Efficient Revenue Sharing and Upper-Level Governments: Theory and Application to Germany

by

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This paper explores conditions under which revenue-sharing grants will achieve efficiency. We develop a general formulation of the state's decision problem of implementing a set of local policies. A theoretical analysis shows that if the state government pursues own policies and cannot levy lump-sum contributions from local jurisdictions, it will implement revenue-sharing grants that induce local governments to raise local tax rates. A subsequent empirical analysis of local tax policy in Germany suggests that attempts by state-level governments to extract fiscal resources from local governments result in higher tax rates at the local level. (JEL: H71, H77)

1 Introduction

Many countries display a substantial degree of taxing autonomy for local jurisdictions, not only with regard to the taxation of land or property, but also with regard to income taxation. As emphasized in the tax competition literature, this may lead to inefficiently low taxes due to the existence of fiscal externalities of local tax policy decisions (e.g., Zodrow and Mieszkowski [1986]). As discussed in the subsequent literature, however, the welfare consequences hinge on several critical assumptions (for a survey, see Wilson [1999]). Wildasin and Wilson [2004] note that the view of a welfare-worsening tax competition is probably most challenged by Leviathan models, where governments pursue objectives other than maximizing the utility of residents.

Despite the debate about the standard negative assessment of tax competition, much of the literature is concerned with potential remedies against tax competition. One possible option to internalize fiscal externalities of local taxation consists in imposing corrective taxes or subsidies, as was first suggested by Wildasin [1989]. Indeed, many

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countries with a decentralized public sector also run systems of redistributive grants to local governments, sometimes referred to as revenue-sharing or -equalizing grants. Recent literature suggests that these systems of grants tend to internalize fiscal externalities arising from tax competition and may restore efficiency (Koethenbuerger [2002], Bucovetsky and Smart [2006]).

While their existence may explain why local governments in those countries make use of distortive taxes (Smart [1998], Dahlby [2002], Buettner [2006]), it is important to note that redistributive or revenue-sharing grants are usually paid by upper-level governments such as the state, the province, or the central government.[1] To consider these governments as benevolent agents solving local inefficiencies seems somewhat difficult. One of the key reasons for a more decentralized public sector is that the efficiency of public-service provision might be higher for local governments than for upper-level governments. There is not only a large literature following the Tiebout hypothesis, suggesting that the mobility of residents between local jurisdictions is a strong force towards efficient provision of local public goods (e.g., Henderson [1985]). As shown by Seabright [1996], even with identical preferences, decentralization may be fostering accountability of government. Further support for more efficient provision of public services at the local level comes from the literature on yardstick competition (e.g., Besley and Case [1995]), where voters can make comparisons of their own local government's policies with the policies of governments in adjacent jurisdictions. For these reasons, a critical perspective on government objectives as taken by the public-choice literature (e.g., Brennan and Buchanan [1980]) seems particularly relevant for upper-level governments, and hence it may seem counterintuitive to invoke upper-level government intervention for an improvement of local government policies.

Besides doubts about the objectives of state governments, it is also important to note that upper-level governments such as states or provinces are usually subject to several institutional restrictions. In federal countries, such as Australia, Canada, Germany, or Switzerland, the subnational level of governments is subject to equalizing transfers that may exert important incentives. Thus, even if states, or similar subnational units of governments, were simply benevolent, they might face incentives to distort the tax policy of local governments.

Against this background, this paper is concerned with the question of whether the efficiency-enhancing property of revenue-sharing grants implemented by upper-level governments subsists once separate state-level objectives or equalization at the state level are taken into consideration. We determine conditions under which revenue-sharing grants will or will not achieve or raise efficiency in local finances and explore the possible consequences if these conditions are not met. To do so, we develop a general formulation of the state's decision problem of implementing a set of local policies deemed appropriate by the state government. This formulation takes in the decision problem of a benevo-

[1] Redistributive grants from upper-level governments are paid to local governments in European countries, such as Sweden, Norway, Germany, Austria, and Spain, among others, as well as in the U.S., where, usually, states are responsible. Also the finances of U.S. school districts partly rely on such redistributive grants.

lent state government that implements efficient local policies as in Bucovetsky and Smart [2006]. A first case where the state government may implement inefficient local policies deals with additional government objectives at the state level that bias government policies towards increasing the size of the public sector, as in Edwards and Keen [1996]. A second case is concerned with the institutional setting within which the state governments operate, by taking account of equalizing transfers between states. These cases enable us to derive some testable hypotheses about how potentially beneficial state intervention introduces distortions of the tax policy decisions of local governments.

We show that if the state government pursues own policies and cannot levy lump-sum contributions from local jurisdictions, it will implement revenue-sharing grants that induce local governments to raise local tax revenues. Moreover, the model also predicts that local tax rates will increase if the state is subject to a state-level equalization scheme.

Our results are in line with the theory of vertical fiscal externalities, where it has been shown that inefficiencies arise when governments at two levels tax the same base (Wrede [1997], Keen and Kotsogiannis [2002], Devereux, Lockwood, and Redoano [2007]), or when one level provides a public input that enhances the fiscal revenues of the other (Dahlby and Wilson [2003], Fenge and Wrede [2007]). In this line of thought, however, the inefficiency stems from the noncooperative use of a common pool resource, and revenue-sharing grants are introduced, at most, exogenously (Grazzini and Petretto [2006], Kotsogiannis [2010]). Contrary to that, in our approach, the grant system is specifically designed by the upper-level government so as to foster its own objectives. Thus, our model is focused on the role, and possible failure, of upper-level governments as coordinating agencies, and on the potentially inefficient use of grants as a governance instrument. In this respect, our model is most closely related to a recent contribution by Enns [2009], who models the revenue-sharing system as the result of bargaining among local jurisdictions. Also in her approach, the grant system is not used to achieve efficiency, since resources are tilted in favor of the jurisdiction with the more attractive disagreement point.

The theoretical implications of our model are contrasted with the experience in Germany, which combines municipal tax autonomy and revenue-sharing grants provided by the states (*Länder*). Previous research also indicates that revenue-sharing grants do in fact exert a strong influence on the jurisdictions' tax policy (Buettner [2006]). At the same time, some of the German states are in an increasingly difficult fiscal situation where the debt burden is rather high, so that they may be tempted to induce local jurisdictions to increase their taxing effort. Moreover, the German system of fiscal federalism provides several incentives and disincentives for government policies at the state level, which can be used to identify the constraints under which the states operate. This enables us to investigate whether, in fact, the response of state governments to changes in their own funds or in federal fiscal institutions includes an adjustment of local revenue-sharing grants.

Consistent with the theoretical approach, our analysis considers the empirical implications for local tax policy and tests whether conditions faced by state policymakers are reflected in the tax policy pursued at the local level. The results indicate that, con-

trolling for differences in the tax base, the local tax rate does respond to a significant extent, and in the way suggested by the theory, to the fiscal conditions at the state level. This supports the concern that the potential benefits from local revenue sharing cannot be obtained if the state, as the institution enforcing the revenue-sharing system, pursues own objectives and faces certain institutional restrictions.

