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Abstract

The paper analyses the impact on the softness of the regional budget constraint of three different funding sources of the bailout: a horizontal equalization scheme, a federal non distortive tax on rents and a federal tax on the capital which generates vertical tax externalities. We show that the funding source of the bailout has a considerable impact both on the credibility of the federal government's commitment and on the regional opportunistic behaviour. By choosing the adequate tax tool, the federal government is able to harden the regional budget constraint.

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1 Introduction

The soft budget constraint problem¹ in intergovernmental relationships is, to some extent, present in all countries but "its severity and the proposed mechanisms to handle it depend on each country's institutions" as emphasized by Rodden, Eskeland and Litvack (2003) in their case studies. Transition economies or developing countries such as Brazil, India and Argentina (Jones, Sanguinetti, and Tommasi (1999), Dillinger, Perry and Webb (2003)), as well as established federations such as the United States, Canada, Sweden (Pettersson-Lidbom and Dahlberg (2003)) and Germany (Seitz (2000)) have recently experienced fiscal crisis linked to the soft budget constraint phenomenon which put substantial stress on macro-fiscal stability. Fundamentally, the combination of the opportunistic behaviour of subnational governments, whose aim is to extract additional transfers from the federal government, and the federal government's inability to deny transfers *ex post* is the heart of the soft budget constraint problem. By extracting bailouts from the federal government, the subnational government shifts part of its spending to the national taxpayers and, generally, this turns out to be politically advantageous. While the federal government finds it optimal *ex ante* to deny additional transfers in order to maintain fiscal discipline in the federation, for a variety of reasons it often finds it optimal *ex post* to bail out the subnational jurisdiction. The most common reasons are insurance against fiscal shocks, political reasons, a large vertical fiscal imbalance or equalization.

The recent theoretical contributions mainly focus on the determinants of the soft budget constraint problem in intergovernmental relationships. Wildasin (1997) establishes a positive correlation between the size of the subnational jurisdiction and the amount of the bailout, *i.e.* the well-known "too big to fail" argument, in the presence of inter-regional spillovers. But the willingness of the federal government to provide a bailout turns out to depend negatively on the size of the subnational jurisdiction, in the presence of economies

¹The concept of soft budget constraint was originally introduced by Kornai (1986) to describe the behaviour of state-owned enterprises in socialist economies that got into huge debt, expecting the rescue by the State *ex post*. This concept has recently been extended to a number of different institutional settings including fiscal federalism.

of scale in the public good provision, as shown by Crivelli and Staal (2006). Another reason of the inability of the federal government to commit dynamically not to bail out, which has been implicitly put forward by Goodspeed (2002), is the existence of constitutional obligations. For instance, the constitution may impose on the federal government to ensure equal opportunities for citizens across the country, as it is the case in Germany. The recent attempt of the heavily indebted city of Berlin to extract a massive bailout from the federal government shows that this implicit equalization objective strongly contributes to generate bailout expectations.

Goodspeed (2002) stresses that transfers from the federal level to the regional level generally involve a "common property problem", since the increasing federal tax rate levied to finance the bailout reduces the opportunistic behaviour of the regional government by increasing its opportunity cost of the borrowing. In practice, in unitary states or federations, the same tax base is often taxed by several levels of government, which generates both horizontal tax externalities among jurisdictions of the same hierarchical level - which compete to attract the mobile base - and vertical tax externalities between different hierarchical levels of government due to the co-occupation of the same tax base (Wilson (1999), Wildasin (2006) for a survey). Since horizontal and vertical tax externalities are a characteristic feature of most countries, understanding the impact of the tax structures and, more particularly, of the funding source of the bailout on the soft budget constraint problem is of considerable importance to the theory of fiscal federalism. Do some tax architectures reinforce the softness of the budget constraint of subnational jurisdictions? Does tax competition serve as a commitment² or disciplinary device to harden the budget constraint of subnational jurisdictions?

The purpose of the paper is to determine how federal transfers should be financed in order to eliminate or at least reduce the soft budget constraint phenomenon in intergovernmental relationships, by giving the subnational governments the incentives to behave fiscally

²Qian and Roland (1998) show that fiscal decentralization, together with horizontal tax-base mobility among the rescuers, may serve as a commitment device for hardening the budget constraints of state-owned enterprises, as this increases the opportunity cost of the bailout.

responsibly and by strengthening the federal government's commitment not to bail out. We consider three different funding sources for the bailout: a horizontal redistribution scheme³ (*i.e.* the bailout is financed by contributions made by the other regions), a federal non distortive tax on rents arising in each region, and a federal distortive tax on the capital which generates vertical tax externalities due to the co-occupation of this endogenous tax base with regions, as modelled by Keen and Kotsogiannis (2002). The basic setting is a two-period model similar to Goodspeed (2002). Regions are allowed to borrow in the first period in order to finance a public good, but the regional budget constraint must be balanced at the end of the second period. Regional governments act as Nash competitors with each other, but play as Stackelberg leaders vis-à-vis the federal government. Regional leadership is particularly appropriate for characterizing the intergovernmental relationships in a bottom-up system, and even more in a system of multiple mandates. The fact that the regional decision-maker is also a Member of Parliament enables him to expect perfectly the federal reaction function. In contrast to Goodspeed (2002), we consider an endogenous (rather than an exogenous) tax base co-occupied by the two layers of government, which generates horizontal and vertical externalities, and we explicitly derive the expressions of the bailout and the opportunity cost of borrowing for the different funding sources.

