How Do Local Governments Decide on Public Policy in Fiscal Federalism? Tax vs. Expenditure Optimization[*]

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Abstract

Previous literature widely assumes that taxes are optimized in local public finance while expenditures adjust residually. This paper endogenizes the choice of the optimization variable. In particular, it analyzes how federal policy toward local governments influences the way local governments decide on public policy. Unlike the presumption, the paper shows that local governments may choose to optimize over expenditures. The result most notably prevails when federal policy subsidizes local fiscal effort. The results offer a new perspective of the efficiency implications of federal policy toward local governments and, thereby, enable a more precise characterization of local government behavior in fiscal federalism.

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1 Introduction

Models of local public finance predominantly take taxes as being optimized while expenditures are residually determined via the budget constraint. The view is one possible prescription of how governments decide on fiscal policy. In making budgetary decisions, governments may equally set expenditures optimally and let taxes adjust residually.[1] Given the two options, a natural question is why governments should prefer one or the other budgetary item as a policy variable. A potential strategic motive is that each item differently influences the amount of federal resources which flow to the jurisdiction. Incentives to attract federal transfers, either intended or unintended by federal policy, are widespread in local public finance. Besides responding to corrective grants to cash in on federal resources, local governments also adjust their taxes in order to receive more formulaic equalizing transfer payments (Smart, 1998, Buettner, 2006, and Egger et al., 2007). Similarly, local governments may well select inefficient local policies to lure more discretionary federal transfers to the local budget, e.g., as part of a bailout package (Wildasin, 1997, Qian and Roland, 1998, and Pettersson-Lidbom, 2008). Building on these insights, the goal of this paper is to analyze whether federal policy has a bearing on the choice of the policy variable in local public finance. That is, we set up a model where the choice of the policy variable is not imposed, but arises endogenously from the fundamentals of the fiscal architecture of the federation. In so doing, we consider two models of fiscal federalism: a model of formula-based equalization and a model of ex-post federal policy. In either model local governments levy a tax on local residents and use the proceeds along with federal transfers to provide a public good.

A presumption might be that expenditure and tax optimization yield identical policy outcomes since taxes and expenditures are inherently related via the budget constraint. This presumption holds true when local economies are fiscally independent, i.e., when there exists no fiscal interaction between policy choices by different local governments. The bias towards tax optimization in the existing literature is innocuous in such a fiscal environment. We show that the equivalence between tax and expenditure policy becomes invalid if local policies are linked via transfer programmes. Key to the result is that tax and expenditure policy have different effects on transfer payments and local governments thus strategically choose their

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[1]Throughout the paper we interchangeably refer to tax (expenditure) optimization as tax (expenditure) policy and to the optimization variable as policy variable.

policy variable in order to gain in transfers. To illustrate the incentives involved in the equilibrium choice of policy variables, consider a two-state federation in which interstate transfers are only conditioned on state taxes, and a rise in one state's tax rate lowers transfer income in the tax-raising state and lures additional transfers to the neighboring state. Were taxes optimized by the neighboring state, public expenditures would adjust residually to the rise in transfer income with no consequences for interstate transfers. With expenditure optimization, however, taxes decrease residually and this response lures more transfers to the neighboring state, financed by a cutback of transfers to the tax-raising state. Given the negative fiscal repercussion, the cost of raising taxes turns out to be higher when the neighboring state sets expenditures instead of taxes.

Playing on this effect, state governments strategically influence the neighbor state's cost of taxation by its own choice of policy variable. To see the equilibrium implications, assume that both states initially optimize over taxes and that one state (let's say state 1) considers deviating to expenditure optimization. The deviation increases the cost of public good provision in state 2 which induces the state to decrease its tax rate. The fiscal adjustment lures more transfers to state 2, financed by a cutback in transfers to state 1. The transfer retrenchment eliminates any incentive to deviate and, in equilibrium, governments set taxes optimally and let expenditures adjust residually. A reversed type of reasoning applies when the transfer scheme exerts a positive incentive effect on state policy.[2] A deviation to expenditure setting lures more transfers to the deviant state's budget, and states choose to optimize over expenditures in equilibrium.

A straightforward question relates to the sensitivity of the results to the channel through which state policy interacts. To infer into it, we consider a different model of fiscal federalism frequently invoked in the literature. In particular, we allow states to "see through" the federal tax policy decision which opens up a second source of fiscal interaction.[3] State policy not only affects the amount of transfers, but also influences the amount of taxes state residents pay to the federal government. In this setting, the divergent interaction of tax and expenditure policy implies that states may not optimize over taxes even though transfers discourage state

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[2]For instance, transfer schemes which equalize fiscal capacities are one type of transfers which exert a positive incentive effect – e.g. Smart (1998). Transfer schemes which build on the notion of fiscal capacity equalization are implemented in, e.g., Australia, Canada, Germany and Switzerland.

[3]The type of "seeing through" delineates a game of decentralized leadership – see, e.g., Wildasin (1997), Qian and Roland (1998), Caplan et al. (2000), Akai and Sato (2005) and Koethenbuerger (2007).

fiscal effort. More precisely, provided the disincentive effect of transfers policy is sufficiently pronounced, the equilibrium choices turn out to be asymmetric in the sense that one state chooses to optimize over taxes, whilst the other state optimizes over expenditures.

The analysis allows for a more informed prediction as to the efficiency of pubic good provision in fiscal federalism. For instance, when transfers encourage local taxation, the prediction of both models considered is that state governments optimize over expenditures. Public good provision is more severely downward distorted than when taxes are optimized (as widely assumed in the literature). However, when transfers undermine taxing incentives, the efficiency prediction as perceived in the literature turns out to be consistent with the equilibrium choice in the first model considered in the paper. With ex-post federal tax policy, the equilibrium only entails tax policy setting if the disincentive effect of transfer policy is not too pronounced. Otherwise, one state sets expenditures and public good provision is higher (either less underprovision or more-severe overprovision) relative to the widely held conjecture in the literature.

The results are of relevance for the design of corrective policy. The prediction as to the magnitude and even as to the sign of the inefficiency generically differs in models with (exogenous) tax optimization and with an endogenous selection of policy variables, and so does the appropriate matching component of the Pigouvian grant. Also, the analysis offers a more nuanced perspective of the effects of federal policy on local public finance. For instance, a reform of the federal transfer formula, which leaves more own-source tax revenues to local governments, may not necessarily promote local spending incentives. Fixing the initial choice of policy variables, public expenditures will indeed rise in response to the reform. However, phasing in the endogeneity of the policy variables, the fiscal response may entail a reduction in local public spending.

While the notion that expenditure and tax policy have different implications for local public finance is well established in the literature, it lacks (to the best of our knowledge) an analysis of when local governments opt for one or the other type of policy setting. In particular, Wildasin (1988) and Bayindir-Upmann (1998) contrast expenditure and tax policy in the presence of capital mobility among jurisdictions. Hindriks (1999) compares transfer and tax competition when households are mobile. The papers do not endogenize the choice of policy instruments over which local governments compete in fiscal competition. More related to the present paper, Akai and Sato (2005) contrast expenditure and tax policy setting in

a two-tier federal system in which the federal government provides transfers ex-post. The choice of the optimization variable is exogenous to the analysis.

Although this paper formally abstracts from tax base mobility, it is helpful in predicting which policy scenario can be sustained as an equilibrium choice in models with tax base mobility. For instance, applying the methodology of the paper to the setting in Wildasin (1988), in which capital mobility is the only fiscal linkage between states, reveals that competition over taxes is the equilibrium choice. The result is supportive for almost all papers on capital tax competition to date which assume that states compete over taxes and expenditures adjust residually.