The paper proceeds as follows. The following section contains the theoretical analysis, which derives empirical implications with regard to local jurisdictions' tax policy. Section 3 then provides an empirical analysis of tax policy in Germany. The last section provides conclusions.

2 Theoretical Analysis

This section formally explores the circumstances under which revenue-sharing grants from an upper-level government fail to restore efficiency in a situation of tax competition. Section 2.1 lays out a standard model of tax competition, and then section 2.2 provides a general description of the state's decision problem. Sections 2.3 and 2.4 then characterize the policy choices of a state that has own objectives, or is subject to fiscal equalization at the state level.

2.1 Tax Competition and Redistributive Grants

We consider a set of n local jurisdictions, labeled $i = 1, \ldots, n$, which are situated in the same state. In each jurisdiction i, a competitive firm produces a homogeneous private good by combining immobile labor with k_i units of mobile capital per unit of labor. The per capita production function $f(k_i)$ is assumed to be identical across jurisdictions, with $f' > 0$ and $f'' < 0$. Local jurisdictions levy a source-based tax on capital at a rate of τ_i units per unit of capital installed in jurisdiction i. Profit maximization by local firms and free mobility of capital imply that the net rate of return to capital, r, is equal across jurisdictions and given by $r = f'(k_i) - \tau_i$. As a consequence, capital demand (per capita) at location i is a function $k_i = f'^{-1}(r + \tau_i) \equiv \phi(r + \tau_i)$ of the gross interest rate $r + \tau_i$, with $\phi'(r + \tau_i) = 1/f''(k_i) < 0$.

The capital endowment of residents in jurisdiction i per capita is s_i. In addition, there is a net supply of capital to the state, given by an increasing function $s(r)$. Then, for any vector of tax rates $\tau = (\tau_i)_{i=1}^n$, the interest rate $r(\tau)$ is determined by the capital market equilibrium condition $\sum_j \phi(r + \tau_j) = \sum_j s_j + s(r)$. Implicit differentiation yields

$$\frac{\partial r}{\partial \tau_i} = -\frac{\phi'(r(\tau) + \tau_i)}{\sum_j \phi'(r(\tau) + \tau_j) - s'(r(\tau))}. \tag{1}$$

Notice that from $\phi' < 0$ and $s' > 0$, it follows that $-1 < \partial r/\partial \tau_i < 0$.

Residents of jurisdiction i derive utility from private (c_i) and public (z_i) consumption per capita according to the utility function $u_i(c_i, z_i) = c_i + \alpha_i v(z_i)$, where v is an increasing and strictly concave function, and $\alpha_i > 0$ may vary across jurisdictions. Private consumption is given by $c_i = f(k_i) - (r + \tau_i)k_i + rs_i$. Public consumption is determined

by the budget constraint of the local government, $z_i = \tau_i k_i + y_i - \vartheta_i k_i$. In this equation, $\tau_i k_i$ are tax revenues, and $y_i - \vartheta_i k_i$ is a revenue-sharing grant received from the state government. The state's grant policy consists of a lump-sum payment y_i and an implicit revenue-sharing contribution determined by the *contribution rate* ϑ_i applied to the local tax base.[2]

Local tax competition takes place after the state has fixed a grant policy $(\vartheta, y) = (\vartheta_i, y_i)_{i=1}^n$. For any such policy, we consider a Nash equilibrium among the local jurisdictions. Taking the capital market equilibrium into account, local jurisdiction $i = 1, 2, \ldots, n$ then solves

$$\text{(M1)} \qquad \max_{\tau_i, z_i} V_i(\tau, z_i)$$
$$\equiv \; f\big(\phi(r(\tau) + \tau_i)\big) - \big[r(\tau) + \tau_i\big]\phi(r(\tau) + \tau_i) + s_i r(\tau) + \alpha_i v(z_i)$$

subject to

$$z_i = \tau_i \phi(r(\tau) + \tau_i) + y_i - \vartheta_i \phi(r(\tau) + \tau_i). \tag{2}$$

The first-order conditions for a maximum are, for $i = 1, 2, \ldots, n$,

$$\alpha_i v'(z_i) = \frac{\phi(r(\tau) + \tau_i) - \big[s_i - \phi(r(\tau) + \tau_i)\big]\frac{\partial r(\tau)}{\partial \tau_i}}{\phi(r(\tau) + \tau_i) + (\tau_i - \vartheta_i)\phi'(r(\tau) + \tau_i)\Big(\frac{\partial r(\tau)}{\partial \tau_i} + 1\Big)}. \tag{3}$$

Optimality requires that the marginal benefit of public funds, $\alpha_i v'(z_i)$, equal the marginal cost of raising public funds given on the right-hand side of (3). Since the contribution rate ϑ_i enters this term, we see that the marginal cost of public funds decreases if the contribution rate ϑ_i is raised. Intuitively, revenue-sharing grants render taxation less costly to the local jurisdiction, since part of the revenue loss induced by a decreasing tax base is recovered through higher grants. By imposing a higher ϑ_i, hence, the state government can induce the local jurisdiction to increase the local tax rate.

Together, the $2n$ equations (2) and (3) implicitly determine the vector of equilibrium tax rates and equilibrium local public-good supplies as a function of the contribution rates and lump-sum payments. Equivalently, in order to emphasize our view of the grant system as a governance instrument of the state, one can invert this relationship and ask how the redistributive grant scheme has to be designed so that the local jurisdictions set their policy variables at the levels deemed appropriate by the state government. Following this reasoning, for any desired $(\tau, z) = (\tau_i, z_i)_{i=1}^n$, we write $\vartheta(\tau, z) = (\vartheta_i(\tau, z))_{i=1}^n$ and

[2]This specification reflects the common characteristic of most transfer systems that transfers are inversely related to the tax base or some corresponding measure of *fiscal capacity*. Since such a grant formula tends to reduce interjurisdictional disparities in fiscal capacities, it is similar to fiscal equalization between provinces and states in Austria, Canada, and Germany. However, in this paper we reserve this term for a system of fiscal transfers at the state level. Notice also that, in general, both the contribution rates and the lump-sum grants are allowed to differ between jurisdictions.

$y(\tau, z) = (y_i(\tau, z))_{i=1}^n$ for the contribution rates and lump-sum payments, which together with local policy choices (τ, z) satisfy (2) and (3) for all $i = 1, 2, \ldots, n$.[3] Accordingly, in the following subsections, we treat the local tax rates and public-goods supplies as choice variables of the state, which are implemented by the functions $\vartheta(\tau, z)$ and $y(\tau, z)$.

