

# Tax Competition in a Fiscal Union with Decentralized Leadership\*

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## Abstract

This paper examines capital tax competition in the presence of an interstate transfer policy without federal commitment. Lack of commitment implies that local tax policy is chosen *prior* to federal transfers. The paper's main result is that ex-post federal policy *neutralizes* horizontal fiscal externalities, insulating tax policy from capital mobility. Federal policy, however, introduces a new source of inefficiency unrelated to tax competition. Specifically, ex-post transfer payments prove to be equivalent to an interstate *revenue-sharing system* which may render federal intervention in the presence of fiscal externalities welfare-deteriorating relative to tax competition.

JEL Classification: H7; H3; H1

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# 1 Introduction

Tax competition is a prevalent feature in the globalized economy, being of concern to policy-makers and academics alike. Though following Zodrow and Mieszkowski [37], a lot of attention is confined to tax competition among politically independent states, in many cases however competing states are members of the same fiscal union. For example in federal economies, such as Germany, U.S.A. and Canada, taxing powers are partially assigned to lower level governments, which allows them to compete for mobile capital (see Messere [23]). Tax competition in a fiscal union differs from inter-union competition in at least two respects. Lacking political and legal barriers, intra-union capital mobility tends to be higher, magnifying concerns of tax competition. More importantly, member states are linked by a common federal tax-transfer policy, which can be expected to significantly alter local incentives to engage in tax competition. However, the hierarchical structure of the public sector is generally neglected in models of tax competition, as pointed out in Oates [26], though it may yield efficiency effects different to those predicted by the standard Zodrow-Mieszkowski-type model and to those used in policy debate.

This paper analyzes tax competition in a two-layer fiscal union with decentralized leadership<sup>1</sup>. Member states engage in capital tax competition and receive lump-sum transfers from the federal budget. Implied by decentralized leadership states choose tax policy, rationally anticipating how the federal layer will respond to policy changes. The federal government however takes states' policy choices as given when deciding on the level of transfers.

This sequence of policy determination, albeit with a slightly different set of instruments, is found to have significance in real-world federal politics. Federal governments are frequently argued to choose transfers after the level of public debt has been chosen by lower-level governments. Moving first, state governments rationally anticipate federal transfers (i.e. bailouts) in case of excessive indebtedness

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<sup>1</sup>Throughout the paper the terms decentralized leadership and state leadership are used interchangeably.

and strategically choose public debt levels at a too high level. Some indications of a decentralized leadership, implying soft state budget constraints, are provided e.g. for the U.S. in Poterba [29] and for Germany in Rodden [31].

Turning to the micro-foundation of a state leadership, political competition or constitutional provisions are identified as two potential candidates for why member states can safely expect the federal government to react ex-post to their policy changes; see Rodden and Eskeland [32]. If fiscally troubled states contain voters, which are politically decisive in federal elections, federal politicians will favor bailing out these states. Alternatively, a constitutionally anchored “grandfathering” role for the federal government, forces the upper level to respond to unsound local fiscal policies by providing funds.<sup>2</sup>

Particularly in the European Union (EU), state leadership appears to be an appropriate representation of intergovernmental commitment, reflecting its historical evolution as a bottom-up federal system and, more importantly, its political structure. Via the council of ministers the EU member states have a significant say in the formulation of EU policy. The council is comprised of ministers of national governments representing national interests at the EU level. Given their active role in the EU legislation, national governments are unlikely to take EU policy parametrically. Instead, when designing national policies they perceive how EU policy reacts to national legislation. The political structure may therefore be interpreted as assigning a Stackelberg leadership to member states and the role of a Stackelberg follower to Brussels.

Apart from constitutional and political factors, the sequence of moves may also inherently originate from the type of fiscal policies pursued by both layers of government. Large scale tax reforms typically occur in larger time intervals. In contrast, transfers are set over a shorter time-horizon, implying that local tax policy is implemented prior to transfers.

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<sup>2</sup>Such a “grandfathering” role is e.g. prescribed by the German constitution. Enforcing this principle, the German supreme court has repeatedly instructed the federal government to provide bailouts to needy states; see Rodden [31].

The paper’s main findings are as follows: By moving first, states anticipate that lump-sum transfers equate public funds ex-post, i.e. after capital taxes have been chosen. “Seeing through” the federal decision-making problem, states perceive transfers to depend on tax rates which convert lump-sum transfers into conditional transfers from each state’s perspective. The perceived conditionality of grants has a twofold effect on taxing incentives. First, they *neutralize* fiscal externalities arising with capital mobility. Ex-post equalization implies that the outflow of capital following an increase in the tax rate and the induced tax base expansion in neighboring states feeds back in form of higher transfers to the tax-raising state. Effectively, each state perceives its tax base to be immobile, which strengthens taxing incentives. Second, ex-post equalization confiscates a fraction of any additionally-collected tax revenues in each state, driving a wedge between the “social” and “private” return to a tax increase. This counteracting effect renders tax policy inefficient, but for reasons other than tax competition. Welfare analysis reveals that federal policy may *reduce* welfare relative to tax competition without federal intervention. Surprisingly, tax competition may be welfare-superior even in the presence of high capital mobility.