We show that the funding source of the intergovernmental transfers has a considerable impact both on the federal government's propensity to bail out and on the regional governments' strategic behaviour. By choosing the adequate tax instrument, the federal government turns out to be able to harden the regional budget constraint. The federal government's incentives for bailing out stem from its aim of equalizing the marginal utilities derived by citizens from the regional public good provision in the second period. Due to their decentralized leadership, the regional governments expect that the federal government will adjust both the amount and allocation of transfers in the second period following an increase in their borrowing in the first period. An expected bailout always encourages the regional government to borrow more than the efficient level, certainly, but this opportunistic

³If the German Constitutional Court would have decided in 2006 to support the demand by Berlin for financial assistance to cope with its high debt, wealthy Länder would have contributed, according to the "Länderfinanzausgleich".

behaviour is deterred by expected negative tax externalities generated by the increase in the federal tax rate.

A horizontal redistribution scheme organized by the federal government, with no federal taxation, is always profitable to the region which increases its borrowing, in spite of the fact that the region itself bears a part of the cost of the bailout which is proportional to its relative valuation of the public good. The amount of the bailout is even higher when financing by a non-distortive tax on rents, since it entirely compensates the additional cost of the debt repayment, but the reduction in the net rents, following an increase in the federal tax rate, deters the region from borrowing excessively. We explicitly derive the conditions under which the absence of funding of the bailout through taxation serves as a disciplinary device to harden the regional budget constraint with respect to the funding through a non-distortive tax on rents. It can be shown that a horizontal redistribution scheme organized by the federal government, with no federal taxation, reduces the regional fiscal irresponsibility in a perfectly symmetric setting. Finally, the impact of the vertical tax competition on the softness of the regional budget constraint crucially depends on the distortive effect of the taxation on capital. The case where the federal government punishes the borrowing region by reducing its transfers in order to compensate the vertical tax externalities borne by the other regions occurs under certain conditions. When hardening the regional budget constraint, the vertical tax competition is virtuous.

The paper is organized as follows. Section 2 presents the two-period model with regional borrowing. Section 3 analyses the federal government's incentives to bail out regions with respect to the funding source. Section 4 studies the impact of the tax structure on the regional incentives to borrow.

2 The model

Consider a federation with n regions, each of which consists of a representative citizen and a representative firm, both immobile. The framework is a simple two-period intertemporal model. Regions have the possibility of borrowing in the first period, but the regional budget

must be balanced at the end of the second period.

2.1 The representative citizen

The representative citizen located in region i derives utility from the consumption of private goods (c_{i1}, c_{i2}) and regional public goods (g_{i1}, g_{i2}) over the two periods⁴:

$$U_i(c_{i1}, g_{i1}, c_{i2}, g_{i2}) = u_i(c_{i1}) + v_i(g_{i1}) + c_{i2} + z_i(g_{i2}), \quad (1)$$

where $u_i(\cdot)$, $v_i(\cdot)$ and $z_i(\cdot)$ are strictly increasing, twice differentiable, and concave. Each citizen has an initial amount of income \bar{w}_i which is split between private consumption c_{i1} and savings $S_i = s_i^i + \sum_{j \neq i} s_i^j$:

$$c_{i1} = \bar{w}_i - S_i. \quad (2)$$

Savings s_i^j invested⁵ in region j by the representative citizen of region i are remunerated at the before-tax interest rate r_j minus the sum of a regional tax rate τ_j and a federal tax rate τ_c . Rents Π_i arising in region i from the industrial activity are fully transferred to the representative citizen, for example, in the form of dividend, and can be taxed at the rate θ_c by the federal government. The level of private consumption in the second period thus corresponds to the principal and interest on savings plus net rents:

$$c_{i2} = \sum_{j=1}^n (1 + r_j - \tau_j - \tau_c) s_i^j + (1 - \theta_c) \Pi_i. \quad (3)$$

2.2 The capital market

The representative firm located in region i produces an output $F(K_i)$ from the capital $K_i = \sum_{j=1}^n s_j^i$ invested in the region, where $F(\cdot)$ is strictly increasing, twice differentiable and concave. The maximization of the profit

⁴As Keen and Kotsogiannis (2002), preferences with respect to c_{i2} are linear, this ensures that savings only depend on the net return of capital.

⁵Capital is freely mobile so that citizens are free to invest their savings anywhere.

$$\Pi_i = F(K_i) - r_i K_i$$

defines the demand for capital $K_i(r_i)$ in region i , where $K'_i = \frac{1}{F''} < 0$. Rents $\Pi_i(r_i)$ arising in region i are thus strictly decreasing with respect to the interest rate r_i , *i.e.* $\Pi'_i = -K_i < 0$.

Capital is perfectly mobile across regions so that it relocates until it earns the same post-tax return ρ in each region:

$$\rho = r_i - \tau_i - \tau_c = r_j - \tau_j - \tau_c \quad \forall i, j. \quad (4)$$

The amount of savings $S_i(\rho)$, which satisfies the first-order condition $\frac{\partial u_i}{\partial c_{i1}} = (1 + \rho)$ from the citizen's program, depends positively on this net return, *i.e.* $S'_i = \frac{\partial S_i}{\partial \rho} = -\frac{1}{\frac{\partial^2 u_i}{\partial c_{i1}^2}} > 0$.

The market-clearing condition

$$\sum_{i=1}^n S_i(\rho) = \sum_{i=1}^n K_i(r_i)$$

implicitly defines the net return $\rho(\tau_1, \dots, \tau_n, \tau_c)$, so that

$$\frac{\partial \rho}{\partial \tau_i} = \frac{K'_i}{\sum_{j=1}^n S'_j - \sum_{j=1}^n K'_j} \in [-1, 0],$$

and

$$\frac{\partial \rho}{\partial \tau_c} = \frac{\sum_{i=1}^n K'_i}{\sum_{j=1}^n S'_j - \sum_{j=1}^n K'_j} \in [-1, 0],$$

implying $\frac{\partial r_i}{\partial \tau_i} = 1 + \frac{\partial \rho}{\partial \tau_i} > 0$ and $\frac{\partial r_i}{\partial \tau_c} = 1 + \frac{\partial \rho}{\partial \tau_c} > 0$. Horizontal and vertical tax externalities coming from the sharing of an endogenous tax base go through the net return of capital ρ . From the horizontal perspective, a tax rate reduction in region i , which increases the net return in that region, leads to a capital outflow in other regions, *ceteris paribus*. From the vertical perspective, a tax rate reduction in region i increases the tax base shared with the federal level, *ceteris paribus*.