2.2 The State Government

The state government's objective function is $V(\tau, z) + \beta w(e)$. It encompasses both the utilitarian welfare of citizens in all local jurisdictions, given by $V(\tau, z) \equiv \sum_j V_j(\tau, z_j)$, and a preference $e \geq 0$ for funds spent at the state level, even if the residents do not derive any utility from those expenditures. This specification captures a Leviathan-type spending bias as in Edwards and Keen [1996]. The weight of the own state objective is expressed by the parameter $\beta \geq 0$, and the subutility function $w(e)$ satisfies $w'(e) > 0$ and $w''(e) < 0$.

The state government has funds in an amount $m \geq 0$ at its disposal. In addition, the state is integrated in a system of state-level equalization transfers. This system might involve lump-sum transfers, which are included in m, as well as a contribution $\xi \sum_j \phi(r(\tau) + \tau_j)$, proportional to the statewide tax base, to be paid by the state. The contribution rate $\xi \geq 0$ reflects the intensity of fiscal equalization at the state level. The state surplus is

$$e(\tau, z; m, \xi) \equiv m - \sum_{j=1}^{n} \xi\phi(r(\tau) + \tau_j) + \sum_{j=1}^{n} \vartheta_j(\tau, z)\phi(r(\tau) + \tau_j) - \sum_{j=1}^{n} y_j(\tau, z) \tag{4}$$

$$= m + \sum_{j=1}^{n} (\tau_j - \xi)\phi(r(\tau) + \tau_j) - \sum_{j=1}^{n} z_j, \tag{5}$$

where the local budget constraints (2) are used to arrive at (5).

The state must observe two restrictions. The first restriction requires that the net expenditures of the state cannot be negative: $e(\tau, z; m, \xi) \geq 0$. The second restriction is motivated by the role of unconditional grants. As is apparent from (4), a decrease in the total amount of such grants, $\sum_j y_j$, provides a lump-sum source of finance for the state government. If such a source of finance is available for marginal spending increases, we have a rather trivial case where the state government's expenditure decision does not conflict with the efficiency of local finances. However, if the state drives down the volume of funds transferred to the local jurisdictions, the nature of the vertical fiscal relations changes. To take an extreme case, suppose $\sum_j y_j$ were zero. In this case, a

[3] While this formulation is in line with our research question, it is also technically convenient. When (ϑ, y) are taken to be the endogenous variables, equations (2) and (3) display a recursive structure: Neither the ϑ_j for the other jurisdictions $j \neq i$, nor any y_j, $j = 1, \ldots, n$, enter the condition (3) for jurisdiction i. Hence, for given (τ, z), this equation alone is sufficient to solve for $\vartheta_i(\tau, z)$, which then can be substituted into jurisdiction i's budget constraint (2) in order to find $y_i(\tau, z)$. In particular, this means that the comparative-static effects $\partial\vartheta_i/\partial\tau_i$ and $\partial\vartheta_i/\partial\tau_j$, $j \neq i$, can be determined by differentiating only (3) for jurisdiction i.

further attempt by the state to use unconditional transfers in order to raise funds would imply that the state government would not assist local governments but would actually levy lump-sum contributions for its own budget. To rule this out, we assume that there is some lower bound for $\sum_j y_j$ where either political costs increase as the operation of local jurisdictions becomes difficult or constitutional limits are binding. This idea is formalized by assuming that the total unconditional grants paid to the jurisdictions have to be at least ny'. In order to distinguish the issue of horizontal redistribution among municipalities from the role of the state's objectives, we nevertheless allow the individual grants y_i to be differentiated among local jurisdictions.

These considerations lead to the optimization problem of the state government:

$$\text{(M2)} \qquad \max_{\tau,z} \; V(\tau,z) + \beta w(e(\tau,z;m,\xi))$$

subject to

$$e(\tau,z;m,\xi) \geq 0, \tag{6}$$

$$\sum_{j=1}^{n} y_j(\tau,z) \geq ny'. \tag{7}$$

In the Lagrangian $\mathcal{L}(\tau,z,\lambda,\mu;\beta,m,\xi)$ for this problem, we associate the variables $\lambda \geq 0$ and $\mu \geq 0$ with the constraints (6) and (7) respectively. An interior solution to (M2) satisfies the first-order conditions

$$\frac{\partial \mathcal{L}}{\partial \tau_i} = \frac{\partial V}{\partial \tau_i} + \big[\beta w'(e) + \lambda\big]\frac{\partial e}{\partial \tau_i} + \mu \frac{\partial \sum_j y_j}{\partial \tau_i} = 0, \quad i = 1,2,\ldots,n, \tag{8}$$

$$\frac{\partial \mathcal{L}}{\partial z_i} = \frac{\partial V}{\partial z_i} + \big[\beta w'(e) + \lambda\big]\frac{\partial e}{\partial z_i} + \mu \frac{\partial \sum_j y_j}{\partial z_i} = 0, \quad i = 1,2,\ldots,n, \tag{9}$$

where, from (M1), (4), and (5),

$$\frac{\partial V}{\partial \tau_i} = -\phi(r+\tau_i) + \sum_{j=1}^{n} \big[s_j - \phi(r+\tau_j)\big]\frac{\partial r}{\partial \tau_i}, \qquad \frac{\partial V}{\partial z_i} = \alpha_i v'(z_i), \tag{10}$$

$$\frac{\partial e}{\partial \tau_i} = \phi(r+\tau_i) + \sum_{j=1}^{n} (\tau_j - \xi)\phi'(r+\tau_j)\frac{\partial r}{\partial \tau_i} + (\tau_i - \xi)\phi'(r+\tau_i), \qquad \frac{\partial e}{\partial z_i} = -1, \tag{11}$$

$$\frac{\partial \sum_j y_j}{\partial \tau_i} = \frac{\partial \Big[\sum_j (\vartheta_j - \xi)\phi(r+\tau_j)\Big]}{\partial \tau_i} - \frac{\partial e}{\partial \tau_i}, \qquad \frac{\partial \sum_j y_j}{\partial z_i} = -\frac{\partial e}{\partial z_i} = 1. \tag{12}$$

The general formulation (M2) encompasses the benchmark case of a benevolent government that is not subject to equalization at the state level. This case, which has been analyzed by Bucovetsky and Smart [2006], is obtained by setting[4] $\beta = 0$ and $m = \xi = 0$. The solution to the program (M2) with these parameter choices describes

[4]It is assumed that $w'(0)$, while large, is finite, so that $\beta w'(0) = 0$ in this case.

the efficient allocation and is denoted by $(\tau^*, z^*, \lambda^*, \mu^*)$, where $(\tau^*, z^*) = (\tau_i^*, z_i^*)_{i=1}^n$. In the case of the benevolent government, a restriction designed to curb the state's powers such as (7) would not be well motivated. Hence, the constraint (7) would not be binding ($\mu^* = 0$) in this case.

In the following, we show how a state government that pursues own objectives, or that is integrated into a system of fiscal equalization at the state level, will prefer tax rates to deviate from the efficient levels so defined. These questions can be addressed by again considering appropriate special cases of the optimization problem (M2).

