \Phi_2(G) \geq \phi_2(t_2). \tag{4b}$$

As we show in the Appendix, this means that the second and third terms on the right hand side of equation (8) sum to a positive number for state 2 and, therefore, under-provision of public goods if state 2 is first mover vis-a-vis the federal government. Yet, although this qualitative result resembles the outcome that would follow without any participation constraint (see above), the underlying mechanism is different here. Since state 2 acts Stackelberg leader vis-a-vis the federal government, a binding participation constraint will in this case imply that state 2 recognizes that maximizing $U_2$ is equivalent to implementing a tax policy that maximizes the reservation utility, $\widehat{U}_2$. As mentioned above, the reservation utility, $\widehat{U}_2 = u_2(y_2 - t_2) + \phi_2(t_2)$, is maximized if $t_2$ is chosen such that

$$\frac{d\widehat{U}_2}{dt_2} = \frac{d\phi_2(t_2)}{dg_2} - \frac{du_2(y_2 - t_2)}{dc_2} = 0. \tag{9}$$

Therefore, $\widehat{MRS_2^{g,c}} = \widehat{U}_{2,g}/\widehat{U}_{2,c} = 1$, meaning that the provision of local public goods in state 2 would be efficient outside the economic federation. However, as long as state 2 remains inside the economic federation, the utility of local public consumption is given by $\phi_2(t_2 - s_2)$. Since the participation constraint can bind only if $s_2 > 0$, it follows that a tax policy that satisfies equation (9) implies

$$\frac{d\phi_2(t_2 - s_2)}{dg_2} > \frac{d\phi_2(t_2)}{dg_2}. \tag{10}$$

Dividing both sides of this inequality by $du_2(y_2 - t_2)/dc_2$ gives $MRS_2^{g,c} > \widehat{MRS_2^{g,c}} = 1$, which means under-provision of the local public good in state 2 and, as a consequence, under-provision of the federal public good.

Finally, since the outcome will most likely be inefficient as soon as the participation constraint binds for a state whose government behaves as first mover vis-a-vis the federal level, a natural conjecture is that the outcome will be inefficient also in the more restrictive case where the participation constraint binds for both states (provided, of course, that at least one of them is first mover in the economic federation).

The following corollary summarizes the efficiency implications of a binding participation constraint:

**Corollary 1.** *A binding participation constraint for state* 2 *solves the problem of inefficient provision of local and federal public goods caused by decentralized leadership if the government in state* 1 *is Stackelberg leader vis-a-vis the federal level, while the government in state* 2 *treats the federal level as a Nash-competitor.*

The intuition behind the corollary is, of course, that the fiscal externalities only vanish in the regime described in part (a) of the proposition.

The basic lesson from our study is that federal ex-post redistribution in terms of public funds does not necessarily cause under-provision of public goods (neither at the lower level nor at the federal level), if the states are free to leave the economic federation. Instead, assessing the efficiency aspects of federal redistribution policy requires more information, and our study shows what additional information to look for. Therefore, whether or not federal ex-post redistribution in terms of public funds distorts the incentives underlying public good provision in fiscal unions where secession is possible is ultimately an empirical question.

As in all economic models, the results depend on the underlying assumptions. An important simplification in our model is that we assume away population mobility throughout the paper. This makes it easy to relate our results to those presented in earlier comparable literature, which examines the implications of ex-post redistribution without participation constraints. If we were to introduce population mobility in the above model, one may distinguish between two types of mobility: (i) resident mobility between the states in the economic federation and (ii) mobility across the federal borders. The first type of mobility clearly affects the analysis and results, since population movement between the states introduces an additional fiscal externality. However, population mobility across the federal borders may under certain conditions work in a way similar to the participation constraint analyzed above. Too see this, consider once again the setting behind part (a) in Proposition 1, while replacing the assumption of secession threat by state 2 with the (analogous) assumption that the residents of state 2 may decide to locate outside the economic federation. In state 1, the residents are still assumed to be immobile. Therefore, if the federal government would like all residents to remain in the economic federation, it must carry out its redistribution policy subject to the reservation utility level for the residents in state 2 (i.e., the utility they would receive if moving outside the economic federation). Since the residents of state 2 are identical in our model, and if the mobility-induced utility constraint binds, our conjecture is that the government in state 1 (the Stackelberg leader vis-a-vis the federal level) provides its own local public good in accordance with the Samuelson condition for exactly the same reason as in part (a) of the proposition. Yet, this similarity to our analysis no longer applies if the residents of state 2 differ in their "attachment to home" (as in, e.g., Mansoorian and Myers, 1993), in which case some of them will move while others remain in their original location. As such, the first mover state 1 will not in this case internalize all externalities associated with federal redistribution. This suggests that resident mobility across federal borders does not necessarily give rise to the same policy incentives as a binding participation constraint following the threat of secession.