Finally, the choice of optimization variable determines with which policy variable state governments commit toward other states' fiscal policy.[4] The endogenous choice of commitment relates the paper to the Industrial Organization literature on endogenous timing of moves, and hence commitment, in models of firm competition (e.g., Van Damme and Hurkens, 1999, and Caruana and Einav, 2008). Therein, the sequence of decisions is determined endogenously, while the choice of optimization variables is exogenous. In this paper it is reversed: the sequence of moves is exogenous while the choice of optimization variables (for state governments) is endogenous.[5]

The outline of the paper is as follows. Section 2 introduces a model of formula-based equalization and Section 3 characterizes the choice of the optimization variable. Section 4 extends the basic model by allowing for ex-post federal tax policy, i.e. local governments have the capacity to "see through" the federal choice of taxes, and characterizes the selection of policy variables. Section 5 summarizes and concludes.

2   Model

Consider two states which may differ with respect to preferences and endowments. The representative household in state i ($i = 1, 2$) derives utility from private and public consumption, c^i and g^i, according to the utility function $U^i(c, g) = u^i(c) + u^i(g)$ where $u^i_k > 0$ and $u^i_{kk} < 0$,

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[4]Optimizing over, e.g., the tax rate implies that other states perceive the tax rate to be held fixed, and thus to be pre-committed, when they choose their policy simultaneously.

[5]Note, the two types of commitment, i.e. the sequencing of moves and the choice of optimization variables, are not equivalent. The former relates to sequential games while the latter already exists in simultaneous move games. Also, with the former type it is the best response of players which determines the value of commitment. With the latter it is the residual variation of fiscal variables (determined by the budget constraint rather than first-order conditions) which is primarily decisive for the choice of the commitment strategy.

$k = c, g$.[6,7] Households have an endowment I^i which is subject to taxation. The private budget constraint is

$$c^i = I^i - T^i, \tag{1}$$

where $T^i \in [0, I^i]$ are taxes levied by state government i. State governments finance public expenditures $\{g^i\}_{i=1,2}$ by locally collected taxes $\{T^i\}_{i=1,2}$ and interstate transfers $\{z^i\}_{i=1,2}$

$$g^i = T^i + z^i. \tag{2}$$

The transfer to state i, z^i, is conditioned on the level of locally collected tax revenues T^i and tax revenues of the neighbor jurisdiction T^j,

$$z^i = \gamma(T^i, T^j), \quad \text{where } z^i + z^j = 0. \tag{3}$$

Given the generality of the transfer formula, we impose three reasonable assumptions:

$$\left| z^i_{T^i} \right| < 1, \qquad \text{sign}\{z^i_{T^i}\} = \text{sign}\{z^j_{T^j}\}, \qquad \text{and} \qquad \text{sign}\{z^i_{T^i}\} = const.$$

First, $\left| z^i_{T^i} \right| < 1$ such that changes in taxes do not imply an over-proportional change in transfers.[8] The marginal tax or subsidy on own-source tax revenues hence does not exceed 100 percent. Second, states are symmetrically treated by transfer policy in the sense that $\text{sign}\{z^i_{T^i}\} = \text{sign}\{z^j_{T^j}\}$. The transfer formula may still be non-linear in taxes and, thereby, the slope $\{z^i_{T^i}\}_{i=1,2}$ may differ in magnitude over the range of feasible taxes. Third, $\text{sign}\{z^i_{T^i}\}$ is non-reversal, i.e., it is the same for all feasible levels of taxes.

The transfer scheme (3) embeds different types of formulaic transfers which most notably differ w.r.t. the sign of the transfer response $z^i_{T^i}$. As an example, transfers which share locally collected tax revenues across states typically respond negatively to a rise in own-source tax revenues (e.g., Baretti et al., 2002), whilst fiscal capacity equalization transfers rise in response to a hike in own-state tax rates (Smart, 1998).[9]

State governments are benevolent and maximize utility of the representative household, while the federal government maximizes the sum of utilities.

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[6]Additive preferences are without loss of generality in Section 3. In Section 4 the identified equilibria extend to non-additive preferences when private and public consumption are complements ($U^i_{cg} < 0$) or weak substitutes, i.e. U^i_{cg} is not too positive.

[7]As long as confusion cannot arise we omit the state-specific superscript for consumption levels.

[8]Subscripts denote partial derivatives throughout.

[9]To firmly model fiscal capacity equalization transfers we would have to introduce a tax-sensitive tax base. One possibility is to allow for endogenous labor supply which negatively responds to higher state taxes on labor – e.g. Smart (1998). The extension would complicate the exposition of the paper, without affecting the main results of the analysis.

Straightforwardly, the (first-best) efficient public expenditure level in state i satisfies

$$\frac{u_g^i}{u_c^i} = 1. \tag{4}$$

The marginal rate of substitution between public and private consumption has to equal the social marginal rate of transformation (normalized at unity).

Unless otherwise stated, the sequence of fiscal decisions is:

Stage 1: States simultaneously choose whether to optimize over taxes or expenditures.

Stage 2: States simultaneously optimize over the policy variable chosen at the first stage.

Stage 3: Transfers $\{z^i\}_{i=1,2}$ are paid, taxes $\{T^i\}_{i=1,2}$ are collected, and households consume $\{c^i, g^i\}_{i=1,2}$.

We refer to the three stages as a policy selection game and we solve for a subgame-perfect equilibrium (in pure strategies) by applying backward induction.

3   Equilibrium Analysis

To isolate the incentive effects inherent to federal policy, it is instructive to first characterize local decision-making in the absence of transfers, i.e. $z^i \equiv 0$. In this case changes in taxes yield a one-to-one change in expenditure levels. The tax price of marginal public spending is unity irrespectively of whether the change in taxes is fixed and expenditures adjust residually or vice versa. Thus, solving

$$\max \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (1) \text{ and } (2) \tag{5}$$

either by differentiating w.r.t. T^i (with g^i being residually determined) or w.r.t. g^i (with T^i being residually determined) yields the first-order condition

$$\frac{u_g^i}{u_c^i} = 1. \tag{6}$$

Public goods are efficiently provided. Noting (1), (2), and (6), optimal state policy is independent of the neighbor state's policy and so is utility in each state. The implications for the equilibrium choice of policy variables at stage 1 of the game are straightforward. Given the absence of fiscal interaction between states and the equivalence between tax and expenditure

optimization within a state, we conclude that any choice of policy variable yields the same level of state utility and, hence, is an equilibrium of the policy selection game.

Proposition 1: *In the absence of transfers* $(z^i \equiv 0)$ *any pair of policy variables selected by state governments is a subgame-perfect equilibrium of the policy selection game.*

We now re-introduce federal transfer policy and analyze the extent to which the equivalence result in Proposition 1 is preserved. Consider first that state government j optimizes over taxes T^j. Optimal policy in state i follows from

$$\max \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (1), (2) \text{ and } (3), \tag{7}$$

taking T^j as given.[10] Differentiating w.r.t. T^i or g^i gives

$$\frac{u_g^i}{u_c^i} = \frac{1}{1 + z_{T^i}^i}. \tag{8}$$

The equivalence between tax and expenditure policy is formally shown in the Appendix. When $z_{T^i}^i < 0 \ (> 0)$ state i anticipates a loss (gain) in transfers in response to a rise in taxes with the consequence that public goods are underprovided (overprovided) relative to the first-best solution (4).

When state j optimizes over expenditures, its taxes adjust residually to a change in transfer income which in turn affects state i's transfer payment. State i realizes the fiscal feedback mediated via the transfer system and, hence, perceives transfer income to be implicitly given by

$$z^{i*} = \gamma(T^i, g^j - z^{j*}), \tag{9}$$

which follows from inserting (2) into (3), to substitute T^j by $g^j - z^{j*}$. State i solves

$$\max \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (1), (2) \text{ and } (9), \tag{10}$$

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[10]Concretely, state i perceives the policy variable T^j as given ($T^j = \overline{T}^j$), but not public consumption in state j. State i anticipates how g^j is influenced by the flow of transfers in response to its policy choice; i.e. $g^j = \overline{T}^j + z^j(\overline{T}^j, T^i)$. The other stage-2 optimization problems are analogous in structure. Note, in the absence of transfers (as in (5)) $g^j = \overline{T}^j$ and state i's conjecture concerning the tax rate in state j pins down state j's expenditure level.

taking g^j as given. Differentiating w.r.t. T^i or g^i, the optimal policy satisfies (see the Appendix)

$$\frac{u_g^i}{u_c^i} = \frac{1}{1 + z_{T^i}^{i*}}. \tag{11}$$

Straightforwardly, public consumption is underprovided (overprovided) relative to the first-best rule when $z_{T^i}^{i*} < 0$ (> 0).