2.3 The regional government

The regional government aims at maximizing the utility $U_i(\cdot)$ of the representative citizen located in its region i . A balanced budget is only required at the end of the second period which allows some intertemporal flexibility. The regional government is able to borrow an amount B_{i1} in the first period in order to finance more of the public good g_{i1} , but the principal and interest of the debt $(1 + r_i) B_{i1}$ must be repaid at the end of the second period⁶. This debt variable turns out to be the instrument of the regional opportunistic behaviour. Each regional government is encouraged to behave strategically in order to receive additional transfers from the federal government. Let T_{i1} denote the initial level of the federal transfer, which is exogenous to the game to be played, and T_{i2} the level of the federal transfer received by region i (or paid if negative) in the second period. The public good provision g_{i2} and the debt repayment are financed by the transfer T_{i2} and the taxation at the rate τ_i of the capital $K_i = \sum_{j=1}^n s_j^i$ invested in the region. Regional budget constraints of a region i are thus given by:

$$g_{i1} = T_{i1} + B_{i1}, \quad (5)$$

and

$$g_{i2} = T_{i2} + \tau_i K_i (r_i) - (1 + r_i) B_{i1}. \quad (6)$$

2.4 The federal government

The federal policy⁷ in terms of transfers is motivated by the maximization of an utilitarian utility function $\sum_{i=1}^n U_i$. In order to evaluate the impact of the source of the funding of the federal transfer⁸ on the soft budget constraint issue, let us consider three cases:

⁶By simplification, the regional debt is held by foreign investors.

⁷By simplification, no public good is provided at the federal level as this would not modify the strategic interactions between the federal and regional governments given our additive utility function.

⁸ T_{i2} can also be negative which amounts to taxing region i .

a) the federal government has no tax power:

$$\sum_{i=1}^n T_{i2} = 0. \quad (7a)$$

Transfers granted to a region k ($T_{k2} > 0$) are balanced by contributions made by the other regions ($T_{-k2} < 0$). The federal government only proceeds to a revenue reallocation among regions in the second period.

b) the federal government levies a non-distortive tax θ_c on rents arising in each region:

$$\sum_{i=1}^n T_{i2} = \theta_c \sum_{i=1}^n \Pi_i(r_i). \quad (7b)$$

Note that bottom-up tax externalities arise from the regional taxation because this modifies the interest rate and thus the level of the rents taxed by the federal government. In contrast, there are no top-down tax externalities due to the fact that the variation of θ_c does not alter the regional tax base.

c) the federal government levies a distortive tax τ_c on capital:

$$\sum_{i=1}^n T_{i2} = \tau_c \sum_{i=1}^n K_i(r_i). \quad (7c)$$

This source of funding generates both top-down and bottom-up tax externalities⁹. Due to the co-occupation of the endogenous tax base, *i.e.* the capital, a change in the tax policy decided either by the regional or federal governments generates vertical tax externalities by altering the tax revenue of both layers.

Our work aims at evaluating the effects of the source of funding of the transfers on the federal government's incentives to bail out and also on the regional government's opportunistic behaviour.

⁹Top-down (resp. bottom-up) tax externalities are caused by the higher (lower) level of government.

2.5 The sequence of budgetary interactions

Regional governments act together as Nash competitors. Each region takes the other regions' borrowing and tax rate as given. In contrast, regional governments are assumed to act as Stackelberg leaders vis-à-vis the federal government. Each regional government knows how the federal government will react in second period, *i.e.* how it will modify the allocation of transfers, and takes into account the reaction function of the federal government in its choice of borrowing in the first period. The level of the regional borrowing will thus depend on the credibility of the federal government's commitment not to bail out in the second period. In addition, regional and federal governments also interact in the second period, but simultaneously, when choosing their tax rates. Finally, the citizens choose their level of savings and consumption. We solve the model by backward induction.

3 The federal government's incentives to bail out

The federal government's best reply to a change in region k 's borrowing is a key determinant of the softness or hardness of the budget constraint at the regional level. The inability of the federal government to commit dynamically not to bail out may indeed induce regional governments to misbehave, distorting their fiscal choices *ex ante*, if they expect additional transfers from the federal government *ex post*. The federal commitment to deny a bailout is credible for $\frac{\partial T_{k2}}{\partial B_{k1}} = 0$ whereas $\frac{\partial T_{k2}}{\partial B_{k1}} > 0$ generates opportunistic expectations at the regional level. To derive the federal government's best reply to a change in region k 's borrowing, let us first derive the sharing rule for regional transfers.

The federal policy is motivated by the maximization of the aggregated utility in the federation. Given regional budgetary choices, the federal government solves

$$\begin{aligned}
& \max_{\mathbf{T}_2, \theta_c, \tau_c} \sum_{i=1}^n [u_i(c_{i1}) + v_i(g_{i1}) + c_{i2} + z_i(g_{i2})] \\
& s.t. \\
& c_{i1} = \bar{w}_i - S_i(\rho), \\
& c_{i2} = (1 + \rho)S_i(\rho) + (1 - \theta_c)\Pi_i(r_i), \\
& g_{i1} = T_{i1} + B_{i1}, \\
& g_{i2} = T_{i2} + \tau_i K_i(r_i) - (1 + r_i)B_{i1}, \\
& \sum_{i=1}^n T_{i2} = \theta_c \sum_{i=1}^n \Pi_i(r_i) + \tau_c \sum_{i=1}^n K_i(r_i).
\end{aligned}$$

In order to evaluate the impact of the source of funding of the transfers on the federal government's incentives to bail out, let us successively consider the case without tax power, the case with federal taxation on rents, and finally the case with vertical tax competition.