The paper contributes to the literature on tax-transfer policy in federal systems. In most literature, federal policy improves welfare. By implementing a Pigouvian-type transfer scheme (Dahlby [13]) or even by using lump-sum transfers (Boadway and Keen [4], and Boadway et al. [5]), federal policy offsets inefficiencies in lower-level decision-making. The unifying assumption, that underlies this body of literature, is that the federal government can commit itself towards lower-level governments (top-down commitment). The seminal paper by Boadway and Flatters [3] equally stands in this tradition. Federal transfers are shown to prevent fiscally-induced migration by levelling out net public benefits accruing to households in different regions. To accomplish this, the federal layer has to be able to commit to the equalization system. Rather than viewing the federal government as a Stackelberg leader (as in Boadway and Keen [4], and Boadway et al. [5]), Hoyt [17]

assumes that both levels of government take the other level's policy choices as given (Nash-behavior). Federal policy is still welfare-improving (relative to a purely decentralized system) with this type of intergovernmental interaction. A first-best allocation, however, can only be implemented if matching grants are available to the federal government.

The role of decentralized leadership in fiscal federalism has only been addressed recently. Silva and Caplan [33], and Caplan et al. [9] analyze federal policy in the presence of transboundary externalities generated either by pollution or public consumption spill-overs. In these models, decentralized leadership proves beneficial since it allows externalities to be internalized.<sup>3</sup> The results conform with the traditional public finance view which favors federal intervention in the presence of local inefficiencies. In contrast, ex-post federal policy may also impose disincentives on lower-level governments (Wildasin [36]). Anticipating federal transfers, state governments are inclined to qualify for additional funds by strategically under-providing local public goods.<sup>4</sup> All these papers however abstract from issues of tax competition. Closest to this paper is Qian and Roland [30]; they investigate the merits of decentralized leadership and fiscal competition in reducing bail-outs of private firms. Though similarly pointing to an efficiency-enhancing role of decentralized leadership, they do not provide a detailed analysis of the intergovernmental incentive structure in tax competition. The internalization effect, inherent in ex-post transfer setting, makes no appearance in their paper.

Finally, by proposing an internalization mechanism for horizontal fiscal externalities, the paper complements recent literature, demonstrating that household mobility (Myers [25]) and local provision of international public goods (Bjorvatn and Schjelderup [2]) have the potential to internalize fiscal externalities.<sup>5</sup> Common

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<sup>3</sup>In Caplan and Silva [10] decentralized leadership yields a first-best allocation in the presence of environmental externalities, only if a pollution tax is available locally. If, instead, local governments control the level of abatement, the allocation is inefficient.

<sup>4</sup>Similarly, lacking federal commitment, federally-mandated equalization schemes tend to reinforce rather than to offset fiscally-induced migration incentives which undermines welfare (Mitsui and Sato [24]). Different to this paper, Mitsui and Sato allow private agents to make their decisions prior to policy formation. The assumption on intergovernmental commitment, however, follows the traditional top-down commitment approach.

<sup>5</sup>Transfers are also present in Myers. Regions may voluntarily transfer resources interregionally

to these contributions, the present paper therefore suggests demand for tax coordination to be less pronounced than indicated by the standard tax competition model.

The paper proceeds as follows: Section 2 presents the set-up of the basic model. Section 3 analyzes tax policy if both levels of government move simultaneously. The effects of decentralized leadership are presented in Section 4 followed by a welfare analysis in Section 5. A summary and some concluding remarks are offered in Section 6. All proofs are relegated to the Appendix.

## 2 The Model

Consider an economy with  $n \geq 2$  identical states each consisting of a representative household and a representative firm. The former derives utility from private and public consumption denoted by  $c$  and  $g$ , respectively. Preferences are given by

$$u = c + b(g),$$

where  $b(\cdot)$  is strictly increasing and concave. Subsequently,<sup>6</sup>

$$\lim_{g \rightarrow \infty} b' = 0, \quad \text{and} \quad \lim_{g \rightarrow 0} b' = \infty. \quad (\text{A})$$

The budget constraint reads  $c = I + r\tilde{k}$ , where  $I$  is income generated by a fixed factor (say land) owned by the representative household,  $r$  is the interest rate, and  $\tilde{k}$  denotes the capital endowment of each household normalized at unity.

Each state produces a single good using the neoclassical production technology  $f(k)$ , which exhibits constant returns to scale.<sup>7</sup> Output can be used on a one-to-one basis for private and public consumption. The representative firm in each state

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in order to “buy” the preferred population size therein. He does not, however, employ an institutionalized transfer system, nor does he model incentives in hierarchical governments (by assuming a one-layer government). The internalization mechanism based on decentralized leadership, proposed in this paper, is thus different to the one suggested by Myers. In fact, household mobility and ex-post transfers complement each other; see the working paper version [22] of this paper.

<sup>6</sup>The superscript ' (") denotes a function's first (second) derivative.

<sup>7</sup>More precisely, the production function exhibits constant returns to scale with respect to both inputs: capital and the fixed factor.

maximizes profits  $\pi = f(k) - (r + t)k$  with  $t$  as the source-based capital tax rate. Profit maximizing input choices follow from the first-order condition  $f'(k) = r + t$ , which defines capital demand as a function of the rental price of capital,  $k(r + t)$ .

The assumption of constant returns to scale implies  $I = f(k) - f'(k)k$ . Private consumption,  $c = I + r\tilde{k}$ , therefore becomes  $c = f(k) - f'(k)k + r\tilde{k}$ .