2.3 Own State Government Objectives

In this subsection, own state objectives, expressed by $\beta > 0$, are analyzed. We assume $m > 0$ and $\xi = 0$, so that some state spending is possible without affecting local finances. Moreover, we restrict attention to situations where the nonnegativity constraint (6) on the state's expenditures is not binding ($\lambda = 0$), so that the state government actually succeeds in keeping some funds for its own purposes. In order to assess the influence of the state's own objective on its choice of the grant scheme, we start by considering the tax rates τ^* and the local public-goods supplies z^* of the efficient solution, and then investigate in which direction the state government would like to adjust the tax rate as soon as it takes the new, selfish objective into account.[5]

In the efficient allocation, the marginal benefit of public funds is equated across jurisdictions:[6] $\alpha_i v'(z_i^*) = \lambda^*$ for all $i = 1, 2, \ldots, n$. Moreover, tax receipts exactly match expenditures for local public goods, implying $e(\tau^*, z^*; m, 0) = m$. Inserting this with (10) to (12) and $\lambda = 0$ in (9) yields $\partial\mathcal{L}/\partial z_i = \alpha_i v'(z_i^*) - \beta w'(m) + \mu$. Now, if $\alpha_i v'(z_i^*) > \beta w'(m)$, the state government actually values funds less than the local jurisdictions. In such a situation, the state government will increase the lump-sum transfer y_i so as to raise z_i beyond the efficient value. Thus, the constraint (7) is not binding, i.e., $\mu = 0$. Since we are interested in a state government that provides only minimal support for local municipalities, it is, however, plausible to restrict attention to the other case where the constraint (7) is binding. Solving (9) then yields the shadow value $\mu = \beta w'(m) - \alpha_i v'(z_i^*) > 0$, which measures the net benefit to the state from transferring one unit of tax revenue from jurisdiction i to the state level.

Inserting μ in (8) yields the marginal benefit $\partial\mathcal{L}(\tau^*, z^*, 0, \beta w'(m) - \lambda^*; m, \beta, 0)/\partial\tau_i$ of an increase in the tax rate τ_i, starting at the efficient level, when the state's own objective is present. Subtracting the corresponding value for the nonselfish government,

[5] Since our aim is to highlight the incentives introduced by own state objectives, we restrict attention to a local analysis of the first-order conditions around the efficient solution. A global analysis would be much more involved while being very unlikely to produce additional economic insights.

[6] To see this, set $\beta = \mu = 0$ in (9) and use the second equations in (10) and (11).

$\partial\mathcal{L}(\tau^*, z^*, \lambda^*, 0; 0, 0, 0)/\partial\tau_i = 0$, and noting that $\partial e/\partial\tau_i$ does not depend on m, one finds

$$\begin{aligned}(13)\qquad &\frac{\partial\mathcal{L}(\tau^*, z^*, 0, \beta w'(m) - \lambda^*; m, \beta, 0)}{\partial\tau_i} - \frac{\partial\mathcal{L}(\tau^*, z^*, \lambda^*, 0; 0, 0, 0)}{\partial\tau_i} \\ &= [\beta w'(m) - \alpha_i v'(z_i^*)] \cdot \left[\frac{\partial e(\tau^*, z^*; m, 0)}{\partial\tau_i} + \frac{\partial \sum_j y_j(\tau^*, z^*)}{\partial\tau_i}\right].\end{aligned}$$

If (13) is positive, a state government with own objectives wishes to raise the tax rate in jurisdictions i above the efficient level. Whether this is true first of all depends on the factor $\beta w'(m) - \alpha_i v'(z_i^*)$. In the case of a binding constraint (7), this is positive, i.e., the state at least *wants* to extract further resources from the local jurisdictions. Whether or not the state government *is able* to extract resources from the local revenue-sharing system by inducing higher local taxes depends, however, on the sign of the second factor in (13). From the first equation in (12), one finds with $\xi = 0$

$$(14)\qquad \frac{\partial e(\tau^*, z^*; m, 0)}{\partial\tau_i} + \frac{\partial \sum_j y_j(\tau^*, z^*)}{\partial\tau_i} = \frac{\partial\big[\sum_j \vartheta_j(\tau^*, z^*)\phi(r(\tau^*) + \tau_j)\big]}{\partial\tau_i}.$$

This factor therefore expresses by how much the aggregate receipts from revenue-sharing contributions $\sum_j \vartheta_j k_j$ collected by the state change if the tax rate in jurisdiction i is increased. If this factor is positive, the state will indeed raise more revenue by implementing a higher τ_i.

In order to illustrate the circumstances where this is the case, a special model may be considered, which is described by the following assumptions:

ASSUMPTION 1 *$s_i = s$ for all $i = 1, 2, \ldots, n$.*

ASSUMPTION 2 *$\tau_i^* = \tau_j^*$ for all $i, j = 1, 2, \ldots, n$, and $s(r(\tau^*)) = 0$.*

ASSUMPTION 3 *$f'''(s) = 0$ and $s''(r(\tau^*)) = 0$.*

Assumption 1 states that capital supplies are symmetric, and Assumption 2 requires that, in the efficient solution, the tax rate be uniform and the aggregate net capital import be zero. Assumption 3 restricts attention to linear capital demand and supply functions.

PROPOSITION 1 (DISTORTION BY STATE GOVERNMENT OBJECTIVES) *(i) If the state government values own funds more than the funds for local jurisdictions, i.e., $\beta w'(m) > \alpha_i v'(z_i^*)$, and if an increase in the tax rate of jurisdiction i increases contributions, i.e.,* (14) *is positive, then a marginal increase in the local tax rate above the efficient level, induced by the revenue-sharing grants, is beneficial for the state government.*

(ii) With Assumptions 1, 2, and 3, and if the supply of capital is sufficiently inelastic, (14) *is positive.*

PROOF Part (i) follows from the discussion in the text. For part (ii), see Appendix.

Part (ii) of Proposition 1 points out that the ability to raise revenue-sharing contributions by increasing tax rates crucially depends on the elasticity of the supply of capital. To understand why this is so, notice that an increase in the tax rate changes contributions by a rate effect and a base effect. The rate effect measures by how much contributions change, for a given tax base per jurisdiction, through the adjustment of contribution rates necessary to implement the higher tax rate. One expects that this effect is positive, since the state will have to raise the contribution rate for jurisdiction i in order to create an incentive for this jurisdiction to increase its tax rate. Although the decisions with regard to the other contribution rates ϑ_j, $j \neq i$, are less obvious, it is shown in the Appendix that, in the special model, this intuition is correct.

The base effect of a tax increase, however, goes in the opposite direction. This effect arises because an increase in the tax rate causes, via the associated fall in the net interest rate, an outflow of capital from the state as a whole and thus a decline in revenue-sharing contributions. If this effect is strong, i.e., if s' is large, it might outweigh the direct effect of collecting more revenue per unit of capital. Conversely, the rate effect must dominate if s' is small. Intuitively, in the extreme case where the state is (almost) a closed economy, the total amount of capital is (almost) fixed, and thus total revenue can only rise if contribution rates increase.