- No federal tax power ($\theta_c = 0, \tau_c = 0$)

When the federal government has no tax power, the first-order conditions are:

$$\frac{\partial z_i}{\partial g_{i2}} = \frac{\partial z_j}{\partial g_{j2}} \quad \forall i, j, \quad (8)$$

$$\sum_{i=1}^n T_{i2} = 0. \quad (9)$$

According to the condition (8), the federal government allocates transfers so as to equalize the marginal utilities of public consumption across citizens in the second period. The marginal utility derived by the public good consumption must be the same for each citizen, independently of the region in which he or she resides. Note that, due to the concavity of $z_i(\cdot) \forall i$, regions with high-valuation citizens receive more transfers from the federal government than regions with low-valuation citizens.

The federal government's best reply to a change in region k 's borrowing is derived by differentiating the first-order conditions (8) and (9) with respect to $T_{k2}, T_{j2} \forall j \neq k$, and B_{k1} , which leads to the following Result:

Result 1: *Without tax power, the federal government always bails out the region k , through lump-sum taxes levied on the other regions, following a rise in region k 's borrowing:*

$$\begin{aligned}\frac{\partial T_{k2}^{nt}}{\partial B_{k1}} &= (1 + r_k) + \frac{1}{(n-1)} \sum_{j \neq k} \frac{\frac{\partial^2 z_j}{\partial g_{j2}^2}}{\frac{\partial^2 z_k}{\partial g_{k2}^2}} \frac{\partial T_{j2}^{nt}}{\partial B_{k1}} > 0, \\ \frac{\partial T_{j2}^{nt}}{\partial B_{k1}} &< 0 \quad \forall j \neq k.\end{aligned}$$

Proof: From the differentiation of the first-order conditions (8) with respect to $T_{i2} \forall i \neq k$, $T_{j2} \forall j \neq k$:

$$\frac{\partial^2 z_i}{\partial g_{i2}^2} dT_{i2}^{nt} = \frac{\partial^2 z_j}{\partial g_{j2}^2} dT_{j2}^{nt} \quad \forall i \neq k, j \neq k,$$

it follows that $dT_{i2}^{nt} \forall i \neq k$ and $dT_{j2}^{nt} \forall j \neq k$ have the same sign. In addition, the differentiation of the federal government's budget constraint:

$$\sum_{i=1}^n dT_{i2}^{nt} = 0,$$

implies that dT_{k2}^{nt} and $\sum_{j \neq k} dT_{j2}^{nt}$ have the opposite sign. Using the expression of $\frac{\partial T_{k2}^{nt}}{\partial B_{k1}}$ and the differentiated federal budget constraint yields

$$\sum_{j \neq k} \left(1 + \frac{1}{(n-1)} \frac{\frac{\partial^2 z_j}{\partial g_{j2}^2}}{\frac{\partial^2 z_k}{\partial g_{k2}^2}} \right) \frac{\partial T_{j2}^{nt}}{\partial B_{k1}} = -(1 + r_k) < 0$$

which implies that $\frac{\partial T_{k2}^{nt}}{\partial B_{k1}} > 0$ and $\frac{\partial T_{j2}^{nt}}{\partial B_{k1}} < 0 \forall j \neq k$. *Q.E.D.*

A rise in region k 's borrowing lowers the regional public good provision g_{k2} by $(1 + r_k) dB_{k1}$ *ceteris paribus*, which no longer satisfies the federal government's aim of equalization given by the condition (8). Once the regional government has played, the cost of not bailing out *ex post* becomes higher from the federal government's perspective than the cost of bailing out, which explains why the federal government always intervenes. The best reply of the federal government with respect to B_{k1} , denoted $T_{k2}^{nt} = \varphi_k^{nt}(B_{k1}, B_{-k1})$ in the absence of federal tax power, consists of two effects. Firstly, the federal government compensates the additional cost of the debt repayment $(1 + r_k)$. Secondly, the equalization of

marginal utilities implies that the cost of the bailout is split among all the regions, including region k , accounting for the asymmetry between them. Note that $\frac{\partial T_{k2}^{rt}}{\partial B_{k1}} = \frac{(n-1)}{n} (1 + r_k)$ and $\frac{\partial T_{j2}^{rt}}{\partial B_{k1}} = -\frac{1}{n} (1 + r_k) \forall j \neq k$ in a symmetric setting.

- Federal taxation on rents ($\tau_c = 0$)

When the federal government only taxes rents arising in each region, the first-order conditions are:

$$\frac{\partial z_i}{\partial g_{i2}} = \frac{\partial z_j}{\partial g_{j2}} \quad \forall i, j, \quad (10)$$

$$-\sum_{i=1}^n \Pi_i + \frac{\partial z_i}{\partial g_{i2}} \sum_{i=1}^n \Pi_i = 0, \quad (11)$$

$$\sum_{i=1}^n T_{i2} = \theta_c \sum_{i=1}^n \Pi_i. \quad (12)$$

The federal government's budgetary choices are still guided by the aim of equalization across the federation in the second period. Its best replies in terms of transfers and taxation to a change in region k 's borrowing, respectively denoted $T_{k2}^{rt} = \varphi_k^{rt}(B_{k1}, B_{-k1})$ and $\theta_c^{rt} = \psi_k^{rt}(B_{k1}, B_{-k1})$, are derived by differentiating the first-order conditions (10), (11) and (12) with respect to T_{k2} , $T_{j2} \forall j \neq k$, θ_c and B_{k1} , which leads to the following Result:

Result 2: *When the federal government is able to tax the rents, it always bails out the region k through additional federal tax revenues, without altering the transfers granted to other regions, following a rise in region k 's borrowing:*

$$\frac{\partial T_{k2}^{rt}}{\partial B_{k1}} = (1 + r_k), \quad \frac{\partial T_{j2}^{rt}}{\partial B_{k1}} = 0 \quad \forall j \neq k \quad \text{and} \quad \frac{\partial \theta_c^{rt}}{\partial B_{k1}} = \frac{(1 + r_k)}{\sum_{i=1}^n \Pi_i}.$$

Contrary to the previous case where the federal government had no tax power, region k 's bailout now amounts to the entire additional cost of the debt repayment $(1 + r_k)$. The bailout is completely financed by an increase in the tax rate θ_c levied on rents, which implies

that the other regions' transfers are not affected by the region k 's level of debt. Whatever the level of the regional debt in the first period, the federal government ensures an optimal level of the public good such that $\frac{\partial z_i}{\partial g_{i2}} = 1 \forall i$. Let us now determine whether this result still applies with vertical tax competition.