The first-order condition  $f'(k^i) = r + t^i$  and the capital market clearing condition  $\sum_{i=1}^n k^i = n\tilde{k}$  characterize a capital market equilibrium, i.e. they define  $r(t^i, \mathbf{t}^{-i})$  and  $k^i(t^i, \mathbf{t}^{-i})$ .<sup>8</sup> Comparative static analysis yields

$$\frac{\partial k^i}{\partial t^i} = \frac{n-1}{n} \frac{1}{f''(k)} < 0, \quad \frac{\partial k^j}{\partial t^i} = -\frac{1}{n} \frac{1}{f''(k)} > 0, \quad \text{and} \quad \frac{\partial r}{\partial t^i} = -\frac{1}{n} < 0, \quad (1)$$

where the responses are evaluated at  $k^i = k^{-i}(= \tilde{k})$ .<sup>9</sup>

The public sector is modelled as a two-layer federal system. State governments tax capital on a source-basis at rates  $\{t^i > 0\}_{i=1, \dots, n}$ . Tax revenues,  $\{t^i k^i\}_{i=1, \dots, n}$ , are recycled by providing a local public good,  $\{g^i = t^i k^i + s^i > 0\}_{i=1, \dots, n}$ . The federal government provides lump-sum grants which are financed by contributions made by member states of the union.  $\{s^i\}_{i=1, \dots, n}$  denotes the net-of contribution payment each state receives (or pays if negative). Both levels of government are assumed to be benevolent. State governments maximize utility of the representative household. The federal government chooses policy to maximize the Benthamite welfare function  $\sum_{i=1}^n u^i(\cdot)$ .

Since regions are identical, attention is subsequently confined to symmetric equilibria.<sup>10</sup>

<sup>8</sup> $\mathbf{t}^{-i}$  stands for a vector comprising all tax rates except for state  $i$ 's tax rate.

<sup>9</sup>The superscript  $-i$  denotes a state other than state  $i$ .

<sup>10</sup>The stark symmetry assumption is invoked to exclusively focus on the incentive effects of ex-post lump-sum transfers on tax setting. With e.g. regional asymmetries in endowments or preferences, which typically create demand for federal transfers, the incentive (substitution) effects would be accompanied by redistributive (income) effects. The latter would originate from positive or negative equilibrium transfer payments.

### 3 Nash-Behavior

This section characterizes public policy if both levels of government choose their policy instruments  $\{t^i, s^i\}_{i=1, \dots, n}$  simultaneously, i.e. each government takes policy choices of other governments as given.<sup>11</sup> However, they account for the effect on capital demand.<sup>12</sup> The outcome will later on be contrasted with the outcome prevailing under decentralized leadership.

The game is solved by backward induction to identify a subgame-perfect equilibrium.

**State Government** State government  $i$  sets its capital tax rate,  $t^i$ , for given  $(s^i, \mathbf{t}^{-i})$  to maximize the utility of the representative household, i.e.

$$\max_{t^i} u^i(c^i, g^i)$$

s.t.

$$c^i = f(k^i) - f'(k^i)k^i + r\tilde{k}, \quad g^i = t^i k^i + s^i, \quad k(t^i, \mathbf{t}^{-i}), \quad \text{and} \quad r(t^i, \mathbf{t}^{-i}).$$

Differentiating with respect to  $t^i$ , inserting Eq. (1), and rearranging yields

$$b' = \frac{1}{1 + \epsilon^i} \quad \text{with} \quad \epsilon^i := \frac{\partial k^i}{\partial t^i} \frac{t^i}{k^i} < 0 \quad (2)$$

at a symmetric equilibrium. Eq. (2) exhibits the well-known feature of capital tax competition: underprovision of local public goods,  $b' > 1$ . Tax competition can be viewed as imposing a horizontal fiscal externality on other states' tax revenues (Wildasin [35]). The outflow of capital enlarges the tax base in neighboring states which constitutes a positive effect not accounted for by the tax-raising state. This failure implies an inefficiently low level of  $g^i$ .<sup>13</sup>

<sup>11</sup>A federal Stackelberg leadership might be considered as a more appropriate scenario. Note, in the current setting, both scenarios yield the same equilibrium allocation. Since transfer payments are zero in a symmetric equilibrium, the federal government cannot strategically influence state tax setting via lump-sum transfers. Therefore, any federal commitment to transfers is neutral.

<sup>12</sup>For simplicity, we suppress the two last stages of the game at which firms determine capital demand for given policy choices and, finally, production takes place, public goods are provided and are consumed together with the private good.

<sup>13</sup>If regions have market power, i.e.  $\frac{\partial r}{\partial t^i} \neq 0$ , decentralized capital taxation typically gives rise to pecuniary externalities due to terms-of-trade effects (DePater and Myers [14]). Since a region's net capital export is zero in a symmetric equilibrium, this externality does not arise here.