We conclude this section by discussing a further consequence of the presence of own state objectives: The fact that the resources of the state government become important for local tax policy. To analyze this issue, denote the solution to (M2) with own objectives by $(\tau, z, \lambda = 0, \mu)$, where $(\tau, z) = (\tau_i, z_i)_{i=1}^n$. From (9) the marginal benefit of public expenditures $\alpha_i v'(z_i)$ is equalized among the local jurisdictions by means of unconditional grants y_i, whether or not (7) is binding. Restricting attention to the latter case and inserting, from (9), $\mu = \beta w'(e(\tau, z; m, 0)) - \alpha_i v'(z_i)$ in (8), one finds the necessary condition $\partial \mathcal{L}(\tau, z, 0, \mu; m, \beta, 0)/\partial \tau_i = 0$ characterizing the optimal choice of the state government with own objectives. To see how a change in m affects this condition, observe from (10) to (12) that in this condition, $\partial V/\partial \tau_i$, $\partial e/\partial \tau_i$, v', and $\partial \sum_j y_j/\partial \tau_i$ do not depend on m, and that $\partial e/\partial m = 1$. Using (12), one then obtains

$$\frac{\partial^2 \mathcal{L}(\tau, z, 0, \mu; m, \beta, 0)}{\partial \tau_i \partial m} = \beta w''(e(\tau, z; m, 0)) \cdot \frac{\partial \sum_j \vartheta_j \phi(r(\tau) + \tau_j)}{\partial \tau_i}. \tag{15}$$

Since $w'' < 0$, this is negative whenever the second term is positive. We thus have:

Proposition 2 (impact on state-level revenue) *Assume that an increase in the tax rate of jurisdiction i raises contributions received by the state, $\partial \sum_j \vartheta_j \phi(r(\tau) + \tau_j)/\partial \tau_i > 0$, and consider a reduction in revenue m experienced by the state government. Then a marginal increase in the local tax rate, induced by the revenue-sharing grants, is beneficial for the state government.*

As is clear from (15), in the case of a benevolent state government with $\beta = 0$, the state's funds have no effect on local tax policy. When the state government has its own objectives, however, it will experience an increase in the marginal value of spending

when such funds are withdrawn. Consequently, by inducing local governments to raise their tax rates, it will strive to recover some of the funds that are lost.

2.4 Fiscal Equalization at the State Level

We now turn to the second interesting special case of the general optimization problem (M2). In this case, equalization at the state level is introduced, which is characterized by $\xi > 0$. In order to compare this case with the efficient solution, we again assume $\beta = 0$ and $\mu = 0$. Moreover, to ensure that the efficient allocation is still feasible for the state government, we restrict attention to the situation where $m = \xi \sum_j \phi(r(\tau^*) + \tau_j^*) =: m^\times$. Thus, fiscal equalization at the state level does not cause a net fiscal transfer from or to the state if tax rates are set at their efficient levels.

Following the same procedure as in section 2.3, we analyze how, starting from the efficient solution, the state would like to adjust the tax rate in jurisdiction i if it is integrated in a system of fiscal equalization transfers. To do so, we compute from (8) the marginal incentive to increase the tax rate above τ_i^*, using (1) and the first equation in (11):

$$\begin{aligned} &\frac{\partial \mathcal{L}(\tau^*, z^*, \lambda^*, 0; 0, m^\times, \xi)}{\partial \tau_i} - \frac{\partial \mathcal{L}(\tau^*, z^*, \lambda^*, 0; 0, 0, 0)}{\partial \tau_i} \\ &\qquad = -\alpha_i v'(z_i^*) \cdot \xi s'(r(\tau^*)) \frac{\partial r(\tau^*)}{\partial \tau_i} \geq 0. \end{aligned} \tag{16}$$

This equation captures the consequences of fiscal equalization at the state level on local tax policy: Typically, a higher tax rate at i reduces the net interest rate and hence capital supply to the state. A tax increase therefore reduces the transfers the state has to pay into the state-level fiscal equalization system. The additional funds $-\xi s' \partial r / \partial \tau_i$ gained this way raise welfare according to the marginal benefit of public spending $\alpha_i v'$. Therefore, with capital mobility, the tax rate τ_i is increased against the case where $\xi = 0$. However, if the capital supply is inelastic ($s' = 0$), (16) is zero. In this case the spending obligation is financed solely by a uniform reduction of grants without altering the contribution rates.

As a result, we can state:

Proposition 3 (distortion by state-level fiscal equalization) *If the state government is subject to a system of fiscal equalization, and if the supply of capital is not completely inelastic, then a marginal increase in the local tax rate above the efficient level, induced by the revenue-sharing grants, is beneficial for the state government.*

3 Empirical Analysis

The above propositions seem to be of particular relevance in the case of the German federation. While local municipalities make use of a local business tax and consequently are involved with tax competition, each state substantially affects local funds by means of a system of revenue-sharing grants. At the same time, state governments have to

ensure, under constitutional law, that their municipalities are able to accomplish their functions. Therefore, the states are obliged to make sure that municipalities receive some adequate level of funding, and hence cannot arbitrarily cut down on grants.[7] Consistent with the theoretical analysis, the empirical investigation uses this institutional setting to test for the influence of fiscal conditions and constraints faced by the state governments on local tax decisions.

3.1 Identification Approach and Specification

In order to identify a state influence on local tax policy we need to find some variation in the conditions faced specifically by state governments but not by local jurisdictions. Moreover, it is important that this variation is not affected or, statistically, correlated with the local jurisdictions' taxing decisions. A first variable that comes to mind is the level of the debt burden. As the level of debt is inherited from past policy, it seems useful to consider a state's debt burden as an indicator of the availability of fiscal resources in the sense of Proposition 2. However, there are two obvious problems with this approach. The first relates to a potential correlation between state and local finances. If there is some common source of shocks driving deficits both at state and local level, the empirical correlation with state-level debt might be misleading. In order to overcome this problem we will include variables for both state and local debt. This allows us to consider the impact of state debt conditional on the local debt burden. A second problem arises from the role of the capital market in the determination of the interest rate. If tax policies are taken into account by the capital market, it seems generally possible that certain tax policies are reflected in the interest rate or the market value of the debt. However, as the federal government is forced by the constitution to provide a backing for state finances, this effect is likely to be negligible.[8]

Another promising source of variation in conditions faced by state governments is the system of fiscal equalization between the states. Depending on the fiscal capacity relative to what is considered as "fiscal need," the system of fiscal equalization allocates funds so that states with low capacity receive transfers while those with high capacity will actually contribute to the system. A change in the fiscal equalization transfers received implies a shift in the state-government budget constraint, which will according to Proposition 2 result in different local tax rates, provided the state government pursues own policies and has already lowered unconditional grants to municipalities. A second potentially important variable derived from the state-level equalization system is the (marginal) contribution rate. This is the rate at which an increase in the statewide business tax base is actually reducing the net transfers received within the state-level fiscal revenue-sharing

[7] For example, Article 73 (1) of the state constitution of Baden-Württemberg; corresponding rules can also be found for the other states. If the state reduced substantially the transfers to the municipalities, they would appeal to the state court of justice (*Staatsgerichtshof*). Two of the last eight decisions of the *Staatsgerichtshof* in Baden-Württemberg, for example, deal with the volume of grants received by the municipalities.

