Does Tax Competition Tame the Leviathan?[*]

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Abstract

We study the impact of tax competition on equilibrium taxes and welfare, focusing on the jurisdictional fragmentation of federations. In a representative-agent model of fiscal federalism, fragmentation among jurisdictions with benevolent tax-setting authorities unambiguously reduces welfare. If, however, tax-setting authorities pursue revenue maximization, fragmentation, by pushing down equilibrium tax rates, may under certain conditions increase citizen welfare. We exploit the highly decentralized and heterogeneous Swiss fiscal system as a laboratory for the estimation of these effects. While for purely direct-democratic jurisdictions (which we associate with benevolent tax setting) we find that tax rates increase in fragmentation, fragmentation has a moderating effect on the tax rates of jurisdictions with some degree of delegated government. Our results thereby support the view that tax competition can be second-best welfare enhancing by constraining the scope for public-sector revenue maximization.

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1 Introduction

Is tax competition good or bad for the wellbeing of society? This has been a question of concern to federal states for as long as taxpayers have been free to settle in whatever part of their country they pleased. And as lucrative tax bases are becoming ever more mobile across national borders too, this issue is fast rising towards the top of the international policy agenda. The main opposing arguments are straightforward. Advocates of tax harmonization think of governments as essentially benevolent maximizers of social welfare, whose ability to offer the optimum level of public goods is undermined by the erosion of their tax base. Conversely, those who view tax competition as a force for good consider governments as self-interested revenue maximizers, whose voracity may be constrained by tax competition.[1]

Research on this question abounds.[2] Economic theory provides elegant statements of the conditions under which tax competition may be a force for good or a force for bad. Edwards and Keen (1996), for example, show that the net welfare effect of tax competition hinges on the relative magnitude of two parameters: the marginal excess burden of taxation and the government's marginal ability to divert tax revenue for its own uses. Such parameters, however, elude precise measurement. Empirical work has therefore focused on indirect approaches, based on observable variables. The most prominent strategy, initiated by Oates (1972, 1985), is to study the relationship between government size and "decentralization", where decentralization is understood alternatively as the share of sub-federal government in consolidated revenues or expenditure (centralism), or as the number of sub-federal governments (fragmentation).[3] This approach draws its working hypothesis from Brennan and Buchanan's (1980) description of governments as revenue-maximizing Leviathans, whose tax raising powers could be held in check by decentralization. Negative partial correlations between government size and decentralization were therefore interpreted as evidence in support of the Leviathan view, and, implicitly at least, of the conjecture that tax competition

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[1] These are stock arguments in debates concerning tax co-ordination, such as on the taxation of e-commerce across US states, on harmonization of value added taxes and corporate taxes in the European Union, or on the definition of "harmful tax competition" by the OECD.

[2] See Wilson and Wildasin (2004) for a comprehensive survey.

[3] Important later contributions to this literature include Nelson (1987), Wallis and Oates (1988), Zax (1989) and Forbes and Zampelli (1989). For a survey, see Feld, Kirchgässner and Schaltegger (2003).

is a force for good. It has come to be recognized, however, that this approach faces a major identification problem, because negative partial correlations between government size and decentralization are also predicted by a model of horizontal tax competition among fully benevolent governments - in which case tax competition is welfare reducing.[4] Hence, regressing government size on decentralization does not allow conjectures on underlying government objectives or on the welfare consequences of tax competition. Recognizing the interpretational ambiguity besetting much of the existing empirical literature, Wilson and Wildasin (2004) therefore conclude their survey with the observation that "more work is needed to incorporate reasonable political processes into tax competition models, leading to sharper empirical distinctions between good and bad tax competition".