**Federal Government** Given states' policy choices  $\{t^i\}_{i=1,\dots,n}$ , the federal government solves

$$\max_{\{s^i\}_{i=1,\dots,n}} \sum_{i=1}^n u^i(c^i, g^i)$$

s.t.

$$c^i = f(k^i) - f'(k^i)k^i + r\tilde{k}, \quad g^i = t^i k^i + s^i, \quad \text{and} \quad \sum_{i=1}^n s^i = 0.$$

The first-order condition is

$$b'(t^i k^i + s^i) = b'(t^j k^j + s^j), \quad j \neq i. \quad (3)$$

The federal government sets transfers so as to equalize the marginal benefit of public consumption across states. Following concavity of  $b(\cdot)$ , any interstate difference in the marginal valuation of public consumption is equalized by transferring funds from the low-valuation to the high-valuation state. The first-order condition (3) and the federal budget constraint implicitly define the set of reaction functions  $\{s^i = \varphi^i(t^i, \mathbf{t}^{-i})\}_{i=1,\dots,n}$ .

Since  $s^i = 0$  in a symmetric equilibrium, the equilibrium allocation is equivalent to the Nash-equilibrium prevailing in a game between non-federated states moving simultaneously. The allocation thus coincides with the standard tax competition outcome.

## 4 Decentralized Leadership

In this section, states are assumed to act as Stackelberg leaders which gives rise to a two-stage game between the two levels of government:<sup>14</sup>

*First Stage:* States simultaneously select their capital tax rates  $\{t^i\}_{i=1,\dots,n}$  taking the reaction of the federal government and capital demand into account. That is, state governments behave as Nash-competitors towards each other.

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<sup>14</sup>Again, the two final stages of the game are suppressed; see footnote 12.

*Second Stage:* The federal level determines its policy variables  $\{s^i\}_{i=1,\dots,n}$  for given states' policy choices. It anticipates the reaction of capital demand.

To characterize the subgame-perfect equilibrium, the game is solved by backwards induction.

**Federal Government** In any subgame-perfect equilibrium, transfer policy follows from the federal best-response functions  $\{s^i = \varphi^i(t^i, \mathbf{t}^{-i})\}_{i=1,\dots,n}$ . To derive the federal best-reply to a change in state  $i$ 's policy, the federal first-order condition  $b'(t^i k^i + s^i) = b'(t^j k^j + s^j)$ ,  $j \neq i$ , is differentiated with respect to  $s^i$ ,  $s^j$ , and  $t^i$ . Summing across  $j$ ,  $j \neq i$ , and using the federal budget constraint  $\sum_{i=1}^n s^i = 0$ , to eliminate the sum of  $s^j$  derivatives, yields for the particular case of equal tax rates

$$\frac{\partial s^i}{\partial t^i} = \frac{1}{n} \sum_{j=1, j \neq i}^n \frac{\partial t^j k^j}{\partial t^i} - \frac{n-1}{n} \frac{\partial t^i k^i}{\partial t^i}. \quad (4)$$

The best-reply of federal transfers  $s^i$  separates into two effects. Firstly, a higher tax rate in state  $i$  generates additional tax revenues  $\frac{\partial}{\partial t^i} t^j k^j$  in state  $j$ ,  $j \neq i$ , and to equalize the levels of  $g$  across states the increase is captured by reducing  $s^j$  and is redistributed in proportion  $\frac{1}{n}$  to all states, as depicted by the first term in Eq. (4). Secondly, the transfer scheme “taxes” state  $i$ 's marginal tax revenues,  $\frac{\partial}{\partial t^i} t^i k^i$ , at a rate  $\frac{n-1}{n}$ . Equalization of public funds also implies that the increase in state  $i$ 's own tax revenues is captured and equally redistributed. Thus,  $s^i$  falls by  $\frac{n-1}{n}$ th of this amount such that state  $i$  only keeps a share  $\frac{1}{n}$  of its additional tax revenues; see the second term in Eq. (4).

**State Government** State government  $i$  solves

$$\max_{t^i} u^i(c^i, g^i)$$

s.t.

$$c^i = f(k^i) - f'(k^i)k^i + r\tilde{k}, \quad g^i = t^i k^i + s^i, \quad k(t^i, \mathbf{t}^{-i}), \quad r(t^i, \mathbf{t}^{-i}), \quad \text{and} \quad s^i = \varphi^i(t^i, \mathbf{t}^{-i}).$$

Using Eq. (1), the first-order condition is

$$-k^i + b' \left( \frac{\partial t^i k^i}{\partial t^i} + \frac{\partial s^i}{\partial t^i} \right) = 0 \quad (5)$$

at a symmetric equilibrium. The term in brackets depicts the total effect of marginally higher taxes on state  $i$ 's public funds. It decomposes in an own tax revenue effect,  $\frac{\partial}{\partial t^i} t^i k^i$ , and - due to decentralized leadership - a transfer effect,  $\frac{\partial}{\partial t^i} s^i$ . Inserting Eq. (4), the effect on state  $i$ 's public funds is

$$\begin{aligned} \frac{dg^i}{dt^i} &= \frac{1}{n} \left( \frac{\partial t^i k^i}{\partial t^i} + \sum_{j=1, j \neq i}^n \frac{\partial t^j k^j}{\partial t^i} \right) \\ &= \frac{1}{n} k^i, \end{aligned} \quad (6)$$