- Vertical tax competition ($\theta_c = 0$)

When the federal government taxes the capital invested in each region, assuming an interior solution, the first-order conditions are¹⁰:

$$\frac{\partial z_i}{\partial g_{i2}} = \frac{\partial z_j}{\partial g_{j2}} \quad \forall i, j, \quad (13)$$

$$-\sum_{i=1}^n K_i + \frac{\partial z_i}{\partial g_{i2}} \sum_{i=1}^n \left[(\tau_i + \tau_c) K_i' \frac{\partial r_i}{\partial \tau_c} - \frac{\partial r_i}{\partial \tau_c} B_{i1} + K_i \right] = 0, \quad (14)$$

$$\sum_{i=1}^n T_{i2} = \tau_c \sum_{i=1}^n K_i. \quad (15)$$

The federal government still allocates transfers among regions so as to equalize the marginal utilities of public consumption across citizens in the second period. From the condition (14), the optimal level of the federal tax τ_c crucially depends on the extent of negative vertical tax externalities which go through the variation of the net return of capital ρ . Following a rise in τ_c , the net return ρ decreases, which both reduces the rents ($\Pi_i' \frac{\partial r_i}{\partial \tau_c} < 0$), and the common tax-base ($K_i' \frac{\partial r_i}{\partial \tau_c} < 0$), and weighs down the debt repayment ($\frac{\partial r_i}{\partial \tau_c} B_{i1} > 0$). The optimal tax rate is such that the marginal benefit of public consumption offsets these negative effects. Note that we cannot rule out the particular case $\tau_c = 0$ which arises for considerable negative tax externalities¹¹. In such a case, transfers granted to some regions are balanced by contributions made by other regions as studied above.

¹⁰Without any rearrangement, the first-order condition with respect to τ_c is

$$\sum_{i=1}^n \left[-\frac{\partial u_i}{\partial c_{i1}} S_i' \frac{\partial \rho}{\partial \tau_c} + (1 + \rho) S_i' \frac{\partial \rho}{\partial \tau_c} + \frac{\partial \rho}{\partial \tau_c} S_i + \Pi_i' \frac{\partial r_i}{\partial \tau_c} + \frac{\partial z_i}{\partial g_{i2}} \left(\tau_i K_i' \frac{\partial r_i}{\partial \tau_c} - \frac{\partial r_i}{\partial \tau_c} B_{i1} \right) \right] + \frac{\partial z_i}{\partial g_{i2}} \left[\sum_{i=1}^n K_i + \tau_c \sum_{i=1}^n K_i' \frac{\partial r_i}{\partial \tau_c} \right] = 0.$$

The expression (14) is obtained by using $\Pi_i' = -K_i$, the first-order condition $\frac{\partial u_i}{\partial c_{i1}} = (1 + \rho)$ from the consumer's program and the market-clearing condition.

¹¹An interior solution implies $\sum_{i=1}^n \left[(\tau_i + \tau_c) K_i' \frac{\partial r_i}{\partial \tau_c} - \frac{\partial r_i}{\partial \tau_c} B_{i1} + K_i \right] > 0$.

Since $\frac{\partial z_i}{\partial g_{i2}}$ is higher than one for all regions from the conditions (13) and (14), we derive the finding that top-down tax externalities induce an underprovision of the regional public good in each region in the second period:

$$\frac{\partial z_i}{\partial g_{i2}} = \frac{\sum_{i=1}^n K_i}{\sum_{i=1}^n \left[(\tau_i + \tau_c) K_i \frac{\partial r_i}{\partial \tau_c} - \frac{\partial r_i}{\partial \tau_c} B_{i1} + K_i \right]} > 1,$$

which is a standard implication of tax competition.

The federal government's best replies in terms of transfers and taxation to a change in region k 's borrowing, respectively denoted $T_{k2}^{vt} = \varphi_k^{vt}(B_{k1}, B_{-k1})$ and $\tau_c^{vt} = \psi_k^{vt}(B_{k1}, B_{-k1})$, are also affected by the vertical tax competition. By differentiating the first-order condition (13) with respect to T_{k2} , $T_{j2} \forall j \neq k$, τ_c and B_{k1} and summing across $j \forall j \neq k$, we obtain the following transfer scheme:

Result 3: *With vertical tax competition, the federal transfers' adjustment following a change in region k 's borrowing satisfies:*

$$\begin{aligned} \frac{\partial T_{k2}^{vt}}{\partial B_{k1}} &= (1 + r_k) + \frac{1}{(n-1)} \sum_{j \neq k} \frac{\frac{\partial^2 z_j}{\partial g_{j2}^2}}{\frac{\partial^2 z_k}{\partial g_{k2}^2}} \frac{\partial T_{j2}^{vt}}{\partial B_{k1}} - \frac{1}{(n-1)} \frac{\frac{\partial^2 z_k}{\partial g_{k2}^2}}{\frac{\partial^2 z_k}{\partial g_{k2}^2}} \sum_{j \neq k} \frac{\partial}{\partial \tau_c} \left(\frac{\partial z_k}{\partial g_{k2}} - \frac{\partial z_j}{\partial g_{j2}} \right) \frac{\partial \tau_c^{vt}}{\partial B_{k1}}, \\ \frac{\partial^2 z_i}{\partial g_{i2}^2} \frac{\partial T_{i2}^{vt}}{\partial B_{k1}} + \frac{\partial}{\partial \tau_c} \frac{\partial z_i}{\partial g_{i2}} \frac{\partial \tau_c^{vt}}{\partial B_{k1}} &= \frac{\partial^2 z_j}{\partial g_{j2}^2} \frac{\partial T_{j2}^{vt}}{\partial B_{k1}} + \frac{\partial}{\partial \tau_c} \frac{\partial z_j}{\partial g_{j2}} \frac{\partial \tau_c^{vt}}{\partial B_{k1}} \quad \forall i \neq k, \forall j \neq k. \end{aligned}$$