# 4  Appendix

*Comparative statics*

If the participation constraint does not bind, the first order conditions of the federal government simplify to read

$$s_1 \quad : \quad U_{1,G} - U_{1,g} + U_{2,G} = 0 \tag{A1}$$

$$s_2 \quad : \quad U_{2,G} - U_{2,g} + U_{1,G} = 0. \tag{A2}$$

Differentiation with respect to $s_1$, $s_2$, $t_1$ and $t_2$, and then applying Cramer's rule, give the following comparative statics:

$$\frac{\partial s_1}{\partial t_1} = \frac{U_{1,gg}(U_{2,gg} + U_{1,GG} + U_{2,GG})}{H^{NC}} > 0, \qquad \frac{\partial s_1}{\partial t_2} = -\frac{U_{2,gg}(U_{1,GG} + U_{2,GG})}{H^{NC}} < 0 \tag{A3}$$

$$\frac{\partial s_2}{\partial t_1} = -\frac{U_{1,gg}(U_{1,GG} + U_{2,GG})}{H^{NC}} < 0, \qquad \frac{\partial s_2}{\partial t_2} = \frac{U_{2,gg}(U_{1,gg} + U_{1,GG} + U_{2,GG})}{H^{NC}} > 0$$

where $H^{NC} = U_{1,gg}U_{2,gg} + (U_{1,gg} + U_{2,gg})(U_{1,GG} + U_{2,GG}) > 0$, while $U_{i,gg} = \partial U_{i,g}/\partial g_i$ and $U_{i,GG} = \partial U_{i,G}/\partial G$ for $i = 1, 2$ denote second order partial derivatives.

If the participation constraint binds for state 2, we differentiate equation (4), (5a) and (5b), respectively, with respect to $\lambda$, $s_1$, $s_2$, $t_1$ and $t_2$ to obtain

$$0 \, d\lambda + U_{2,G} \, ds_1 + (U_{2,G} - U_{2,g}) \, ds_2 = 0 \, dt_1 - (U_{2,g} - U_{2,c}) \, dt_2 \tag{A4a}$$

$$U_{2,G} \, d\lambda + \Omega_{s_1,s_1} \, ds_1 + (U_{1,GG} + (1+\lambda)U_{2,GG}) \, ds_2 = U_{1,gg} \, dt_1 + 0 \, dt_2 \tag{A4b}$$

$$(U_{2,G} - U_{2,g}) \, d\lambda + (U_{1,GG} + (1+\lambda)U_{2,GG}) \, ds_1 + \Omega_{s_2,s_2} \, ds_2 = 0 \, dt_1 + U_{2,gg}(1+\lambda) \, dt_2 \tag{A4c}$$

in which $\Omega_{s_1,s_1} = U_{1,gg} + U_{1,GG} + (1+\lambda)U_{2,GG} < 0$ and $\Omega_{s_2,s_2} = (1+\lambda)(U_{2,gg} + U_{2,GG}) + U_{1,GG} < 0$. Now, let $H > 0$ denote the determinant of the Hessian matrix, such that

$$H = 2 \, U_{2,G}(U_{1,GG} + (1+\lambda)U_{2,GG})(U_{2,G} - U_{2,g}) - (U_{2,G})^2 \Omega_{s_2,s_2} - (U_{2,G} - U_{2,g})^2 \Omega_{s_1,s_1} > 0,$$

where we have used $U_{2,G} - U_{2,g} < 0$ from the federal government's first order conditions. Equations (A4a)-(A4c) then imply the following comparative statics:

$$\frac{\partial s_1}{\partial t_1} = -\frac{(U_{2,G} - U_{2,g})^2 U_{1,gg}}{H} > 0 \tag{A5a}$$

$$\frac{\partial s_1}{\partial t_2} = \frac{(U_{2,g} - U_{2,c})\Gamma + (U_{2,G} - U_{2,g})U_{2,G}U_{2,gg}(1+\lambda)}{H} \tag{A5b}$$

$$\frac{\partial s_2}{\partial t_1} = \frac{U_{2,G}U_{1,gg}(U_{2,G} - U_{2,g})}{H} > 0 \tag{A5c}$$

$$\frac{\partial s_2}{\partial t_2} = \frac{(U_{2,g} - U_{2,c})\Psi - (U_{2,G})^2 U_{2,gg}(1+\lambda)}{H} \tag{A5d}$$

where

$$\Gamma = U_{2,G}U_{2,gg}(1+\lambda) + U_{2,g}[U_{1,GG} + (1+\lambda)U_{2,GG}] < 0$$

$$\Psi = (U_{2,G} - U_{2,g})[U_{1,gg} + U_{1,GG} + (1+\lambda)U_{2,GG}] - U_{2,G}(U_{1,GG} + (1+\lambda)U_{2,GG}) > 0.$$