where the last equation is derived by using Eq. (1), imposing symmetry, and using the capital market clearing condition,  $\sum_{j=1}^n k^j = n\bar{k}$ , to eliminate the sum of  $k^j$  derivatives. The sum in brackets gives the change in tax revenues of *all* state governments following a higher  $t^i$ . Note,  $\frac{\partial}{\partial t^i} t^i k^i = k^i + t^i \frac{\partial}{\partial t^i} k^i$ . The first term  $k^i$  depicts marginal tax revenues if capital was immobile. The latter term gives the drop in tax revenues due to an outflow of capital in response to a higher  $t^i$ . Given by Eq. (4),  $s^i$  adjusts such that both effects enter state  $i$ 's budget at a rate  $\frac{1}{n}$ . Furthermore, since the cross-budget effects originating from capital mobility,  $\sum_{j=1, j \neq i}^n \frac{\partial t^j k^j}{\partial t^i}$ , are positive (by Eq. (1)),  $s^i$  rises by  $\frac{1}{n}$  of the tax revenue increase in other states. Importantly, as capital only relocates within the fiscal union, the marginal effects mediated by capital mobility offset each other, i.e.  $\frac{1}{n} \left( t^i \frac{\partial}{\partial t^i} k^i + \sum_{j=1, j \neq i}^n \frac{\partial}{\partial t^i} t^j k^j \right) = 0$  at  $t^i = t^j$ ,  $j \neq i$ . From the perspective of each state, transfers absorb the effect of capital mobility on public funds. A marginal increase in  $t^i$  amounts to additional revenues equal to  $k^i$ , a share  $\frac{1}{n}$  of which only accrues to state  $i$ ; see Eq. (6).

Plugging Eq. (6) into Eq. (5) and rearranging yields

$$b' = n. \quad (7)$$

Collecting one unit of tax revenues reduces private consumption by exactly the same amount, but increases public funds only by  $\frac{1}{n}$  units due to revenue sharing. The

state marginal cost of public funds becomes upwardly distorted (as  $n > 1$ ) inducing an underprovision of  $g^i$ . Proposition 1 summarizes the findings.

**Proposition 1:** *Decentralized leadership neutralizes tax competition, i.e. capital mobility does not downwardly distort public good provision. However, interstate lump-sum redistribution effectively becomes an interstate revenue-sharing system which renders public good provision inefficiently low.*

## 5 Comparing Welfare

Given symmetric states and the fact that local public goods are underprovided in both previously analyzed scenarios, the welfare difference can be inferred from the tax rate differential  $t^d - t^N$  where  $t^d$  and  $t^N$  denote equilibrium tax rates under decentralized leadership and Nash-behavior, respectively.

**Lemma 1:** *If  $n \rightarrow \infty$ ,  $t^N > t^d$ .*

The dominance of the revenue sharing effect can best be rationalized by comparing the marginal cost of taxation under both regimes. Under decentralized leadership, the marginal cost of public funds,  $n$ , converges to infinity. The revenue sharing system allocates only a negligible fraction of the social marginal effect of a tax rise to the respective state budget. With tax competition, a rising  $n$  magnifies the perceived response of the tax base to a rise in the tax rate, thereby increasing the marginal cost of taxation as well. However, the effect proves to be less pronounced. In fact, following Eqs. (1) and (2) the marginal cost of public funds becomes  $(1 + t^N/f''(1))^{-1} < \infty$  which leaves states with stronger taxing incentives in tax competition relative to ex-post federal intervention.

For notational simplicity,  $\gamma := -f''(1)^{-1}$ , subsequently.  $\gamma$  has a ready economic interpretation. Since concavity of the production function is inversely related to the

tax base elasticity,  $\gamma$  provides a measure for the intensity of tax competition based on production technology.<sup>15</sup>

**Lemma 2:** *Let the size of the fiscal union be  $n \in [2, \infty)$  and  $\tilde{\gamma}$  implicitly defined by  $\epsilon^i(t^d(n), n, \tilde{\gamma}) = -1$ . Then for every  $n$ , there exists a  $\gamma^* \in [0, \tilde{\gamma})$  which yields  $t^d = t^N$ . Moreover,*

$$t^d \begin{matrix} \geq \\ \leq \end{matrix} t^N \iff \gamma \begin{matrix} \geq \\ \leq \end{matrix} \gamma^* \quad \gamma \in [0, \tilde{\gamma}). \quad (8)$$

Contrary to  $t^d$ , the tax rate under Nash-behavior  $t^N$  is influenced by  $n$  as well as by  $\gamma$ . Fixing  $n$ , if tax competition becomes fierce enough as specified by  $\gamma > \gamma^*(n)$ ,  $t^N$  is sufficiently pressured downward such that decentralized leadership yields higher welfare despite the presence of the revenue-sharing effect.

The example  $b(g) = \ln g$  is used to illustrate  $\gamma^*$  as a function of  $n$ . In this case, the threshold level,  $\gamma^*$ , takes the particularly simple form  $\gamma^* = n$  for  $n \geq 2$ .<sup>16</sup> Figure 1 depicts parameter combinations for which  $t^d - t^N$  becomes positive or negative. A noteworthy observation is that contrary to tax competition considerations a positive relation between the magnitude of  $t^d - t^N$  and  $|\epsilon^i|$  does not hold per se. Comparative statics in  $\gamma$  indeed confirm this intuition. However, fixing  $\gamma$ , an increase in the size of the fiscal union  $n$  tends to render  $t^d - t^N$  negative even though  $|\epsilon^i|$  magnifies.