[8] Seitz [1999] describes how supreme court decisions on federal support have prevented the rating of state bonds from deteriorating relative to the federal level.

system. As stated in Proposition 3, given a higher contribution rate, the state might want to induce local jurisdictions to increase taxing effort. A significant positive coefficient of this variable will actually provide evidence on the pure (dis)incentive effect of state-level fiscal equalization on the state's operation of the local finances. With this approach, the empirical analysis is related to the work of Baretti, Huber, and Lichtblau [2002], who find some support for the hypothesis that intergovernmental relations at the state level exert an adverse disincentive effect on a state's revenue collection effort. In contrast, our analysis is concerned with the incentive effects on local taxation resulting from the provision of revenue-sharing grants by the state.

To exploit the variation in local conditions, one could think of running a simple regression relating indicators of the tax rates chosen on their potential determinants such as debt levels, revenue from equalization grants, and contribution rates. However, as these indicators depend on previous tax policies,[9] in the presence of autocorrelation in tax policy, a correlation with the error term might result. Therefore, we condition on the tax policy in the previous period and include the lagged tax rate as an explanatory variable. We also include state-level fixed effects that control for differences in the initial conditions. Note that the inclusion of lags in the panel-data regression is innocuous in our case, because the time period extends over 24 years (see below).

3.2 Data

To study the German case, we have collected an annual database for German states in the period between 1970 and 2003. Since data on the new states in former East Germany are only available from 1991 onwards, those states are excluded. Furthermore, we exclude the three so-called city–states of Hamburg, Bremen, and Berlin, since for them there is no real distinction between state and local level. The database contains information about the average tax rate for the local business tax in each of the states and corresponding revenue data as well as net interest expenses. In addition, the database provides detailed information about the treatment of each state in the state-level equalization system. More specifically, the database allows us to compute for each state and each year all contributions and transfers related to fiscal equalization at the state level. Some further control variables are used to capture the population size, the lagged tax base, and election years both at local and at state level. The latter will control for political business-cycle effects, which have been found to be important at the local level (e.g., Bordignon, Cerniglia, and Revelli [2003]). In order to make sure that the fiscal indicators for state and local budgets are not reflecting common shocks, we also include a measure of state-level revenues that are shared with municipalities due to constitutional requirements (*obligatorischer Steuerverbund*).

⇐**Au.:** O.K.?

Table 1 provides some descriptive statistics. The local tax rate is depicted by the *collection rate* (*Hebesatz*), which is an unknown concept for readers not acquainted with

[9]Note that fiscal equalization revenue and marginal contribution rates are determined by lagged values of fiscal capacity. A description of the German fiscal equalization law and further relevant statutory definitions are available from the authors upon request.

Table 1

Descriptive Statistics

Variable	Mean	Std. dev.	Min	Max
Collection rate (in %)	352.3	37.57	254.0	431.6
State debt service (€ per capita)	143.0	10.77	1.386	495.6
Municipal debt service (€ per capita)	48.19	23.11	1.340	94.13
Shared state tax revenues (€ per capita)	1132	458.3	308.2	2218
Population (in 1000)	7372	4992	1043	18073
State (net) equalization revenue (€ per capita)	−17.24	107.2	−474.7	196.0
State marginal contribution rate (in %)	42.97	13.94	8.139	72.01
Rel. fiscal capacity	1.861	0.278	0.890	2.460
Business tax revenues (€ per capita)	231.9	89.51	59.27	497.8
State parliament election year	0.246	0.432	0	1
Municipal council election year	0.202	0.400	0	1

Note: Annual data for eight German states in the period 1970–2003.

the German business tax. However, it is rather simple: In the time period covered by the analysis, the tax law sets a base rate of 5% and requires each local jurisdiction to set its *collection rate*. For instance, the collection rate might be a figure of 380%, which means that the statutory tax rate applied to the firm is $3.8 \times 0.05 = 19\%$. The collection rate displays substantial variation across time and states. Note that the level and the variation of debt service are much larger at the state than at the local level. The state net equalization revenue varies strongly between positive and negative values, indicating that some states receive positive transfers while others are net contributors. Note that the marginal contribution rate is above 40% at the mean, indicating that on average a state has to transfer an amount of more than 40 cents out of each euro of additional tax revenue. A problem with this variable is, however, that it shows not only a high degree of variation across states, but also fluctuations in time.

3.3 Results

Table 2 provides results from alternative specifications. In order to control for the heterogeneity of states, state fixed effects are included. To control for autocorrelation in tax policy, the lag of the tax rate is included. We also control for the tax base, but since the current tax base is codetermined by the current tax rate, only the lag of the tax base is employed. Specification (1) uses a basic set of explanatory variables; specification (2) additionally employs a cubic trend polynomial in order to test for the importance of common trends. Specifications (3) to (5) test for an effect of the state-level fiscal equalization system, including also terms capturing the differences in fiscal capacity.

The high R^2 reflects the presence of state-level fixed effects as well as the inclusion of the lagged dependent variable. The strong effect of the lagged collection rate supports a standard partial adjustment process. With regard to elections, the political business-cycle hypothesis is confirmed in the sense that current municipal council elections do

Table 2

Determinants of Local Business Tax Rates

Variable	(1)	(2)	(3)	(4)	(5)
Collection rate, lag	0.892 **	0.896 **	0.892 **	0.889 **	0.890 **
	(0.032)	(0.035)	(0.032)	(0.032)	(0.033)
Standardized business tax base, log, lag	−12.7 **	−12.6 **	−13.5 **	−14.0 **	−14.0 **
	(3.97)	(3.89)	(4.20)	(4.24)	(4.26)
State debt service, log	4.56 **	4.96 **	4.34 **	4.29 **	4.27 **
	(1.46)	(1.71)	(1.61)	(1.60)	(1.60)
Municipal debt service, log	3.33 **	3.21 **	3.30 **	3.47 **	3.42 **
	(1.49)	(1.52)	(1.55)	(1.52)	(1.53)
State parliament election year	−0.343	−0.315	−0.288	−0.239	−0.246
	(0.822)	(0.832)	(0.823)	(0.814)	(0.816)
Municipal council election year	−1.56 **	−1.65 **	−1.59 **	−1.48 **	−1.48 **
	(0.720)	(0.723)	(0.726)	(0.688)	(0.689)
Shared state tax revenues	−3.32	1.11	−2.16	−1.26	−1.16
	(4.06)	(9.62)	(5.12)	(5.26)	(5.23)
Population, log	40.8 **	47.0 **	40.5 **	32.8 **	31.5 **
	(12.7)	(20.8)	(13.6)	(14.2)	(14.1)
State marginal contribution rate			−0.012	0.003	0.002
			(0.016)	(0.016)	(0.017)
State (net) equalization revenue			−0.000	−0.025 *	−0.026 *
			(0.012)	(0.015)	(0.016)
Relative fiscal capacity			−2.14	313. **	−75.4
			(20.7)	(155.)	(1505.)
Relative fiscal capacity (quadratic)				−167. **	210.6
				(83.4)	(1482.)
Relative fiscal capacity (cubic)					−121.6
					(484.)
R^2 (adjusted)	0.9799	0.9802	0.9800	0.9804	0.9804