*Proof of Proposition 1*

The decision-problem faced by the government in state $i$ (for $i = 1, 2$) can be written

$$\underset{t_i}{Max} \; U_i = u_i(y_i - t_i) + \phi_i(t_i - s_i) + \Phi_i(s_1 + s_2).$$

In part (a), the government of state 2 behaves as a Nash-competitor vis-a-vis the federal government and treats $s_1$ and $s_2$ as exogenous. The corresponding first order condition reads $U_{2,g} - U_{2,c} = 0 \Rightarrow MRS_2^{g,c} = 1$. For state 1, whose government is first mover vis-a-vis the federal level and exploits the reaction functions given in equations (6a) and (6b), the corresponding first order condition becomes

$$(U_{1,g} - U_{1,c}) + (U_{1,G} - U_{1,g})\frac{\partial s_1}{\partial t_1} + U_{1,G}\frac{\partial s_2}{\partial t_1} = 0. \tag{A6}$$

By substituting equations (A5a) and (A5c) into equation (A6) and rearranging, the second and third terms on the right hand side of equation (A6) will cancel out and, as a consequence, $MRS_1^{g,c} = 1$. Finally, by substituting $U_{1,c} = U_{1,g}$ and $U_{2,c} = U_{2,g}$ into equations (5a) and (5b), we have $\sum_i MRS_i^{G,c} = 1$.

The proof of part (b) is analogous. Here the government of state 1 either behaves as a Nash-competitor or Stackelberg leader vis-a-vis the federal level, which means that the first order condition either takes the form $U_{1,g} - U_{1,c} = 0$ or is given by equation (A6), whereas the first order condition for the first mover government in state 2 is given by

$$(U_{2,g} - U_{2,c}) + (U_{2,G} - U_{2,g})\frac{\partial s_2}{\partial t_2} + U_{2,G}\frac{\partial s_1}{\partial t_2} = 0. \tag{A7}$$

Substituting equations (A5b) and (A5d) into equation (A7), we obtain after some algebra

$$(U_{2,g} - U_{2,c}) - (U_{2,g} - U_{2,c}) = 0. \tag{A8}$$

This implies that there exists no unique solution for $t_2$ when the government in state 2 acts as a Stackelberg leader.∎

*Implications of participation constraint (4b) when state 2 is Stackelberg leader vis-a-vis the federal level*
If the participation constraint takes the form of (4b), i.e., $\phi_2(t_2 - s_2) + \Phi_2(G) \geq \phi_2(t_2)$, and if this constraint is binding, the comparative statics of $s_1$ and $s_2$ with respect to $t_1$ would still remain as in equation (A5a) and (A5c), respectively, whereas the comparative statics with respect to $t_2$ change to read

$$\frac{\partial s_1}{\partial t_2} = \frac{\left(U_{2,g} - \widehat{U}_{2,g}\right)\Gamma + (U_{2,G} - U_{2,g})U_{2,G}U_{2,gg}(1 + \lambda)}{H} \tag{A5b-new}$$

$$\frac{\partial s_2}{\partial t_2} = \frac{\left(U_{2,g} - \widehat{U}_{2,g}\right)\Psi - (U_{2,G})^2 U_{2,gg}(1 + \lambda)}{H} > 0 \tag{A5d-new}$$

where $H$, $\Gamma$ and $\Psi$ take the same forms as before. Note that $U_{2,g} = d\phi_2(t_2 - s_2)/dg_2$ and $\widehat{U}_{2,g} = d\phi_2(t_2)/dg_2$, and $s_1 > 0$ means $U_{2,g} - \widehat{U}_{2,g} > 0$. Substituting equations (A5b-new) and (A5d-new) into equation (A7), we

have

$$
\begin{aligned}
0 = {} & (U_{2,g} - U_{2,c}) + (U_{2,G} - U_{2,g}) \left[ \frac{\left(U_{2,g} - \widehat{U}_{2,g}\right)\Psi - (U_{2,G})^2 U_{2,gg}(1+\lambda)}{H} \right] \\
& + U_{2,G} \left[ \frac{\left(U_{2,g} - \widehat{U}_{2,g}\right)\Gamma + (U_{2,G} - U_{2,g})U_{2,G}U_{2,gg}(1+\lambda)}{H} \right].
\end{aligned}
$$

Notice that the final part of the first row and the final part of the second row cancel out. Rearrangement then gives $MRS_2^{g,c} > 1$, where we have used $U_{2,g} - \widehat{U}_{2,g} > 0$, $U_{2,G} - U_{2,g} < 0$, $\Gamma < 0$, and $\Psi > 0$.