In order to plausibly assess the scope for tax competition (Nash-behavior) to yield higher welfare, we employ empirical estimates of demand elasticities as reported in Chirinko et al. [11]. A firm-level demand elasticity of  $-0.25$ , which provides an

<sup>15</sup>Note, a higher degree of concavity requires less capital outflow in response to a tax rise to restore the arbitrage condition  $f'(k^i) - t^i = f'(k^j) - t^j$ ,  $j \neq i$ . A second measure for tax competition fierceness is member state size. Rewriting Eq. (1) gives  $\frac{\partial}{\partial t^i} k^i = -\gamma \left(1 + \frac{\partial}{\partial t^i} r(n)\right)$ . Larger values of  $n$  diminish tax burden shifting onto capital owners by reducing interest rates which expose states to more competition. Both measures prove critical in the welfare comparison.

<sup>16</sup>With this specification, tax rates amount to  $t^d = \frac{1}{n}$  and  $t^N = \frac{n}{n+\gamma(n-1)}$ . Setting  $t^d = t^N$  the threshold level  $\gamma^*$  becomes equal to  $n$  for  $n > 1$ . In the limiting case,  $n \rightarrow \infty$   $t^d \rightarrow 0$  and, given l'Hôpital's rule,  $t^N \rightarrow \frac{1}{1+\gamma} > 0$  for  $\gamma < \infty$ . Therefore,  $t^N > t^d$  as predicted by Lemma 1.

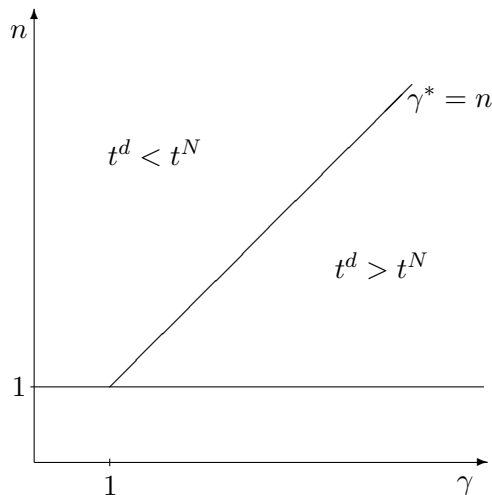


Figure 1: Welfare comparison for  $b(g) = \ln g$ .

upper bound (in absolute value) for the tax base elasticity  $\epsilon^i$ ,<sup>17</sup> gives  $1 < \frac{1}{1+\epsilon^i} < 2$ . Following Eqs. (2) and (7), the marginal cost of public funds under tax competition appears to be less attenuated for  $n \geq 2$ , indicating  $t^d - t^N < 0$ .

The results of Lemma 1 and 2 are summarized in Proposition 2.

**Proposition 2:** *If the number of states is infinite, the effect of revenue-sharing under decentralized leadership unambiguously implies lower welfare relative to Nash-behavior (tax competition). With a finite number of states, however, a decentralized leadership may prove to be welfare-superior.*

The following lemma provides some more intuition for Proposition 2.

**Lemma 3:** *With a fiscal union comprising  $n$  symmetric states, it follows*

$$\left. \frac{\partial s^i}{\partial t^i} \right|_{t^i=t^N} \begin{matrix} \geq 0 \\ < 0 \end{matrix} \iff t^d \begin{matrix} \geq \\ < \end{matrix} t^N.$$

<sup>17</sup>To see this, note that the firm-level capital demand response to a higher tax rate reads  $\frac{1}{f''(k^i)}$ . The regional capital demand response (Eq.(1)) differs from the firm-level one by the term  $\frac{n-1}{n}$  which falls below unity for any  $n \geq 2$ .

The result has a straightforward explanation. Incentives to tax capital are strengthened if a higher capital tax rate translates into more transfers. As shown in Smart [34], transfer competition (i.e.  $\frac{\partial}{\partial t^i} s^i > 0$ ) reduces welfare when not being complemented by tax competition. Governments are inclined to choose an inefficiently high tax rate in an attempt to attract transfers. Here, however, allowing for transfer competition proves beneficial since the prospects of higher transfers raises tax rates from an inefficiently low level.<sup>18</sup>

Additionally, Lemma 3 relates the paper to the literature on vertical fiscal externalities. Differentiating the sum of utility except that of state  $i$  with respect to  $t^i$  yields

$$\sum_{j=1, j \neq i}^n \frac{du^j}{dt^i} = \sum_{j=1, j \neq i}^n \frac{\partial u^j}{\partial g^j} \left( \underbrace{t^j \frac{\partial k^j}{\partial t^i}}_{(a)} + \underbrace{\frac{\partial s^j}{\partial t^i}}_{(b)} \right). \quad (9)$$

Term (a) captures the positive horizontal fiscal externality a marginal tax increase imposes on other state budgets. It is this effect which renders tax competition inefficient. Ex-post federal intervention allows for a second type of fiscal externality represented by the term (b). A change in state  $i$ 's tax policy alters public transfers allocated to other states which constitutes a vertical fiscal externality. Implied by symmetry and the federal budget constraint,  $\frac{\partial}{\partial t^i} s^j = -\frac{1}{n-1} \frac{\partial}{\partial t^i} s^i$ ,  $j \neq i$ , horizontal fiscal externalities are mitigated by a negative vertical fiscal externality if  $\frac{\partial}{\partial t^i} s^i \Big|_{t^i=t^N} > 0$ . Consequently,  $t^d > t^N$ .