Comparing (8) and (11) reveals that state i's policy is inefficient for any choice of optimization variable by the neighboring state, but the scope of inefficiency depends on which variable the neighboring state optimizes. Implicitly differentiating (9) and using the self-financing requirement $z_{T^j}^i = -z_{T^j}^j$ yields

$$z_{T^i}^{i*} = \frac{z_{T^i}^i}{1 + z_{T^j}^j} \quad \Rightarrow \quad z_{T^i}^{i*} < z_{T^i}^i. \tag{12}$$

The tax-induced change in transfers is more favorable for state i (either more inflow or less outflow) when state j optimizes over taxes.[11] The rationale is that tax and expenditure policy interact differently through the transfer scheme. More precisely, assume higher taxes reduce entitlement payments, $z_{T^i}^i < 0$. A rise in state i's taxes reduces transfers to state i and, in order to balance the budget, increases transfers to state j. When state j optimizes over taxes, the additional transfer income increases public expenditures in state j. Transfer payments are unaffected by the residual adjustment. Differently, when state j optimizes over expenditures, the rise in transfer income reduces state i taxes. In response, more transfers go to state j, financed by a further cutback of transfers to state i – hence (12) follows. The negative repercussion on state i's budget renders public good provision more costly. Analogously, when $z_{T^i}^i > 0$ a higher tax in state i decreases state j's transfer income. When state j optimizes over expenditures, state j's taxes rise residually which yields a budget-balancing retrenchment of state i's transfer income. The retrenchment dilutes state i's incentives to spend on public consumption. We can thus summarize:

Lemma 1: *State i's incentives to provide public goods are less pronounced when state j optimizes over expenditures rather than taxes. In particular, provided $z_{T^i}^i < 0$ (> 0) public*

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[11]Thus, in case $z_{T^i}^i < 0$ the first-order condition (11) only holds provided $z_{T^i}^i$ is not too negative. Otherwise, state i will select a zero tax rate. To save on notation we abstract from corner solution in what follows.

goods are more severely underprovided (less severely overprovided) in state i when public expenditures rather than taxes are subject to optimization in state j.

We will now turn to the subgame-perfect choice of the optimization variable at stage 1 of the game. This involves a comparison of stage-2 utilities for any possible combination of optimization variables by both states. Utility in the different stage-2 games may differ because the tax price in the neighboring state depends on the own choice of policy variable. States understand the effect and are inclined to manipulate the neighbor state's policy in order to qualify for more transfers. Before proceeding, note that in any stage-2 subgame, the states' best responses are implicitly defined by the first-order conditions (8) and (11), respectively. Equilibrium existence follows from standard fixed point theorems. We assume uniqueness and stability of the stage-2 equilibrium throughout.[12] Equilibrium stability implies that a change in a state's tax price translates into a change in the stage-2 equilibrium tax to the opposite sign; an implication which simplifies the analytical exposition in what follows.

We will first analyze the case of $z^i_{T^i} < 0$. Consider both states initially optimize over taxes. When state i deviates from tax to expenditure optimization, state i's public good level, and thus taxes, stay the same unless state j changes its policy in response.[13] In fact, state j faces a distinct interaction of policy variables via the transfer scheme when state i optimizes over g^i rather than T^i. As observed in connection with Lemma 1, the tax price of marginal public expenditures rises and T^j will be set at a lower level in the ensuing equilibrium. To infer the induced change in state i's well-being, we compute state i's utility when it optimally sets its policy for given state j's policy. To this end, let's define $v^i(T^j)$ as the utility evaluated at taxes T^i satisfying the optimality condition (8) for given T^j.[14] Invoking the envelope theorem and rearranging (all these steps are relegated to the Appendix), the change in utility $v^i(T^j)$ in response to a hike in state j's taxes is

$$\frac{dv^i(T^j)}{dT^j} = -u^i_g z^j_{T^j}. \tag{13}$$

Since T^j drops following the deviation, state i experiences a loss in transfers and thereby
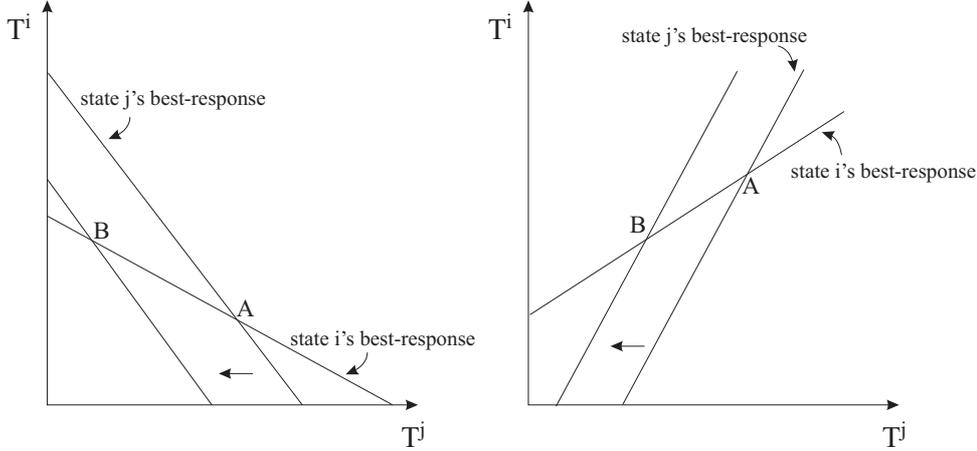

Figure 1: Best Responses for $z_{T^i}^i < 0$ (left panel) and $z_{T^i}^i > 0$ (right panel).

in utility. By symmetry of policy incentives, neither state has an incentive to switch to expenditure optimization given that the neighbor state optimizes over taxes. A reversed type of argument applies when $z_{T^j}^j > 0$ with the consequence that state i's utility increases when setting expenditures rather than taxes.

To graphically illustrate state i's best response at stage 1, consider $z_{T^i T^j}^i \equiv 0$. In this case it is straightforward to show that states' taxes are unambiguously strategic substitutes (complements) if $z_{T^i}^i < 0$ (> 0). The left panel in Figure 1 depicts the best responses by both states when $z_{T^i}^i < 0$. Point A is the initially prevailing equilibrium of the stage-2 game.[15] The switch to expenditure policy by state i shifts state j's best-response function inwards. The locus of state i's best-response function stays the same (implicitly defined by (8)), and the new tax choices are illustrated by point B. From (13), the change in state i's utility, when moving along state i's best-response function from A to B, is negative. Hence, state i becomes worse off due to the deviation. The right panel in Figure 1 depicts both states' best responses for $z_{T^i}^i > 0$. The initial equilibrium of the stage-2 subgame is point A. Following state i's deviation to expenditure policy state j's tax price rises, and state j's best-response function shifts inwards. Taxes T^j decrease (see point B). Following (13), state i's utility rises when moving along state i's best response from the initial equilibrium A to the new equilibrium B. In sum:

Lemma 2: *Assume that state j optimizes over taxes. State i's best response is to optimize over taxes (expenditures) iff $z_{T^i}^i < 0$ (> 0).*

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[15]For simplicity, best responses are drawn as linear functions.