Both the amount of the bailout and the sharing of federal transfers are modified by the vertical tax externalities arising from the tax base sharing. The aim of equalization across the federation requires an adjustment of the allocation of the transfers which depends on the relative impact of the vertical tax competition on the marginal utilities of the public good consumption in the second period. The amount of the bailout $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}}$ thus crucially depends on the asymmetry among regions and on the federal government's best reply in terms of taxation to a change in region k 's borrowing $\frac{\partial \tau_c^{vt}}{\partial B_{k1}}$. The case where $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}} < 0$ and $\frac{\partial \tau_c^{vt}}{\partial B_{k1}} > 0$ cannot be excluded. By differentiating the federal government's budget constraint

with respect to $T_{i2} \forall i$, τ_c and B_{k1} , we establish that:

$$\frac{\partial \tau_c^{vt}}{\partial B_{k1}} = \frac{\sum_{i=1}^n \frac{\partial T_{i2}^{vt}}{\partial B_{k1}}}{(1 + \varepsilon_c) \sum_{i=1}^n K_i} \iff \frac{\partial \tau_c^{vt}}{\partial B_{k1}} (1 + \varepsilon_c) \sum_{i=1}^n K_i = \sum_{i=1}^n \frac{\partial T_{i2}^{vt}}{\partial B_{k1}} \quad (16)$$

where $\varepsilon_c = \frac{\partial \sum_{i=1}^n K_i}{\partial \tau_c} \frac{\tau_c}{\sum_{i=1}^n K_i}$ is the elasticity of the federal tax base with respect to the federal tax rate. Assuming $\varepsilon_c \in [-1, 0]$ in line with empirical findings¹², aggregated transfers move in the same way as the federal tax rate following a change in region k 's borrowing. The value of $\frac{\partial \tau_c^{vt}}{\partial B_{k1}}$ (and thus the amount $\sum_{i=1}^n \frac{\partial T_{i2}^{vt}}{\partial B_{k1}}$) obtained by differentiating the first-order conditions (13), (14) and (15) depends on the specification of the model and, more particularly, on the distortive impact of vertical tax competition¹³. As regards sharing of regional transfers, $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}}$ (resp. $\frac{\partial T_{j2}^{vt}}{\partial B_{k1}} \forall j \neq k$) can either be positive or negative, depending on the respective valuations for the public good provided in the second period and the value of $\frac{\partial \tau_c^{vt}}{\partial B_{k1}}$. However, by considering the perfectly symmetric case, we are able to state the following results:

Result 4: *With vertical tax competition, in a perfectly symmetric setting, the federal transfer scheme simplifies as follow:*

$$\begin{aligned} \frac{\partial T_{k2}^{vt}}{\partial B_{k1}} &= (1 + r_k) + \frac{\partial T_{j2}^{vt}}{\partial B_{k1}}, \\ \frac{\partial T_{i2}^{vt}}{\partial B_{k1}} &= \frac{\partial T_{j2}^{vt}}{\partial B_{k1}} \quad \forall i \neq k, \forall j \neq k, \end{aligned}$$

which implies that:

- for $0 < \frac{\partial \tau_c^{vt}}{\partial B_{k1}} (1 + \varepsilon_c) \sum_{i=1}^n K_i < (1 + r_k)$, the federal government always bails out the region k , through both additional federal tax revenues and lump-sum taxes levied on the other regions, following a rise in region k 's borrowing¹⁴.

- for $\frac{\partial \tau_c^{vt}}{\partial B_{k1}} (1 + \varepsilon_c) \sum_{i=1}^n K_i > (1 + r_k)$, the federal government always bails out the region k , as well as the other regions, following a rise in region k 's borrowing.

¹²See Chirinko, Fazzari, Steven and Meyer (1999) for instance.

¹³Computations on request.

¹⁴Note that Goodspeed (2002) only considers two possibilities, *i.e.* $\sum_{j \neq k} \frac{\partial T_{j2}}{\partial B_{k1}} > 0$ or $\sum_{j \neq k} \frac{\partial T_{j2}}{\partial B_{k1}} = 0$, while our model also leads to envisaging $\sum_{j \neq k} \frac{\partial T_{j2}}{\partial B_{k1}} < 0$.

- for $\frac{\partial \tau_c^{vt}}{\partial B_{k1}} (1 + \varepsilon_c) \sum_{i=1}^n K_i < -(n-1)(1+r_k)$, the federal government reduces all the transfers, following a rise in region k 's borrowing. Vertical tax competition serves as a commitment device for hardening the regional budget constraint.