*Binding participation constraint*

To exemplify what type of mechanisms that may give rise to a binding participation constraint for state 2, let us consider the following logarithmic functional form of the utility function presented in equation (1):

$$
U_i = \alpha_i \cdot \ln(y_i - t_i) + \beta_g^i \cdot \ln(t_i - s_i) + \beta_G^i \cdot \ln(s_i + s_j). \tag{A9}
$$

If we start by solving the federal government´s problem in the absence of any binding participation constraint, the federal reaction functions become

$$
s_1 = \frac{1 + \mu_2}{1 + \mu_1 + \mu_2} \cdot t_1 - \frac{\mu_1}{1 + \mu_1 + \mu_2} \cdot t_2 \tag{A10a}
$$

$$
s_2 = \frac{1 + \mu_1}{1 + \mu_1 + \mu_2} \cdot t_2 - \frac{\mu_2}{1 + \mu_1 + \mu_2} \cdot t_1 \tag{A10b}
$$

$$
G = \frac{t_1 + t_2}{1 + \mu_1 + \mu_2} \tag{A10c}
$$

where $\mu_1 = \beta_g^1 / \left(\beta_G^1 + \beta_G^2\right)$ and $\mu_2 = \beta_g^2 / \left(\beta_G^1 + \beta_G^2\right)$. When state 2 acts as a Nash-competitor towards the federal government, we can solve for state government's optimal tax policy as

$$
t_2 = \frac{\beta_g^2}{\alpha_2 + \beta_g^2} \cdot y_2 + \frac{\alpha_2}{\alpha_2 + \beta_g^2} \cdot s_2. \tag{A11}
$$

Combining equation (A11) with the federal reaction functions gives

$$
t_2 = \frac{\beta_g^2 \cdot A_2}{\alpha_2 + \beta_g^2} \cdot y_2 - \frac{\alpha_2 \cdot A_2}{\alpha_2 + \beta_g^2} \cdot \frac{\mu_2}{1 + \mu_1 + \mu_2} \cdot t_1 \tag{A12}
$$

where

$$
A_2 = \frac{\left(\alpha_2 + \beta_g^2\right) \cdot (1 + \mu_1 + \mu_2)}{\left(\alpha_2 + \beta_g^2\right) \cdot (1 + \mu_1 + \mu_2) - \alpha_2 \cdot (1 + \mu_1)}. \tag{A13}
$$

Substituting equation (A10c) into equation (A9), while using that $t_2$ is determined by equation (A12), the welfare in state 2 of remaining in the economic federation can be written as

$$
\begin{aligned}
U_2 = {} & \alpha_2 \cdot \ln\left(\frac{\alpha_2}{\alpha_2 + \beta_g^2}\right) + \beta_g^2 \cdot \ln\left(\frac{\beta_g^2}{\alpha_2 + \beta_g^2}\right) \\
& + \left(\alpha_2 + \beta_g^2\right) \cdot \ln\left(y_2 - \frac{1 + \mu_1}{1 + \mu_1 + \mu_2} \cdot t_2 + \frac{\mu_2}{1 + \mu_1 + \mu_2} \cdot t_1\right) \\
& + \beta_G^2 \cdot \ln\left(\frac{t_1 + t_2}{1 + \mu_1 + \mu_2}\right). \tag{A14}
\end{aligned}
$$

If, on the other hand, state 2 would leave the federation, the fall-back utility will be given by (where $G = 0$ and $t_2$ is determined by equation (A11) for $s_2 = 0$)

$$\widehat{U}_2 = \alpha_2 \cdot \ln\left(\frac{\alpha_2}{\alpha_2 + \beta_g^2}\right) + \beta_g^2 \cdot \ln\left(\frac{\beta_g^2}{\alpha_2 + \beta_g^2}\right) + \left(\alpha_2 + \beta_g^2\right) \cdot \ln\left(y_2\right). \tag{A15}$$

To illustrate a situation where the welfare of leaving the federation exceeds the welfare of remaining inside, i.e., where $U_2 - \widehat{U}_2 \leq 0$, consider the following numerical values

$$\alpha_2 = 1,\ \beta_g^2 = 0.1,\ \beta_G^2 = 0.1,\ \beta_g^1 = 0.5,\ \beta_G^1 = 0.9,\ y_2 = 100,\ t_1 = 30.$$

They imply

$$\mu_2 = 0.1,\ \mu_1 = 0.5,\ A_2 = 6.77,\ t_2 = 50$$

meaning that the utility difference becomes $U_2 - \widehat{U}_2 = -0.266$. The reason as to why the utility of leaving the economic federation in this case exceeds the utility of remaining inside the economic federation for state 2 is that the resident in state 1 attaches a relatively higher value to the local public good than the resident in state 2 (i.e., $\beta_g^1 > \beta_g^2$). The larger this difference in the fundamental preferences, the more resources will be transferred from state 2 to state 1, and the lower will be the welfare for state 2 of remaining in the economic federation.

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