Suppose now that state j initially optimizes over g^j and state i over T^i. From Lemma 1 we observe that a deviation to expenditure optimization by state i increases state j's tax price which incentivizes state j to spend less on public consumption. Defining $v^i(g^j)$ as state i's utility evaluated at public policy which satisfies the optimality condition (11), the envelope theorem implies (see the Appendix)

$$\frac{dv^i(g^j)}{dg^j} = -u_g^i \frac{z_{T^j}^j}{1 + z_{T^j}^j}. \tag{14}$$

As the drop in state j's expenditures translates into a lower tax, state i's transfer income and thus utility drops (rises) in response to the lower tax in state j when $z_{T^j}^j < 0 \ (> 0)$.[16]

Lemma 3: *Assume that state j optimizes over expenditures. State i's best response is to optimize over taxes (expenditures) iff $z_{T^i}^i < 0 \ (> 0)$.*

Combining Lemma 2 and 3, we conclude for the case $z_{T^i}^i < 0$ that state i loses in utility when optimizing over expenditures instead of taxes. The result holds irrespective of whether state j optimizes over taxes or expenditures. Hence, in the subgame perfect equilibrium of the policy selection game both states optimize over taxes. When $z_{T^j}^j > 0$ state i gains in utility when optimizing over expenditures rather than taxes. Again, the finding holds irrespective of whether state j optimizes over taxes or expenditures. Consequently, the subgame perfect equilibrium of the policy selection game entails states to optimize over expenditures.

Proposition 2: *The subgame perfect equilibrium of the policy selection game entails tax (expenditure) optimization when transfers undermine (strengthen) state fiscal incentives, i.e., $z_{T^i}^i < 0 \ (> 0)$.*

States compete for transfers and choose the optimization variable strategically so as to lure more funds to the public budget. Although the results have been derived in the absence of resource mobility, the logic underlying the results equally applies when states do not compete for transfers, but for mobile resources. To be more precise, consider a model of symmetric

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[16]The diagrammatic exposition of the choice of policy variables is analogous to Figure 1. We hence refrain from a graphical illustration (as we do for all other games analyzed in the sequel).

capital tax competition in which states tax capital at source and decide on the tax system to attract more capital (Zodrow and Mieszkowski, 1986, and Wildasin, 1988). Therein, the interstate flow of resources is in capital rather than in transfers, and the formal analog to the tax-induced flow of transfers, $z^i_{T^i}$, is how the capital tax base responds to own-state tax hikes. As governments spend tax revenues on a public consumption good, which in itself has no bearing on the return to capital, the tax base response is negative. The conclusion is that states choose to compete for mobile capital by optimizing over taxes.[17] A formal proof of the result is relegated to Appendix B.

4 Ex-Post Federal Tax Policy and Formula-Based Transfers

In the sequel we analyze the robustness of the results derived in the last section. In so doing, we resort to an alternative, frequently invoked model of fiscal federalism in which the federal government has taxing authority, but cannot commit to tax policy, i.e., it sets federal policy after states have determined their policy. This type of vertical interaction is referred to as decentralized leadership and lies at the root of the soft budget constraint syndrome in fiscal federalism – see, e.g., Wildasin (1997), Qian and Roland (1998), Caplan et al. (2000), Akai and Sato (2005) and Koethenbuerger (2007).[18] In particular, consider the federal government has access to taxes $\{t^i\}_{i=1,2}$.[19] The budget constraint of the household in state i becomes

$$c^i = I^i - T^i - t^i. \tag{15}$$

For simplicity, we retain the assumption that transfers are budget-balancing, $z^i + z^j = 0$. The federal budget constraints thus read

$$t^1 + t^2 = 0 \quad \text{and} \quad z^1 + z^2 = 0. \tag{16}$$

Federal taxes redistribute private income across states, while transfers redistribute public funds across states. The budgetary dichotomy simplifies the analysis without affecting the

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[17]In particular, when both states initially optimize over taxes, a deviation to expenditure optimization by one state leads to lower capital taxes in the neighboring state and, thereby, to an outflow of capital in the deviant state. Anticipating the negative effect on own-state revenues, states choose to compete over taxes.

[18]See Kornai et al. (2003) and Vigneault (2007) for a review of the related literature.

[19]A non-uniform tax scheme can be implemented by a uniform federal tax scheme and state-specific subsidies to address disparities in private consumption. Thus, the net tax revenue the federal government collects in each state differs (as allowed for here). With the richer set of instruments, we could allow the federal government to pre-commit toward the common tax scheme and to set subsidies ex-post, i.e., after state governments have moved (as in, e.g., Caplan et al., 2000). Importantly, the results of the analysis would be preserved.

qualitative insights.[20]

The sequence of decisions becomes:

Stage 1: States simultaneously choose whether to optimize over taxes or expenditures.

Stage 2: States simultaneously optimize over the policy variable chosen at the first stage.

Stage 3: The federal government selects $\{t^i\}_{i=1,2}$ for given state policy.

Stage 4: Transfers $\{z^i\}_{i=1,2}$ are paid, taxes $\{t^i, T^i\}_{i=1,2}$ are collected, and households consume $\{c^i, g^i\}_{i=1,2}$.

Solving backwards, the federal government solves

$$\max_{\{t^i\}_{i=1,2}} \sum_{i=1,2} u^i(c,g) \quad \text{s.t.} \quad \text{Eqs. } (2),(3),(15) \text{ and } (16), \tag{17}$$

taking the states' policy choices as given. In so doing, the federal government sets taxes in order to equalize the marginal utility of private consumption, i.e.

$$u_c^i = u_c^j, \quad i \neq j. \tag{18}$$

At stage 2, state government i anticipates the effect its policy has on the federal government's choice of tax rates. Assume first that both states optimize over taxes. Differentiating the federal first-order condition (18) and the federal budget constraint w.r.t. t^i, t^j, and T^i and inserting $-T_{t^i}^i = T_{t^j}^i$ in the differentiated first-order condition, to eliminate the t^j derivative, yields

$$t_{T^i}^i = -\frac{u_{cc}^i}{u_{cc}^i + u_{cc}^j} \in (-1,0). \tag{19}$$

More locally collected tax revenues, T^i, reduce private consumption in state i. To equalize the marginal utility of consumption across states (see (18)), the federal government reduces the federal tax rate t^i.

Replacing (1) by (15) in state i's optimization problem (7) and additionally taking (16) and (19) into account, public good provision satisfies

$$\frac{u_g^i}{u_c^i} = \left(1 - \frac{u_{cc}^i}{u_{cc}^i + u_{cc}^j}\right) \frac{1}{1 + z_{T^i}^i}. \tag{20}$$

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[20]The identified equilibria of the policy selection game equally exist in the absence of the assumption. Details of the calculations are available upon request.

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The first-order condition equally applies when state i optimizes w.r.t. g^i rather than T^i (see the Appendix). Evident from (20), the federal tax-transfer policy influences the perceived tax price of marginal public expenditures in two ways: ex-post federal tax policy provides a subsidy on state i's taxing effort as depicted by the bracketed term, while the transfer scheme imposes a tax (subsidy) on state i's taxing effort when $z^i_{T^i} < 0$ (> 0). Federal tax-transfer policy hence renders public good provision inefficiently high or low.

Differently, consider state i still optimizes w.r.t. T^i, but conjectures state j to set expenditure levels optimally. Starting at (18), iterating the same steps involved in deriving (19) (now differentiating w.r.t. g^j rather than T^j) and noting (9), the marginal adjustment in t^i following a rise in T^i is

$$t^i_{T^i} = -\frac{u^i_{cc}}{u^i_{cc} + u^j_{cc}} - \frac{u^j_{cc} z^{j*}_{T^i}}{u^i_{cc} + u^j_{cc}}. \tag{21}$$

The first term coincides with (19); representing a subsidy on state i's marginal tax revenues. As to the second term, z^{j*} denotes transfer payments for state j when state i conjectures state j to optimize over expenditures as defined in (9). A rise in state i's taxes translates into a change in entitlement payments which depends on the sign of $z^{j*}_{T^i}$. As state j's taxes adjust residually to the change in transfers, its private consumption rises (drops) when $z^{j*}_{T^i} > 0$ (< 0). To restore (18), the federal government offsets the imbalance in private consumption by reducing (increasing) t^i.