In this paper we seek to advance towards that aim through two main contributions. First, we address the difficulty of distinguishing good from bad tax competition in a way that is tied rigorously to the theory. We derive a reduced-form relationship which involves only observable variables and maps monotonically into welfare effects, drawing on a model of fiscal federalism in the vein of Keen and Kotsogiannis (2002). In this model too, the difference between welfare-improving and welfare-reducing tax competition hinges on largely unobservable structural parameters. However, we can establish the following simple prediction: if the relationship between states' "smallness" and the equilibrium state tax rate is positive for states that have relatively benevolent governments, and if, other things equal, this same relationship turns negative for states that have relatively less benevolent governments, then the latter effect can be interpreted as evidence of welfare-increasing "Leviathan taming". The intuition is straightforward. The smaller state j, the less it internalizes the externalities created by its tax decision on the tax base of other jurisdictions, both horizontally (i.e. for the other states in the federation, whose tax base shrinks if state j lowers its tax rate) and vertically (i.e. for the federal government, whose tax base increases if state j lowers its tax rate). Smallness therefore exacerbates distortions created by externalities. Dominant horizontal externalities lead to state taxes that are too low, while vertical externalities push towards state taxes that are too high. If smallness is *positively* correlated with state tax rates set by relatively *benevolent* governments, this implies that the domi-

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[4]This has in fact first been pointed out by Oates (1985, footnote 2) himself, as he stated that "other sorts of models besides Leviathan could produce such an outcome".

nating externality pushes towards equilibrium state axes that are too high. If smallness is at the same time *negatively* correlated with tax rates among *Leviathan* states, all else equal, this implies that smallness (i.e. tax competition) must be a good thing for the citizens of those states, as it countervails both their governments' intrinsic desire to overtax and the externalities pushing towards excessively high taxes.

An empirical evaluation of this prediction requires extraneous information on the benevolence of government. Our second main contribution is to exploit an empirical setting that allow us to distinguish *a priori* between government objectives across jurisdictions. We compile a detailed new data set of local taxation in Switzerland, which offers a particularly propitious laboratory for research on tax competition, thanks to the exceptional institutional diversity and fiscal autonomy of Swiss sub-federal jurisdictions. One feature of the Swiss data is that they allow us to classify jurisdictions by the benevolence of their governments, where we associate benevolence with the intensity of direct-democratic control in matters of local taxation. We thereby have empirical measures for all the variables that appear in the theoretical prediction we wish to test.

We estimate the impact of government benevolence on the relationship between local tax rates and the relative smallness of jurisdictions, controlling for differences in revenue needs, locational attractiveness and systemic idiosyncrasies. A spatial GMM estimator is employed to allow for unobserved spatial dependence. We find that, if they have benevolent governments, relatively smaller jurisdictions set higher equilibrium tax rates, but that this relationship is reversed in jurisdictions with greater scope for governmental revenue maximization. Hence, our estimation results coincide with the theoretical prediction. Our empirical specification allows us to interpret this finding as evidence that tax competition lowers equilibrium taxes *because* governments are Leviathans, and the underlying theory identifies this as evidence of beneficial tax competition. We thereby overcome the interpretational ambiguity of prior empirical work.

Our paper contributes to some additional issues raised in the literature. One recurrent theme in empirical research following Oates (1985) concerns the appropriate definition of "decentralization", the metric for the intensity of tax competition. We plead in favor of the fragmentation version: while, to the extent that governments are benevolent, relative sizes

of federal and subfederal government budgets are endogenous, the number of jurisdictions, and thus the relative size of a representative jurisdiction, can more plausibly be treated as exogenous with respect to citizens' *fiscal* preferences.[5] We therefore model the intensity of tax competition via differences in states' smallness, in terms of their population shares, and we treat the fiscal share of the subfederal government level as an endogenous variable.

By allowing for fiscal interdependencies not only among same-level governments but also among different hierarchical government layers, our analysis takes account of the fact that the standard model of purely horizontal tax competition is increasingly inappropriate as a framework for analyzing non-coordinated tax setting in many real-world contexts. Both fiscal decentralization from national to sub-national governments and (to an as yet lesser extent) delegation of fiscal competencies from national governments to supranational institutions are evident global trends.[6]

Finally, our study is related to a growing literature that seeks to establish how different democratic institutions shape policy outcomes.[7] The impact of direct democracy represents one of the key themes in this research area. Gerber (1996) and Besley and Coate (2000) model how the availability of direct-democratic instruments will push policy outcomes towards the preferences of the median voter. Matsusaka (2005) offers a survey of the relevant theoretical and empirical literature and concludes that "direct democracy works", precisely because it mitigates agency problems between voters and potentially Leviathan governments.[8] Our contribution is to explore the indirect effect of direct democracy on local taxation via its interaction with fiscal externalities. This causal link has not, to our knowledge, been studied before.