Note: Dependent variable is the average business tax rate of the municipalities by state and year, weighted by the local tax base. All specifications include state-specific fixed effects. Robust standard errors in parentheses. If significant at the 5% (10%) level, coefficients are marked with two stars (one star). Specification (2) includes a cubic trend.

exert the expected negative effect. Elections for the state government are not found to influence taxation. With regard to the debt service, we find not only that the municipal debt service exerts a significant effect on the local tax rate, but also that the burden of debt service at state level proves significant across all specifications. While we cannot say whether this effect is the consequence of changes in the local revenue-sharing system, in the light of Proposition 2 this supports the view that the availability of fiscal resources at the state level exerts an influence on the tax policy of local jurisdictions.

With regard to incentives generated by the state-level fiscal equalization system, note that the specifications test for the effects conditional on (relative) fiscal capacity. This is important in order to make sure that the results capture the effect of fiscal equalization rather than simply reflecting differences in the taxing capacity.[10] In order to make sure that also no nonlinear differences in the fiscal capacity are driving the result, specifications (4) and (5) employ quadratic and cubic specifications, respectively. In these specifications, some support is found for an effect of the volume of transfers received. While the sign is consistent with the theoretical expectation, the parameter is estimated not very precisely and is significantly different from zero only at the 10% level.

Because net revenue from equalization may be negative, it is entered in per capita terms. In order to compare the magnitude of the estimate with that of an increase in the state's debt burden, we have to evaluate the semielasticity obtained for the debt burden at the mean. Using the value 143 € per capita as depicted in Table 1, we obtain an average marginal effect of the state debt service of about 0.028, which is similar in absolute terms to the effect of the net equalization revenue. Since the debt shows a much higher level of significance, this similarity in size is reassuring also with respect to the effect of net equalization revenue, which is much more difficult to identify in the current setting. The point estimates imply that an increase in state revenue or a decline in the debt burden of about 100 € per capita leads to a reduction in the collection rate by 2.5 to 2.8 percentage points, i.e., 0.13 to 0.14 percentage points in the statutory tax rate in the short run, or about 1.2 to 1.3 percentage points in the long run.[11] The marginal contribution rate for the state, which determines to what extent net transfers received shrink in response to an increase in business tax revenue, shows no significant effect. This variable, however, shows rather strong fluctuations, since the system of fiscal equalization not only responds in a nonlinear fashion to the fiscal capacity of the considered state, but also depends in a nonlinear way on the fiscal capacity of the other states. This makes it very hard to identify incentive effects of fiscal equalization at the state level.

In summary, we can state that the empirical analysis provides partial confirmation of

[10] Since equalization grants and marginal contribution rates are determined by a complicated, nonlinear, albeit clearly defined system, identification can rely on regression discontinuity (see Buettner [2006]). More specifically, since we control for the potential influence of fiscal capacity in the estimation, we can separate out the differential treatment of the states.

[11] This calculation is based on the point estimate for the coefficient of the lag of the collection rate of 0.89.

the above theoretical predictions. The results obtained for the states' debt service and the states' transfer revenues suggest that the position of the state government's budget line has a significant effect on the level of taxation chosen by the local governments in a state: A decline in available fiscal resources at the state level causes an increase in local tax rates.[12] This is in line with Proposition 2 and thus suggests that, in pursuit of own objectives, state governments exert incentives on local governments in order to extract fiscal resources.

4 Conclusions

The recent literature has emphasized that revenue-sharing grants may tend to internalize fiscal externalities arising from tax competition (Koethenbuerger [2002], Bucovetsky and Smart [2006]), at least to some extent. While the existence of revenue-sharing grants might explain why local governments make use of distortive taxes in spite of tax competition (Smart [1998], Buettner [2006]), it is difficult to derive policy recommendations. Since a critical perspective on government objectives seems particularly relevant for upper-level governments, it is not obvious that we should consider upper-level governments as benevolent agents alleviating local inefficiencies.

Given this background, the current paper has explored the conditions under which revenue-sharing grants from upper-level governments will or will not achieve efficiency in local finances. We have considered a standard model of tax competition of local jurisdictions and introduced a system of redistributive or revenue-sharing grants from an upper-level government. The basic model has then been extended in order to allow for variations in the government objectives at the state level. The theoretical results suggest that, as in the literature on vertical tax competition, attempts of upper-level governments to extract fiscal resources from the local revenue-sharing system will tend to undermine the efficiency of local finances.

These concerns are corroborated by the results from an empirical analysis of local tax policy in Germany, which suggest that attempts of state governments to extract fiscal resources from the local revenue-sharing system exert an upward pressure on tax rates. This finding raises doubts on whether the state government should really be considered as pursuing policies only in the interest of local jurisdictions. Rather, the theoretical and empirical results of the paper support concerns that the potential benefits from local revenue sharing cannot be reaped if the state pursues own policies and operates under conditions that give rise to inefficiencies at the state level.

[12] Similar results have been obtained for Canadian provinces. Esteller-Moré and Solé-Ollé [2002] find that provinces that receive equalization grants set higher personal income tax rates if the contribution rate to the equalization system is increased. Karkalakos and Kotsogiannis [2007] show that an increase in the volume of federal grants received induces provinces to reduce their corporate income tax rates.

Appendix

A.1 Proof of Proposition 1(ii)

Step 1: Simplification of (14).[13] Assumptions 1 and 2 together imply $\phi(r+\tau_i^*) = \phi(r+\tau_j^*) = s$ for all $i, j = 1, 2, \ldots, n$. From (1), also the derivative $\partial r/\partial\tau_i$ is identical for all i. Using these facts in the necessary condition for the efficient tax rate τ_i^*, which is derived from (8) to (11) by setting $\beta = \mu = 0$, one arrives at $\lambda^* = \alpha_i v'(z_i^*) = s/[s + \tau_i^*\varphi'\big(1 + n(\partial r/\partial\tau_i)\big)]$ for all $i = 1, 2, \ldots, n$. Comparison with (3) then shows that the efficient allocation is supported by a uniform contribution rate $\vartheta_i(\tau^*, z^*) = \vartheta_j(\tau^*, z^*)$ for all $i, j = 1, 2, \ldots, n$. Using this and $\phi(r+\tau_i^*) = s$, and replacing, from (1), $\sum_j \phi'(\partial r/\partial\tau_i) + \phi'$ by $s'(\partial r/\partial\tau_i)$, one finds that (14) is equivalent to

$$\vartheta_i(\tau^*, z^*)s'\frac{\partial r}{\partial\tau_i} + s\sum_j \frac{\partial\vartheta_j}{\partial\tau_i}.$$

The first term in this expression, while negative, is small in absolute value if s' is small, as is assumed in part (ii) of Proposition 1. Therefore, what needs to be shown is that the second term is strictly positive.