Proof: Inserting the expressions of $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}}$ and $\frac{\partial T_{j2}^{vt}}{\partial B_{k1}}$ in the condition (16) gives:

$$\begin{aligned} \frac{\partial T_{k2}^{vt}}{\partial B_{k1}} &= \frac{(n-1)}{n} (1+r_k) + \frac{1}{n} (1+\varepsilon_c) \sum_{i=1}^n K_i \frac{\partial \tau_c^{vt}}{\partial B_{k1}}, \\ \frac{\partial T_{j2}^{vt}}{\partial B_{k1}} &= \frac{1}{n} \left[(1+\varepsilon_c) \sum_{i=1}^n K_i \frac{\partial \tau_c^{vt}}{\partial B_{k1}} - (1+r_k) \right] \end{aligned}$$

which allows us to derive the previous results. *Q.E.D.*

The relative extent of the additional cost of the debt repayment $(1+r_k)$ and the additional federal tax revenues following a change in region k 's borrowing $\left(\frac{\partial \tau_c^{vt}}{\partial B_{k1}} (1+\varepsilon_c) \sum_{i=1}^n K_i \right)$, crucially determines whether a threat from the federal government not to bail out is credible or not. Note that for $(1+\varepsilon_c) \sum_{i=1}^n K_i \frac{\partial \tau_c^{vt}}{\partial B_{k1}} = (1+r_k)$ (resp. $\frac{\partial \tau_c^{vt}}{\partial B_{k1}} = 0$), the results are the same as those with a taxation on rents (resp. no taxation). Let us now evaluate the impact of the funding source of the bailout on the regional opportunistic behaviour.

4 The regional government's opportunistic behaviour

The regional policy maker of the region k , which is motivated by the maximization of the utility of the representative citizen located in its region, solves

$$\begin{aligned} \max_{B_{k1}, \tau_k} \quad & u_k(c_{k1}) + v_k(g_{k1}) + c_{k2} + z_k(g_{k2}) \\ \text{s.t.} \quad & \\ & c_{k1} = \bar{w}_k - S_k(\rho) \\ & c_{k2} = (1+\rho)S_k(\rho) + (1-\theta_c)\Pi_k(r_k) \\ & g_{k1} = T_{k1} + B_{k1} \\ & g_{k2} = T_{k2} + \tau_k K_k(r_k) - (1+r_k)B_{k1} \end{aligned}$$

expecting the federal government's reaction function, respectively

$$T_{k2}^{nt} = \varphi_k^{nt}(B_{k1}, B_{-k1}) \quad (17a)$$

$$T_{k2}^{rt} = \varphi_k^{rt}(B_{k1}, B_{-k1}) \quad \text{and} \quad \theta_c^{rt} = \psi_k^{rt}(B_{k1}, B_{-k1}) \quad (17b)$$

$$T_{k2}^{vt} = \varphi_k^{vt}(B_{k1}, B_{-k1}) \quad \text{and} \quad \tau_c^{vt} = \psi_k^{vt}(B_{k1}, B_{-k1}) \quad (17c)$$

when the federal government has no tax power (17a), when it levies a tax θ_c on rents (17b) and when it levies a tax τ_c on capital (17c).

In order to evaluate the impact of the funding source of the bailout on the regional government's opportunistic behaviour, let us successively consider the first-order conditions without federal tax power, with federal taxation on rents and finally with vertical tax competition.

- No federal tax power ($\theta_c = 0, \tau_c = 0$)

$$\begin{aligned} \frac{\partial v_k}{\partial g_{k1}} + \frac{\partial z_k}{\partial g_{k2}} \left(\frac{\partial T_{k2}^{nt}}{\partial B_{k1}} - (1 + r_k) \right) &= \frac{\partial v_k}{\partial g_{k1}} + \frac{\partial z_k}{\partial g_{k2}} \sum_{j \neq k} \frac{\frac{\partial^2 z_j}{\partial g_{j2}^2}}{\frac{\partial^2 z_k}{\partial g_{k2}^2}} \frac{\partial T_{j2}^{nt}}{\partial B_{k1}} = 0 \quad (18a) \\ \frac{\partial \rho}{\partial \tau_k} S_k + \Pi'_k \frac{\partial r_k}{\partial \tau_k} + \frac{\partial z_k}{\partial g_{k2}} \left(K_k + \tau_k K'_k \frac{\partial r_k}{\partial \tau_k} - \frac{\partial r_k}{\partial \tau_k} B_{k1} \right) &= 0 \end{aligned}$$

- Federal taxation on rents ($\tau_c = 0$)

$$\begin{aligned} \frac{\partial v_k}{\partial g_{k1}} + \frac{\partial z_k}{\partial g_{k2}} \left(\frac{\partial T_{k2}^{rt}}{\partial B_{k1}} - (1 + r_k) \right) - \frac{\partial \theta_c^{rt}}{\partial B_{k1}} \Pi_k &= \frac{\partial v_k}{\partial g_{k1}} - (1 + r_k) \frac{\Pi_k}{\sum_{i=1}^n \Pi_i} = 0 \quad (18b) \\ \frac{\partial \rho}{\partial \tau_k} S_k + (1 - \theta_c) \Pi'_k \frac{\partial r_k}{\partial \tau_k} + \frac{\partial z_k}{\partial g_{k2}} \left(K_k + \tau_k K'_k \frac{\partial r_k}{\partial \tau_k} - \frac{\partial r_k}{\partial \tau_k} B_{k1} \right) &= 0 \end{aligned}$$

- Vertical tax competition ($\theta_c = 0$)

$$\frac{\partial v_k}{\partial g_{k1}} + \frac{\partial z_k}{\partial g_{k2}} \left(\frac{\partial T_{k2}^{vt}}{\partial B_{k1}} - (1 + r_k) \right) + \left[\frac{\partial \rho}{\partial \tau_c} S_k + \Pi'_k \frac{\partial r_k}{\partial \tau_c} + \frac{\partial z_k}{\partial g_{k2}} \left(\tau_k K'_k \frac{\partial r_k}{\partial \tau_c} - \frac{\partial r_k}{\partial \tau_c} B_{k1} \right) \right] \frac{\partial \tau_c^{vt}}{\partial B_{k1}} = 0 \quad (18c)$$

$$\frac{\partial \rho}{\partial \tau_k} S_k + \Pi'_k \frac{\partial r_k}{\partial \tau_k} + \frac{\partial z_k}{\partial g_{k2}} \left(K_k + \tau_k K'_k \frac{\partial r_k}{\partial \tau_k} - \frac{\partial r_k}{\partial \tau_k} B_{k1} \right) = 0$$

Regardless of the funding source of the bailout, the equilibrium tax rate results from a trade-off between the reduction in the utility derived from the private good consumption and the increase in the utility derived from the public good consumption in the second period. On the one hand, the rise in the regional tax rate reduces the net return of savings, *i.e.* $\frac{\partial \rho}{\partial \tau_k} S_k < 0$, and the rent accruing to the citizen through an increase in the cost of capital, *i.e.* $\Pi'_k \frac{\partial r_k}{\partial \tau_k} < 0$, which reduces the private consumption c_{i2} . On the other hand, the rise in the regional tax rate generates additional tax revenues, which are higher than the additional cost of the debt repayment for an interior solution, and this allows the regional government to produce more of the public good.