The nature of the vertical fiscal externality differs from those analyzed in previous literature.<sup>19</sup> Therein either federal tax setting exerts an externality on lower-level governments' budgets ("top-down" vertical fiscal externality) or vice versa ("bottom-up" vertical fiscal externality). With decentralized leadership, state tax policy affects other state budgets via federal policy changes. Continuing the analogy, this effect constitutes a "bottom-up-top-down" vertical fiscal externality.

Following the equivalent steps as in deriving Eq. (4) one can derive the expression

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<sup>18</sup>See Bucovetsky and Smart [6], Köthenbürger [21], and Qian and Roland [30] for a similar beneficial role of transfer competition.

<sup>19</sup>See Keen [19] for a comprehensive overview of the literature on vertical fiscal externality.

for  $\frac{\partial}{\partial t^i} s^j$ ,  $j \neq i$ .<sup>20</sup> Inserting this expression into  $\frac{d}{dt^i} g^j = \frac{\partial}{\partial t^i} t^j k^j + \frac{\partial}{\partial t^i} s^j$ ,  $j \neq i$ , and rearranging terms shows that the combined effect of the fiscal externalities (a) and (b) in Eq. (9) is

$$\frac{dg^j}{dt^i} = \frac{1}{n} k^i, \quad j \neq i.$$

Capital mobility does not affect the budgets of neighboring states. The vertical fiscal externality (b) neutralizes the horizontal fiscal externality (a) arising with tax competition, but simultaneously introduces a different fiscal externality. Equalization implies that a fraction  $\frac{1}{n}$  of the social impact of a marginally higher  $t^i$  on public funds, equal to  $k^i$ , accrues to state  $j$ ,  $j \neq i$ ; a positive fiscal externality pointing to a underprovision of  $g^i$  - see Eq. (7).

## 6 Conclusion

The paper shows that decentralized leadership fundamentally changes the nature of capital tax competition in a fiscal union. With capital tax rates set prior to federal transfers, horizontal fiscal externalities due to capital mobility among members of the fiscal union are absent. However, ex-post federal transfer policy effectively becomes an interstate revenue-sharing mechanism which implies inefficiently low equilibrium tax rates. Welfare analysis reveals that tax competition may appear to be the preferred federal governance structure.

The analysis makes a number of simplifying assumptions. For instance, the federal government is not subject to capital mobility. If the federal level were also to engage in tax competition, ex-post transfer setting would only neutralize horizontal fiscal externalities operating within the federation. As a consequence, the tax base elasticity at the state and federal level coincides. However, capital tax competition

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<sup>20</sup>Following these steps,  $\frac{\partial}{\partial t^i} s^j$  reads

$$\frac{\partial s^j}{\partial t^i} = \frac{1}{n} \sum_{l=1, l \neq j}^n \frac{\partial t^l k^l}{\partial t^i} - \frac{n-1}{n} \frac{\partial t^j k^j}{\partial t^i}, \quad j \neq i.$$

The interpretation of the optimal federal response is analogous to that of Eq. (4).

with states outside the federation still prevails. The effect of a less severe underprovision tendency in tax competition is counteracted by the intra-union equalization of public funds. Furthermore, assigning a wage tax to the state government in addition to the capital tax does not change the results qualitatively. The downward-pressure on the wage tax exerted by intra-union capital mobility is neutralized.<sup>21</sup> At least partly, however, the revenue-sharing effect undoes the induced increase in the wage tax rate.<sup>22</sup>

The literature does not provide econometric guidance on which type of inter-governmental commitment (i.e. (de)centralized leadership or even Nash-behavior) is more descriptive in federal economies. The only paper addressing the issue of commitment so far is Hayashi and Boadway [15]. Analyzing business tax setting in Canada, they find inconclusive results as to whether the federal government acts as a Stackelberg leader or Nash-competitor towards provinces. Given the lack of empirical evidence, it is however at least instructive to contrast the different scenarios; especially if the policy outcomes fundamentally deviate as shown in the paper.

In particular, three diverging implications are noteworthy. Firstly, the more pronounced capital mobility among union member states<sup>23</sup>, originating e.g. from the creation of a single capital market in a union, does not necessarily imply fiercer tax competition as typically conjectured in the literature (e.g. Begg et al. [1]). Indeed, with ex-post transfers the potential advantage of a higher capital mobility can be reaped without suffering the costs associated with a more severe underprovision of public services.<sup>24</sup>

Secondly, even if potentially welfare-enhancing, tax coordination among independent states appears to be difficult to achieve in practice. This failure is partly explained by the potential non-verifiability of effective tax rates, but also by the lack

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<sup>21</sup>See Bucovetsky and Wilson [7] for why the wage tax is downwardly distorted in tax competition.

<sup>22</sup>The working paper version [22] of this paper contains a more detailed analysis of these extensions.

<sup>23</sup>See e.g. Helliwell and McKittrick [16] for an empirical analysis.