Substituting (1) by (15) in state i's optimization problem (10) and additionally taking (16) and (21) into account, state i chooses a level of public goods which satisfies

$$\frac{u^i_g}{u^i_c} = 1 - \frac{u^i_{cc}}{u^i_{cc} + u^j_{cc}}. \tag{22}$$

The first-order condition holds irrespectively of whether state i optimizes over taxes or expenditures (see the Appendix). It might be intuitive that state i chooses an inefficient policy in the pursuit of a favorable treatment under federal policy. What might be less intuitive is that the tax price of public expenditures is independent of how federal transfers respond to state policy and, thus, that the inefficiency is only related to the federal tax response. The rationale is that the adjustment in federal taxes insulates state governments from the incentive effects of transfers; albeit the federal government aligns the marginal utility of private consumption which is not directly affected by transfer payments. However, when a rise in state i's tax, for instance, lowers state i's entitlement payments, the induced inflow of

transfers in state j reduces the amount of taxes state j levies on its residents. Private consumption in state j consequently rises and the federal government offsets the imbalance in private consumption across states by lowering state i's tax as captured by the second term in (21). The positive effect on state i's utility turns out to be proportional to the negative effect of transfers, thereby nullifying the latter. In sum, ex-post federal tax policy neutralizes the incentive effect of transfer policy and subsidizes state-financed spending. Consequently, the state i's tax price is unambiguously below the social price.

Lemma 4: *Public good provision in state i is either inefficiently high or low under tax policy setting by state j. When state j sets expenditures public good provision in state i is inefficiently high. In particular, provided $z^i_{T^i} < 0 \, (> 0)$ state i's incentives to spend on public goods are more pronounced (weaker) when state j optimizes over expenditures instead of taxes.*

The divergence of policy incentives is due to the fact that state policy instruments interact differently through federal tax-transfer policy. To illustrate the interaction, suppose a higher tax rate in state i leads to more transfers in state j, i.e. $z^i_{T^i} < 0$. Under tax policy setting by state j, the residual adjustment in public expenditures does not spill back through federal tax-transfer policy to state i. Transfers are formally conditioned only on taxes and federal tax policy seeks to align private consumption levels. In contrast, when state j sets expenditures, the higher transfer income lowers state j's tax rate (residually determined). Private consumption c^j rises which yields a lower federal tax rate in state i – a repercussion which strengthens state i's fiscal incentives.[21]

To infer how federal tax-transfer policy influences the choice of the optimization variable at stage 1 of the game, we proceed by characterizing incentives of each state to unilaterally deviate from a given combination of policy variables. As in the previous section, we will assume the stage-2 equilibrium to be unique and stable throughout. Assume first that states initially optimize over taxes and that transfers undermine taxing incentives ($z^i_{T^i} < 0$). As inferred from Lemma 1, a change to expenditure policy on the part of state i reduces state j's tax price, and the new equilibrium entails a higher tax T^j. The impact on state i's utility is evaluated using state i's best-response function as implied by the first-order condition (20). Define $v^i(T^j)$ as the associated utility level for a given level of T^j. Applying the envelope

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theorem, deriving the tax-transfer responses and rearranging (all the steps are relegated to the Appendix), we get

$$\frac{dv^i(T^j)}{dT^j} = -u_c^i \frac{1 + z_{T^i}^i + z_{T^j}^j}{1 + z_{T^i}^i} \frac{u_{cc}^j}{u_{cc}^i + u_{cc}^j}. \tag{23}$$

Provided $z_{T^i}^i + z_{T^j}^j < -1$ ($\in (-1, 0)$), utility rises (drops) following state i's change in the optimization variable.[22] The intuition is that both the federal tax t^i and the transfer payment z^i rise in response to state j's tax hike, exerting counteracting effects on state i's utility. The disincentive effect of transfer policy amplifies the positive transfer response in two ways: First, the stronger the disincentive effect $z_{T^j}^j$ the larger the inflow of transfers to state i in response to a higher tax rate T^j. Second, the more pronounced $z_{T^i}^i$ the higher the inflow of transfers to state i which results from the residual reduction in its own tax rate subsequent to the first-round inflow of transfers. If the joint effect is sufficiently strong (as measured by $z_{T^i}^i + z_{T^j}^j$) the positive transfer response dominates the rise in federal taxes t^i.

The result changes when transfers promote taxing incentives ($z_{T^i}^i > 0$). In this case, state j decreases its tax rate in response to state i's deviation from tax to expenditure optimization which exerts two unidirectional effects on state i's utility: the federal tax t^i decreases, to level off differences in private consumption, and transfers increase. In response, state i unambiguously enjoys a higher level of utility in the new equilibrium.

Lemma 5: *Consider state j optimizes over taxes. State i has an incentive to deviate from tax to expenditure policy if either $z_{T^i}^i > 0$ or $z_{T^i}^i < 0$ and $z_{T^i}^i + z_{T^j}^j < -1$.*

Finally, assume state j optimizes over expenditures. Provided transfers discourage state fiscal effort, a switch to expenditure optimization by state i increases expenditures, and thus taxes, in state j. To unravel the impact on state i's utility, define $v^i(g^j)$ as state i's utility evaluated at state i's best-response function which follows from (22). Invoking the envelope theorem, computing the responses in transfers and federal taxes, and rearranging yields (the derivation is dealt with in the Appendix)

$$\frac{dv^i(g^j)}{dg^j} = -u_c^i \frac{u_{cc}^j}{u_{cc}^i + u_{cc}^j} < 0. \tag{24}$$

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[22]For expositional simplicity, we omit the special case $z_{T^i}^i + z_{T^j}^j = -1$, in which $dv^i(T^j)/dT^j = 0$, throughout.

The federal government taxes state i's household at a higher rate in response to the deviation, just to counteract the imbalance in private consumption which results from the higher tax T^j.[23] Accordingly, state i becomes worse off. Following a related line of arguments, state i becomes better off following the deviation when transfers encourage state fiscal effort.

Lemma 6: *Consider state j optimizes over expenditures. State i has an incentive to deviate from tax to expenditure optimization iff $z_{T^i}^i > 0$.*

What are the equilibrium implications of both Lemmata? When $z_{T^i}^i < 0$, Lemma 6 rules out expenditure optimization as an equilibrium since both states have an incentive to deviate. Lemma 5 shows that tax optimization is an equilibrium if transfer responses $z_{T^i}^i + z_{T^j}^j$ are not too pronounced. Otherwise, we observe an asymmetric equilibrium, i.e., one state optimizes over taxes whilst the other state does so over expenditures. When $z_{T^i}^i > 0$ Lemma 5 rules out tax policy as an equilibrium outcome, and the only policy which is immune to a unilateral deviation is expenditure optimization – see Lemma 6. To summarize,

Proposition 3: *(i) When transfer policy undermines state fiscal incentives $(z_{T^i}^i < 0)$ the subgame perfect equilibrium of the policy selection game entails both states to optimize over taxes if the overall disincentive effect of transfer policy, as measured by $z_{T^i}^i + z_{T^j}^j < 0$, is sufficiently weak, i.e., $z_{T^i}^i + z_{T^j}^j \in (-1, 0)$. Otherwise, states choose to optimize over different policy variables in equilibrium. (ii) When transfer policy strengthens state fiscal incentives $(z_{T^i}^i > 0)$ the subgame perfect equilibrium involves both states to optimize over expenditures.*

Common to the analysis in Section 3, states choose their policy variable such that the induced adjustment in fiscal policy of the neighboring state yields a favorable response in federal policy. However, different to the preceding model, tax optimization is not the unique equilibrium outcome when transfers discourage states from relying on own-source public funds. In fact, states select themselves into different policy regimes if the disincentive effect is sufficiently strong.[24]

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[23]Note, the federal tax response absorbs the effect of transfer policy on state i – see (22).

[24]The required strength of the disincentive effect is not implausibly large. Empirical estimates of the "marginal tax" federal transfer programmes impose on own-source tax revenues may well exceed 0.5 (e.g., Baretti et al., 2002, and Zhuravskaya, 2000).