In the absence of decentralized leadership, the region would choose a level of debt which satisfies the following condition:

$$\frac{\partial v_k}{\partial g_{k1}} - (1 + r_k) \frac{\partial z_k}{\partial g_{k2}} = 0 \Leftrightarrow \frac{\frac{\partial v_k}{\partial g_{k1}}}{\frac{\partial z_k}{\partial g_{k2}}} = (1 + r_k).$$

The price faced by the regional government when it borrows would amount exactly to the marginal cost of the debt repayment $(1 + r_k)$.

Given that $0 < \frac{\partial T_{k2}^{vt}}{\partial B_{k1}} < (1 + r_k)$, in the case of the absence of funding through taxation, the inability of the federal government to commit not to bail out always reduces the regional opportunity cost of borrowing. From the moment the federal government levies taxes in order to finance the additional transfers, the increase in the federal tax pressure reduces, *ceteris paribus*, the regional incentives to borrow. As a result, the decentralized leadership does not always give a strategic advantage to the regional government over the federal government. It turns out, from the comparison between (18a) and (18b), that:

Result 5: *The funding of the bailout via the horizontal redistribution scheme rather than via the tax on rents serves as a disciplinary device to harden the regional budget constraint when:*

$$\frac{\frac{\partial z_k}{\partial g_{k2}}}{(n-1)} \sum_{j \neq k} \frac{\frac{\partial^2 z_j}{\partial g_{j2}^2}}{\frac{\partial^2 z_k}{\partial g_{k2}^2}} \frac{\partial T_{j2}^{nt}}{\partial B_{k1}} < -(1+r_k) \frac{\Pi_k}{\sum_{i=1}^n \Pi_i},$$

which is always the case in a perfectly symmetric setting, since $\frac{\partial z_k^{nt}}{\partial g_{k2}} > 1$.

As for the impact of the funding through taxation on capital, which generates vertical tax externalities, on the regional incentives to borrow, it depends on the respective extent of $\frac{\partial z_k}{\partial g_{k2}} \left(\frac{\partial T_{k2}^{vt}}{\partial B_{k1}} - (1+r_k) \right)$ and $\left[\frac{\partial \rho}{\partial \tau_c} S_k + \Pi'_k \frac{\partial r_k}{\partial \tau_c} + \frac{\partial z_k}{\partial g_{k2}} \left(\tau_k K'_k \frac{\partial r_k}{\partial \tau_c} - \frac{\partial r_k}{\partial \tau_c} B_{k1} \right) \right] \frac{\partial \tau_c^{vt}}{\partial B_{k1}}$. The term in square brackets being negative, a rise in τ_c following an increase in the region k 's borrowing always dissuades the region from borrowing because it reduces the proceeds of citizens' savings $\frac{\partial \rho}{\partial \tau_c} S_k$, the rents $\Pi'_k \frac{\partial r_k}{\partial \tau_c}$, the regional tax revenues $\tau_k K'_k \frac{\partial r_k}{\partial \tau_c}$ and weights the debt repayment $\frac{\partial r_k}{\partial \tau_c} B_{k1}$. So, when the federal tax rate reacts positively (resp. negatively) to an increase in borrowing, the region is less (resp. more) incited to borrow. In addition, the less the region values an additional unit of public good with respect to the others regions, the lower its additional transfer, which reduces its incentives to borrow.

Result 6: *The vertical tax competition may serve as a disciplinary device to harden the regional budget constraint as well as it may encourage a regional opportunistic behaviour.*

Proof: The vertical tax competition clearly serves as a disciplinary device (resp. encourages a regional opportunistic behaviour) when $\frac{\partial \tau_c^{vt}}{\partial B_{k1}} > 0$ and $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}} < 0$ (resp. $\frac{\partial \tau_c^{vt}}{\partial B_{k1}} < 0$ and $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}} > 0$). *Q.E.D.*

The vertical tax competition may thus be virtuous, by hardening the regional budget constraint. In accordance with the Result 3, it clearly occurs when $\frac{\partial T_{k2}^{vt}}{\partial B_{k1}} < 0$ following a rise in the federal tax rate on capital, *i.e.* when the vertical tax externalities borne by the other regions $j \neq k$ are much more higher than the cost borne by the region k . To some extent, the federal government punishes the borrowing region by reducing its transfers in order to compensate the vertical tax externalities borne by the other regions.

5 Concluding remarks

The funding source of the intergovernmental transfers turns out to have a considerable impact both on the federal government's propensity to bail out and on the regional governments' fiscal responsibility. From a simple decentralized leadership model over two periods, we compare the hardening impact of three funding sources of the bailout: a horizontal equalization scheme with no federal taxation, a federal non distortive tax on rents, and a federal tax on the capital which generates vertical tax externalities. Especially in a symmetric setting, the funding of the bailout *via* an horizontal equalization scheme organized by the federal government, with no federal taxation, improves the fiscal discipline with respect to the funding *via* a non-distortive tax. Interestingly, the vertical tax competition may be virtuous, by hardening the regional budget constraint.

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