Step 2: Proof that $\sum_j \partial\vartheta_j/\partial\tau_i > 0$. In order to sign this expression, the derivatives $\partial\vartheta_i/\partial\tau_i$ and $\partial\vartheta_j/\partial\tau_i$ for $j \neq i$ are to be computed from (3) for jurisdictions i and j. This is simplified substantially by observing that with Assumption 3, $\varphi'' = s'' = 0$ and hence, from (1), $\partial^2 r/\partial\tau_i^2 = \partial^2 r/\partial\tau_j\partial\tau_i = 0$. Moreover, in a symmetric situation, $\partial r/\partial\tau_i = \partial r/\partial\tau_j$ for all i, j. Since $\alpha_i v'(z_i^*) = \alpha_j v'(z_j^*) = \lambda^*$ for all i, j, one arrives at

$$\text{(A1)} \qquad \frac{\partial\vartheta_i}{\partial\tau_i} = \frac{-\Big(1+\frac{\partial r}{\partial\tau_i}\Big)^2 + 2\lambda^*\Big(1+\frac{\partial r}{\partial\tau_i}\Big)}{\lambda^*\Big(1+\frac{\partial r}{\partial\tau_i}\Big)},$$

$$\text{(A2)} \qquad \frac{\partial\vartheta_j}{\partial\tau_i} = \frac{-\frac{\partial r}{\partial\tau_i}\Big(1+\frac{\partial r}{\partial\tau_i}\Big) + \lambda^*\frac{\partial r}{\partial\tau_i}}{\lambda^*\Big(1+\frac{\partial r}{\partial\tau_i}\Big)} \qquad \text{for } j \neq i.$$

Since all $\partial\vartheta_j/\partial\tau_i$, $j \neq i$, are equal in a symmetric situation, we obtain from (A1) and (A2)

$$\sum_{j=1}^{n}\frac{\partial\vartheta_j}{\partial\tau_i} = \frac{-\Big(1+\frac{\partial r}{\partial\tau_i}\Big)^2 + 2\lambda^*\Big(1+\frac{\partial r}{\partial\tau_i}\Big) + (n-1)\Big[-\frac{\partial r}{\partial\tau_i}\Big(1+\frac{\partial r}{\partial\tau_i}\Big) + \lambda^*\frac{\partial r}{\partial\tau_i}\Big]}{\lambda^*\Big(1+\frac{\partial r}{\partial\tau_i}\Big)}$$

[13] All functions involved in this proof are evaluated at the efficient solution (τ^*, z^*) and the resulting interest rate. Therefore, for ease of notation, the arguments in the functions are mostly suppressed in this proof.

$$\text{(A3)} \qquad = \frac{-\left(1+\frac{\partial r}{\partial \tau_i}\right)\left(1+n\frac{\partial r}{\partial \tau_i}\right)+\lambda^*\left[2+(n+1)\frac{\partial r}{\partial \tau_i}\right]}{\lambda^*\left(1+\frac{\partial r}{\partial \tau_i}\right)}.$$

From $\lambda^* > 0$ and $1 + \partial r/\partial \tau_i > 0$, it follows that $\sum_j \partial \vartheta_j/\partial \tau_i > 0$ if and only if the numerator in (A3) is positive. In a symmetric situation we have from (1): $1+n(\partial r/\partial \tau_i) = s'/(s' - n\varphi') > 0$. Since $\partial r/\partial \tau_i < 0$, it follows that $\sum_j \partial \vartheta_j/\partial \tau_i > 0$ is true if

$$\text{(A4)} \qquad \lambda^*\left[2+(n+1)\frac{\partial r}{\partial \tau_i}\right] > 1+n\frac{\partial r}{\partial \tau_i}.$$

Now from $\varphi' < 0$ and $1 + n(\partial r/\partial \tau_i) > 0$, it follows that $\lambda^* > 1$. Moreover, from (1), $2 + (n + 1)(\partial r/\partial \tau_i) = [2s' + (1 - n)\varphi']/(s' - n\varphi') > 0$, where the sign follows from $\varphi' < 0$ and $n > 1$. Thus, the left-hand side of (A4) is larger than $2 + (n + 1)(\partial r/\partial \tau_i)$. Therefore, (A4) is true if $2 + (n + 1)(\partial r/\partial \tau_i) > 1 + n(\partial r/\partial \tau_i)$, i.e., if $1 + \partial r/\partial \tau_i > 0$. From (1), this is satisfied, so that $\sum_j \partial \vartheta_j/\partial \tau_i > 0$ is proved. *Q.E.D.*

A.2 Data Sources and Definitions

The basic data set consists of annual data for Germany in the period 1970 until 2003. The population and GDP data are obtained from the Federal Statistical Office (*Statistisches Bundesamt*). The same applies to average collection rates, standardized business tax revenues (*Gewerbesteuergrundbetrag*), and state tax revenues, as well as to the data on debt service. Business tax revenue-sharing contributions (*Gewerbesteuerumlagesätze*) are obtained from the Federal Ministry of Finance (*Bundesministerium der Finanzen*).

Average collection rates of the business tax (*Gewerbesteuer*) are averages of the municipalities' collection rates (*Hebesätze*) for the years (*Rechnungsjahre*) 1970–2003, weighted by the tax base. *State net equalization revenue, marginal contribution rates*, and *relative fiscal capacity* are obtained from a full implementation of the fiscal equalization law and further relevant statutory definitions for each year in the period 1970–2003 (a description of the system is available upon request). Federal fiscal equalization rules (*Finanzausgleichsgesetz* – FAG) are obtained from the *Bundesgesetzblatt*. Data for calculating fiscal capacity (*Finanzkraftmesszahl*) and fiscal need (*Ausgleichsmesszahl*) are taken from the annual enactments to implement the fiscal equalization law (*Zweite Verordnung zur Durchführung des Gesetzes über den Finanzausgleich zwischen Bund und Ländern in den Ausgleichsjahren 1970–2002*). These enactments are also obtained from the *Bundesgesetzblatt*. *Relative fiscal capacity* is defined as the ratio of fiscal capacity to fiscal need. *Debt service* is defined as annual interest expenses net of interest income. *Election years* for state and local elections are obtained from the *Friedrich-Naumann-Stiftung* (*Archiv des Liberalismus*).

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