The finding that states may not optimize over the same policy variable opens up the possibility that the tax price of marginal public expenditures drops when transfer policy exerts a stronger disincentive effect on state policy. For illustrative simplicity, assume the transfer system (3) to be linear and $z_{T^i}^i = z_{T^j}^j$. A reform of the transfer formula such that the transfer slope changes from a pre-reform level above -0.5 to a post-reform level below -0.5 leaves fewer own-source tax revenues to the state. Conditional on the initial choice of policy variables (here taxes – see Lemma 6), incentives to spend on public goods are predicted to be diluted (see (20)). Taking the endogeneity of the policy variable into account, one state changes from tax to expenditure policy while the other state still engages in tax policy. Implied by Lemma 4, spending incentives are strengthened in the non-switching state and, as a consequence, its outlays on public consumption rise.

5   Conclusion

Previous literature predominantly assumes taxes to be optimized and expenditures to adjust residually. The paper endogenizes the choice of policy variables by state governments and, in particular, explores how federal policy toward state governments influences the choice. Albeit the equilibrium choice turns out to be sensitive to the way federal tax-transfer policy targets state policy, a common finding in both models considered is that governments choose to optimize over expenditures when federal transfers subsidize state fiscal effort. The paper's results are of relevance for the design of corrective policy and for evaluating the impact of non-Pigouvian federal tax-transfer schemes on the efficiency of state policy. Specifically, the conditional response (i.e., for a given choice of policy variables) and the unconditional response (i.e., accounting for the adjustment of policy variables) of local policy to changes in federal policy differ not only quantitatively, but may also differ qualitatively. A reform of the federal tax-transfer system, which discourages state spending conditional on the choice of policy variable, may in fact promote spending incentives when accounting for the endogeneity of the choice.

The main part of the paper builds on the assumption that state budgets are only fiscally linked through federal policy. In practice, budgets are also fiscally connected through the mobility of taxable resources such as capital or households. As shown for the canonical capital tax competition model (see Appendix B), the logic underlying the results straightforwardly

applies to models with capital mobility. Having said this, we believe that the paper's insights will likewise provide a helpful starting point for analyzing the choice of policy variables in different models of local public finance; e.g., nesting fiscal interaction through both tax base mobility and federal policy.

Finally, a natural question is whether the strategic incentives pertaining to the choice of policy variables may not be more multi-faceted than suggested in the paper. For instance, decomposing the expenditure side of the budget into consumption outlays and infrastructure investment, states are equally in a position to compete for transfers by optimizing over, e.g., consumption expenditures and taxes and by letting infrastructure spending adjust residually. Which pair of policy variables ultimately constitutes an equilibrium choice and how the choice influences the efficiency of the local public sector are interesting questions which are left to future research.

A Appendix

A.1 Derivation of (8)

Tax policy A rise in state i's tax rate dT^i implies a change in transfers by $z^i_{T^i}dT^i$, and public expenditures increase by $dg^i = (1+z^i_{T^i})dT^i$. The tax price of marginal public spending is $dT^i/dg^i = 1/(1 + z^i_{T^i})$. Thus, the first-order condition is (8).

Expenditure policy Inserting (2) into (3), to express transfers to state i as an implicit function of policy variables in state i, g^i, and state j, T^j, we have $\bar{z}^i = \gamma(g^i - \bar{z}^i, T^j)$ with slope $\bar{z}^i_{g^i} = z^i_{T^i}/(1 + z^i_{T^i})$. A rise in expenditure by dg^i now leads to a change in transfers by $\bar{z}^i_{g^i}dg^i$. In response to it, taxes have to increase by $dT^i = (1 - \bar{z}^i_{g^i})dg^i$. Hence, $1 - \bar{z}^i_{g^i}$ is the tax price of marginal public spending under expenditure optimization and the first-order condition is

$$\frac{u^i_g}{u^i_c} = 1 - \bar{z}^i_{g^i}. \tag{25}$$

Inserting the explicit form of the slope term $\bar{z}^i_{g^i}$ into the tax price shows that it coincides with the tax price under tax optimization. The first-order condition (25) is hence equivalent to (8).

A.2 Derivation of (11)

Tax policy   Given (9) a rise in taxes by dT^i yields a change in transfers equal to $z^{i*}_{T^i}dT^i$. Expenditures residually rise by $(1+z^{i*}_{T^i})dT^i$ which gives a tax price of marginal public spending of $1/(1+z^{i*}_{T^i})$. The first-order condition thus becomes (11).

Expenditure policy   Inserting (2) into (3), to express transfers to state i as an implicit function of policy variables in state i and state j, g^i and g^j, we get $\tilde{z}^i = \gamma(g^i - \tilde{z}^i, g^j - \tilde{z}^j)$. Now, a rise in expenditures by dg^i requires an adjustment in taxes at an amount $(1-\tilde{z}^i_{g^i})dT^i$. The tax price is $1 - \tilde{z}^i_{g^i}$ and the first-order condition reads

$$\frac{u^i_g}{u^i_c} = 1 - \tilde{z}^i_{g^i}. \tag{26}$$

Implicit differentiation of $\tilde{z}^i$, while using $\tilde{z}^i_{T^j} = -\tilde{z}^j_{T^j}$, gives $\tilde{z}^i_{g^i} = z^i_{T^i}/(1+z^i_{T^i}+z^j_{T^j})$. Inserting the slope term into (26) and inserting (12) into the first-order condition under tax policy (11) shows that conditions (11) and (26) coincide.

A.3 Derivation of (13)

A rise in T^j when state i sets expenditures yields a change in utility $v^i(T^j)$ of

$$\frac{dv^i(T^j)}{dT^j} = u^i_c z^{i*}_{T^j}, \tag{27}$$

where the term has been simplified by invoking the envelope theorem. Using (12) (re-indexed to state j) to compute $z^{i*}_{T^j} = -z^{j*}_{T^j}$, and, thereafter, inserting the slope term and (8) into (27), the utility change (27) simplifies to

$$\frac{dv^i(T^j)}{dT^j} = -u^i_g z^j_{T^j}. \tag{28}$$

A.4 Derivation of (14)

Marginally increasing g^j when state i optimizes over expenditures implies a change in utility $v^i(g^j)$ which is equal to

$$\frac{dv^i(g^j)}{dg^j} = u^i_c \tilde{z}^i_{g^j}. \tag{29}$$

$\tilde{z}^i = \gamma(g^i - \tilde{z}^i, g^j - \tilde{z}^j)$ implicitly defines transfer payments to state i as a function of expenditure levels in both states. Implicit differentiation and using $\tilde{z}^i_{g^j} = -\tilde{z}^j_{g^j}$ yields

$\tilde{z}^i_{g^i} = z^i_{T^i}/(1 + z^i_{T^i} + z^j_{T^j})$. Inserting the latter expression (re-indexed to state j) and (26) into (29) and noting that transfers are self-financing

$$\frac{dv^i(g^j)}{dg^j} = -u^i_g \frac{z^j_{T^j}}{1 + z^j_{T^j}}. \tag{30}$$

A.5   Derivation of (20)

Tax policy   Increasing the state tax by dT^i, the combined effect on state and federal taxes, $T^i + t^i$, is $(1 + t^i_{T^i})dT^i$. Expenditures change by $(1 + z^i_{T^i})dT^i$ which yields a tax price equal to $(1 + t^i_{T^i})/(1 + z^i_{T^i})$. The first-order condition is (20).