<sup>24</sup>A similar argument is derived in Persson and Tabellini [28] by invoking political economy mechanisms. In particular, strategic delegation of politicians partly neutralizes the impact of economic integration on capital tax rates.

of institutions enforcing tax coordination agreements between independent states.<sup>25</sup> Instead, the federal level may implicitly induce state governments to choose capital tax rates in a coordinated way by making contingent transfers (e.g. Wildasin [35], and Dahlby [13]). The paper casts doubt on this frequently encountered argument. In fact, federal intervention, when coupled with commitment problems, may render unfettered tax competition welfare-superior. The paper thus underlines the need for a careful evaluation of second-best federal institutions for implementing tax coordination.<sup>26</sup>

Finally, tax and yardstick competition are argued to lie at the root of the empirically validated complementarity between local capital tax rates.<sup>27</sup> According to the present paper, a third channel of interaction proves equally capable of explaining the interaction. More precisely, equilibrium tax interaction may exclusively be generated by federal transfers, even in the presence of capital mobility. Disentangling the various sources of strategic interaction may therefore be a promising venue for future empirical research, shedding more light on the relevance of the tax competition argument relative to competing explanations.

## A Appendix

### A.1 Proof of Lemma 1

Comparing Eqs. (2) and (7) reveals that  $t^d - t^N \gtrless 0$  iff  $-\frac{n-1}{n} \gtrless \epsilon^i|_{t^i=t^N}$ . For  $n \rightarrow \infty$ , the term  $-\frac{n-1}{n}$  approaches  $-1$  giving  $t^d - t^N \gtrless 0$  iff  $-1 \gtrless \epsilon^i|_{t^i=t^N}$ . The rest of the proof proceeds by first proving the existence of  $t^N$ . In a second step, it is shown that  $-1 < \epsilon^i|_{t^i=t^N}$  at the equilibrium under Nash-behavior.

First step: Inserting Eq. (1) into the right-hand-side of Eq. (2) and evaluating the term at  $\tilde{k} = 1$  shows that the marginal cost of taxation is equal to  $(1 + t/f''(1))^{-1}$  for

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<sup>25</sup>Non-verifiability implies that any tax coordination agreement cannot be conditioned on effective tax rates. Only a subset of instruments, ultimately influencing effective tax rates, can be part of such an agreement (e.g. statutory tax rates). Facing this incompleteness, partial coordination may result in even fiercer tax competition via tax instruments still under local discretion; see Crémer and Gahvari [12].

<sup>26</sup>See Kehoe [20], Janeba [18], and Perroni and Scharf [27] for a related cautious argument on the desirability of federally-mediated policy coordination.

<sup>27</sup>See Brueckner [8] for a survey.

$n \rightarrow \infty$ . Note, if  $t \uparrow -f''(1)$ ,  $(1 + t/f''(1))^{-1} \rightarrow \infty$  and if  $t \rightarrow 0$ ,  $(1 + t/f''(1))^{-1} \rightarrow 1$ . Given monotonicity and continuity of  $(1 + t/f''(1))^{-1}$  and condition (A) imposed on  $b'$ , there always exists a unique tax rate  $t^N \in (0, -f''(1))$  satisfying Eq. (2).

Second step: Following Eq. (1) and  $\tilde{k} = 1$ ,  $\epsilon^i|_{t^i=t^N} = t^N f''(1)^{-1}$  for  $n \rightarrow \infty$ . As shown in the first step,  $t^N < -f''(1)$  yielding  $\epsilon^i|_{t^i=t^N} > -1$ , which completes the proof.

## A.2 Proof of Lemma 2

Let the size of the fiscal union be given by  $n \in (1, \infty)$ . Eq. (7) uniquely defines  $t^d$  as a function of  $n$ . Now, insert  $t^d(n)$  in  $\epsilon^i$  evaluated at a symmetric equilibrium. Using (1),  $\epsilon^i$  can now be written as a function of  $n$  and  $\gamma$ , i.e.  $\tilde{\epsilon}(n, \gamma) := \epsilon^i(t^d(n), n, \gamma)$ . Note, if  $\gamma \rightarrow 0$ ,  $\tilde{\epsilon}(n, \gamma)$  goes to 0. Furthermore, if  $\gamma \rightarrow \infty$ ,  $\tilde{\epsilon}(n, \gamma)$  converges to  $-\infty$  and - given continuity of  $\tilde{\epsilon}(n, \gamma)$  - the intermediate value theorem guarantees a value of  $\tilde{\gamma}$  which yields  $\tilde{\epsilon}(n, \tilde{\gamma}) = -1$ . At an interior solution, we thus have  $\gamma \in [0, \tilde{\gamma})$ . Again, given by the intermediate value theorem, there exists a value  $\gamma^* \in [0, \tilde{\gamma})$  which satisfies  $\tilde{\epsilon}(n, \gamma^*) = -\frac{n-1}{n}$ . Following Eqs. (2) and (7),  $t^d - t^N \geq 0$  iff  $-\frac{n-1}{n} \geq \epsilon^i|_{t^i=t^N}$ . Therefore,  $t^d$  and  $t^N$  coincide for parameter values  $n$  and  $\gamma^*$ , proving the first assertion in Lemma 2.

To prove the second assertion, note that following Eqs. (2) and (7)

$$\frac{dt^d}{d\gamma} = 0 \quad \text{and} \quad \frac{dt^N}{d\gamma} < 0.$$

Starting from  $n$  and  $\gamma^*$ , the tax differential  $t^d - t^N$  increases as  $\gamma$  increases which gives condition (8).

## A.3 Proof of Lemma 3

Given Eqs. (2) and (7),  $t^d - t^N \geq 0$  iff  $-\frac{n-1}{n} \geq \epsilon^i|_{t^i=t^N}$ . Evaluating Eq. (4) in a symmetric equilibrium, inserting Eq. (1), and using the aforementioned condition, proves Lemma 3.

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