Expenditure policy   As a first step insert (2) into the federal first-order condition (18), to substitute T^i for $g^i - \bar{z}^i$, where $\bar{z}^i = \gamma\left(g^i - \bar{z}^i, T^j\right)$. Differentiating the modified optimality condition w.r.t. t^i, t^j, and g^i yields the response $t^i_{g^i} = -u^i_{cc}(1 - \bar{z}^i_{g^i})/(u^i_{cc} + u^j_{cc})$. The change in the combined tax burden to a rise in expenditures thus is $[1 - \bar{z}^i_{g^i} - u^i_{cc}(1 - \bar{z}^i_{g^i})/(u^i_{cc} + u^j_{cc})]dg^i$. The bracketed term represents the tax price of marginal public expenditures. Hence,

$$\frac{u^i_g}{u^i_c} = 1 - \bar{z}^i_{g^i} - u^i_{cc}(1 - \bar{z}^i_{g^i})/\left(u^i_{cc} + u^j_{cc}\right). \tag{31}$$

Noting that $\bar{z}^i_{g^i} = z^i_{T^i}/\left(1 + z^i_{T^i}\right)$, the first-order condition (31) equals the first-order condition under tax policy (20).

A.6   Derivation of (22)

Tax policy   Given (21) the effect of a rise in taxes by dT^i on the combined tax burden $t^i + T^i$ is $[u^j_{cc}(1 - z^{j*}_{T^i})/(u^i_{cc} + u^j_{cc})]dT^i$. Expenditures change by $(1 + z^{i*}_{T^i})dT^i$. Since transfers are budget-balancing, $z^{i*}_{T^i} = -z^{j*}_{T^i}$ the tax price of marginal public expenditures simplifies to $1 - u^i_{cc}/(u^i_{cc} + u^j_{cc})$ and the resulting first-order condition is (22).

Expenditure policy   Inserting (2) into (3), to express transfers to state i as an implicit function of policy variables in state i and state j, g^i and g^j, $\tilde{z}^i = \gamma(g^i - \tilde{z}^i, g^j - \tilde{z}^j)$. Next, insert (2) into the federal first-order condition (18), to substitute T^i and T^j for $g^i - \tilde{z}^i$ and $g^j - \tilde{z}^j$. Differentiating the modified optimality condition w.r.t. t^i, t^j, and g^i, while accounting for (16), yields the response $t^i_{g^i} = -u^i_{cc}/(u^i_{cc} + u^j_{cc}) + \tilde{z}^i_{g^i}$. Now, a rise in expenditures by dg^i yields a change in the tax burden of $(1 + t^i_{g^i} - \tilde{z}^i_{g^i})dg^i$. The tax price is $1 + t^i_{g^i} - \tilde{z}^i_{g^i}$ and

consequently, the first-order condition becomes

$$\frac{u_g^i}{u_c^i} = 1 + t_{g^i}^i - \tilde{z}_{g^i}^i.$$

(32)

Finally, inserting the tax response $t_{g^i}^i$ into (32) shows that the first-order conditions under tax and expenditure optimization, (22) and (32), coincide.

A.7 Derivation of (23)

Invoking the envelope theorem, the change in utility when state i optimizes over expenditures is

$$\frac{dv^i(T^j)}{dT^j} = -u_c^i(t_{T^j}^i - z_{T^j}^{i*}).$$

(33)

Noting, following (16), that $t_{T^j}^i = -t_{T^j}^j$ and $z_{T^j}^i = -z_{T^j}^j$ and inserting (12) and (19) into (33), the utility change becomes

$$\frac{dv^i(T^j)}{dT^j} = -u_c^i \frac{1 + z_{T^i}^i + z_{T^j}^j}{1 + z_{T^i}^i} \frac{u_{cc}^j}{u_{cc}^i + u_{cc}^j}.$$

(34)

A.8 Derivation of (24)

When state i optimizes over expenditures, the envelope theorem implies

$$\frac{dv^i(g^j)}{dg^j} = -u_c^i(t_{g^j}^i - \tilde{z}_{g^j}^i).$$

(35)

To characterize both federal responses, insert (2) into (3), to express transfers to state i as an implicit function of policy variables in state i and state j, g^i and g^j, $\tilde{z}^i = \gamma(g^i - \tilde{z}^i, g^j - \tilde{z}^j)$. Next, insert (2) into the federal first-order condition (18), to substitute T^i and T^j for $g^i - \tilde{z}^i$ and $g^j - \tilde{z}^j$. Differentiating the modified federal optimality condition w.r.t. t^i, t^j, and g^j, while accounting for (16), yields the response $t_{g^j}^j = -u_{cc}^j/(u_{cc}^i + u_{cc}^j) + \tilde{z}_{g^j}^j$. Plugging $t_{g^j}^i = -t_{g^j}^j$ into (35) and noting that transfers are self-financing yields

$$\frac{dv^i(g^j)}{dg^j} = -u_c^i \frac{u_{cc}^j}{u_{cc}^i + u_{cc}^j} < 0.$$

(36)

B Appendix: Capital Tax Competition

Consider 2 symmetric states. In each state i ($i = 1, 2$), the representative household is endowed with capital K and a fixed factor (e.g., inelastically supplied labor) which is normalized to unity. The income of the household is given by $c^i = w^i + rK$ where w^i is the

wage rate in state i and r is the interest rate determined in the international capital market. Households derive utility from private consumption c^i and from a local public good g^i. The utility function is[25]

$$U(c^i, g^i) = u(c^i) + u(g^i), \tag{37}$$

where $u_k^i > 0$ and $u_{kk}^i < 0$, $k = c, g$. Regional output can be transformed on a one-to-one basis either in a private good c^i or a local public good g^i. Output is produced using the technology $f(k^i)$ which exhibits (i) constant returns to scale and (ii) a positive and declining marginal productivity of capital. Firms are assumed to be profit-maximizer. Profits are given by

$$\pi^i = f(k^i) - w^i - (r + T^i)k^i. \tag{38}$$

Capital employment k^i is taxed at source at a rate T^i. Firms maximize (38) with respect to k^i, which leads to the first-order condition

$$f'(k^i) = r + T^i. \tag{39}$$

(39) implicitly defines regional capital employment as a function of the tax rate T^i and the interest rate r. The wage rate w^i equals $f(k^i) - f'(k^i)k^i$. Hence, noting (39), private consumption is given by

$$c^i = f(k^i) + r(K - k^i) - T^i k^i. \tag{40}$$

Capital is perfectly mobile across states and locates in the state which offers the highest net-of-tax rate of return. The capital market equilibrium is characterized by the first-order condition (39) and the capital market clearing condition

$$k^1 + k^2 = 2K. \tag{41}$$

(39) and (41) define capital employment and the interest rate as a function of both states' tax rates, $k^i(T^i, T^j)$ and $r(T^i, T^j)$. The responses of k^i and k^j to a change in t^i are given by

$$k_{T^i}^i = \Delta^{-1} \quad \text{and} \quad k_{T^i}^j = -\Delta^{-1} \quad \text{with } \Delta \; := \; f''(k^i) + f''(k^j) < 0. \tag{42}$$

In each state tax revenues, $T^i k^i$, are recycled by providing a public consumption good, g^i, whose price is normalized at unity:

$$g^i = T^i k^i. \tag{43}$$

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[25]We adopt the same utility function as in the main part of paper. The additive structure is without loss of generality.

B.1 Tax Optimization by State j

Assume first that state i optimizes over taxes. State i solves

$$\max_{T^i} \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (40), (42) \text{ and } (43), \tag{44}$$

taking T^j as given. Differentiating w.r.t. T^i the first-order condition is

$$u_c^i(f'(k^i)k_{T^i}^i + r_{T^i}(K - k^i) - rk_{T^i}^i - k^i - T^ik_{T^i}^i) + u_g^i(T^ik_{T^i}^i + k^i) = 0 \tag{45}$$

Evaluated at a symmetric equilibrium $(k^i = K)$ and inserting (39) yields

$$-u_c^i k^i + u_g^i(T^ik_{T^i}^i + k^i) = 0. \tag{46}$$

Consider state i optimizes over expenditures. Inserting the public budget constraint into $k^i(T^i, T^j)$ to express capital employment and the interest rate as a function of expenditures g^i and taxes T^j gives $\tilde{k}^i(g^i/\tilde{k}^i, T^j)$ and $\tilde{r}(g^i/\tilde{k}^i, T^j)$. The slope of $\tilde{k}^i$ w.r.t. g^i is

$$\tilde{k}_{g^i}^i = \frac{k_{T^i}^i/\tilde{k}^i}{1 + k_{T^i}^i g^i/(\tilde{k}^i)^2} < 0. \tag{47}$$

State i solves

$$\max_{g^i} \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (40), (43) \text{ and } (47), \tag{48}$$

taking T^j as given. Differentiating (48) w.r.t. g^i gives

$$u_c^i(f'(\tilde{k}^i)\tilde{k}_{g^i}^i + \tilde{r}_{g^i}(K - \tilde{k}^i) - \tilde{r}\tilde{k}_{g^i}^i - 1) + u_g^i = 0. \tag{49}$$

Evaluated at a symmetric equilibrium $(k^i = K)$ and inserting (39), the first-order condition simplifies to

$$u_c^i(T^i\tilde{k}_{g^i}^i - 1) + u_g^i = 0. \tag{50}$$

Inserting (47) and noting (43), the first-order condition (50) reduces to (46). Thus, given that state j optimizes over taxes, expenditure and tax optimization by state i yield identical policy incentives.

B.2 Expenditure Optimization by State j

Consider state i optimizes over taxes. Inserting the public budget constraint by state j into $k^i(T^i, T^j)$ to express capital employment in state i and the interest rate as a function of taxes T^i and expenditures g^j gives $k^{*i}(T^i, g^j/k^{*j})$ and $r^*(T^i, g^j/k^{*j})$. The slope of k^{*i} w.r.t. T^i is

$$k^{*i}_{T^i} = \frac{k^i_{T^i}}{1 - k^i_{T^j} g^j/(k^{*i})^2}. \tag{51}$$

State i solves

$$\max_{T^i} \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (40), (43) \text{ and } (51), \tag{52}$$

taking g^j as given. Differentiating (52) w.r.t. T^i gives

$$u^i_c(f'(k^{*i})k^{*i}_{T^i} + r^*_{T^i}(K - k^{*i}) - r^* k^{*i}_{T^i} - k^{*i} - T^i k^{*i}_{T^i}) + u^i_g(T^i k^{*i}_{T^i} + k^{*i}) = 0. \tag{53}$$

Evaluated at a symmetric equilibrium $(k^{*i} = K)$ and inserting (39) yields

$$u^i_c(-k^{*i}) + u^i_g(T^i k^{*i}_{T^i} + k^{*i}) = 0. \tag{54}$$

Finally, suppose state i optimizes over expenditures. Inserting the public budget constraint by state j into $k^i(T^i, T^j)$ to express capital employment in state i and the interest rate as a function of expenditures g^i and expenditures g^j gives $\bar{k}^i(g^i/\bar{k}^i, g^j/\bar{k}^j)$ and $\bar{r}(g^i/\bar{k}^i, g^j/\bar{k}^j)$. The slope of $\bar{k}^i$ w.r.t. g^i is

$$\bar{k}^i_{g^i} = \frac{k^i_{T^i}/\bar{k}^i}{1 + k^i_{T^i} g^i/(\bar{k}^i)^2 - k^i_{T^j} g^j/(\bar{k}^j)^2}. \tag{55}$$

State i solves

$$\max_{g^i} \quad U^i(c, g) \quad \text{s.t.} \quad \text{Eqs.} \quad (40), (43) \text{ and } (55), \tag{56}$$

taking g^j as given. Differentiating (56) w.r.t. g^i

$$u^i_c(f'(\bar{k}^i)\bar{k}^i_{g^i} + \bar{r}_{g^i}(K - \bar{k}^i) - \bar{r}\bar{k}^i_{g^i} - 1) + u^i_g = 0. \tag{57}$$

Evaluated at a symmetric equilibrium $(\bar{k}^i = K)$ and inserting (39) the first-order condition reduces to

$$u^i_c(T^i \bar{k}^i_{g^i} - 1) + u^i_g = 0. \tag{58}$$

Inserting (55) into (58) and rearranging gives

$$-u_c^i(k^i + k_{T^i}^i) + u_g^i(k^i + T^i k_{T^i}^i - T^j k_{T^j}^j) = 0. \tag{59}$$

To compare the first-order condition (59) with the first-order condition (54), insert the capital response (51) into (54) which reveals that both first-order conditions coincide. Thus, given that state j optimizes over expenditures, expenditure and tax optimization by state i yield identical policy incentives.

The analyze how policy incentives differ when state j sets expenditures rather than taxes, we compare (46) and (54). In symmetric equilibrium ($k^{*i} = k^i$) the conditions differ by the response of capital to changes in the policy variable. Using the public budget constraint (43) and the fact that the capital market clears, i.e. $k_{T^j}^i = -k_{T^j}^j$ the response (51) becomes

$$k_{T^i}^{*i} = \frac{k_{T^i}^i}{1 + k_{T^j}^j T^j / k^j}.$$

The capital response $k_{T^i}^{*i}$ differs from $k_{T^i}^i$ by the term $1/(1 + k_{T^j}^j T^j / k^j)$ which is state j's tax price of marginal public expenditures when state j and state i optimize over taxes - see (46). It exceeds unity and thus the capital response $k_{T^i}^{*i}$ is larger in absolute value relative to $k_{T^i}^i$. We conclude that the tax price of marginal public expenditures is higher when state j optimizes over expenditures rather than taxes.

Lemma A1: *State i's incentives to provide public goods are less pronounced when state j optimizes over expenditures rather than capital taxes.*

The intuition for the result is that following a rise in state i's tax rate capital moves from state i to state j. The inflow of capital leads to a rise in expenditures when state j sets taxes, but leads to a reduction in taxes when state j sets expenditures. In the latter case even more capital will move to state j in response to a tax hike in state i and, hence, state i's tax price of marginal public expenditures is higher. The finding is in line with Wildasin (1988).

B.3 Equilibrium Choice of Policy Variable

To infer into the choice of policy variable, we first characterize the best response of state i given that state j optimizes over taxes. We assume the stage-2 equilibrium to be unique and stable throughout. Consider state i initially optimizes over taxes and switches to expenditure

optimization. Invoking Lemma A1, the tax price of marginal public expenditures in state j rises and, given stability of the equilibrium, state j's tax rate will be lower in the new second-stage equilibrium. The effect on state i's utility can be computed by defining $v^i(T^j)$ as state i's utility evaluated at state i's policy which satisfies the first-order condition (46). Using (39) the response in utility to a rise in state j's tax rate is

$$\frac{dv^i(T^j)}{dT^j} = u_c^i T^i k_{T^j}^{*i}. \tag{60}$$

The sign of the utility change is positive since $k_{T^j}^{*i} = -k_{T^j}^{*j} > 0$ - see (51). Since T^j decreases, state i experiences a loss in utility when deviating. Thus,

Lemma A2: *Assume that state j optimizes over capital taxes. State i's best response is to optimize over capital taxes.*

Differently, assume state j optimizes over expenditures. When state i switches from tax to expenditure optimization state j's tax price of marginal public expenditures goes up. Owing to equilibrium stability, state j's level of expenditures and thus taxes will be lower in the new symmetric equilibrium. Denoting state i's utility evaluated at the policy satisfying the first-order condition (54) by $v^i(g^j)$, the change in utility emanating from a rise in g^j is

$$\frac{dv^i(g^j)}{dg^j} = u_c^i T^i \tilde{k}_{g^j}^i. \tag{61}$$

The term has already been simplified by using (39). Since g^j is set at a lower level and, following (47), $\tilde{k}_{g^j}^i = -\tilde{k}_{g^j}^j > 0$, state i's utility drops following the deviation.

Lemma A3: *Assume that state j optimizes over expenditures. State i's best response is to optimize over capital taxes.*

Combining Lemma A2 and A3, state i has a dominant strategy: optimizing over taxes is a best response irrespective of state j's choice of policy variable. Consequently,

Proposition A1: *The subgame-perfect equilibrium of the policy selection game entails both states to optimize over capital taxes.*

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