The paper is organized as follows. Section 2 sets out the theory and derives the estimable predictions. In Section 3, we discuss our estimation strategy and describe the empirical setting. Regression results are reported in Section 4, and Section offers 5 a concluding

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[5] Fragmentation represents the standard approach for modelling the intensity of tax competition in theories of fiscal federalism and Leviathan governments (see, e.g., Epple and Zelenitz, 1981; Keen and Kotsogiannis, 2003). We consider the possibility of endogenous jurisdictional smallness in our estimations.

[6] See Epple and Nechyba (2004) for a survey of the theoretical and empirical literature on fiscal decentralization.

[7] This literature is surveyed comprehensively by Besley and Case (2003).

[8] For a survey of empirical studies using US data, see Matsusaka (2004). Based on data for the Swiss cantons, Feld and Matsusaka (2003) and Funk and Gathmann (2005) find that direct democracy acts as a brake on public expenditure. Frey and Stutzer (2000) even report that, *ceteris paribus*, residents of more direct democratic cantons are happier than those of cantons with more strongly delegated government.

summary and discussion.

2 The model

2.1 A small open federation

Our theoretical framework is a "small open federation" variant of the model developed by Keen and Kotsogiannis (2002), extended to allow for heterogeneous government objectives and state sizes while retaining the assumptions that private agents hold identical preferences and that there is a single mobile tax base.

Consider a federation with $N \geq 1$ states. Each state j is populated by M_j investor-firms.[9] Hence, the federation's total population is given by $\sum_{j=1}^{N} M_j = M$. Investor-firms determine the within-federation, per-firm supply (S) and demand (K) of a perfectly mobile production factor.[10] Firms use an identical concave production technology $F(K_j)$, with $F' > 0$ and $F'' < 0$. The net-of-tax rate of return ρ of the factor is determined in a federation-wide capital market. The factor is taxed by federal and state governments at rates T and t_j respectively, with $\tau_j = T + t_j$. We denote the vector of state tax rates by $\mathfrak{t}$, with elements t_j. The vector of equilibrium state tax rates is denoted by $\mathfrak{t}^*$.

For tractability of the model, we impose four assumptions on this general structure:

Assumption 1: Inward investment from outside the federation is zero.

Assumption 2: $F'' = c < 0$, where c is a constant.

Assumption 3: State taxes are strategic complements.

Assumption 4: The equilibrium federal tax rate T is independent of the distribution of investor-firms across states.

The main implication of these assumptions is that they allow us to maintain most of the simplifying symmetry of the Keen-Kotsogiannis model while allowing for variations in state sizes and in the objective functions of state governments.[11]

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[9] We will use the terms "investor" and "firm" interchangeably.

[10] K can represent any mobile production factor that might be taxed by governments, e.g. labor. For simplicity we denote it as "capital".

[11] To relax Assumption 1 by allowing for two-way investment flows would complicate the model without changing the main results. Assumption 2 implies that the sensitivity of the demand for capital does not depend on the tax rate. Assumption 3 is a sufficient condition allowing us to solve analytically for the relationship between state size and the equilibrium state tax rate. This assumption is supported by the sizable empirical literature on tax reaction functions (see Brueckner, 2003, for a survey). Assumption 4

Profit maximization determines per-firm capital demand $K_j = K(\rho + \tau_j)$, with $K'_j = 1/c$ from Assumption 2. State j's aggregate capital demand is simply $M_j K_j$. Rent, defined as the difference between the value of production and the rental cost of capital, $\pi_j = \pi(\rho + \tau_j)$, is distributed to the investor.

Each investor is endowed with e units of K, of which S_j is invested within the federation and the remainder is invested in the rest of the world (ROW).[12] Returns in the ROW are normalized to zero. This implies that ρ can take negative values if the rate of return is lower in the federation than in the ROW.

Preferences over private goods are given by

$$W_j^{private} = (e - S_j) + \pi_j + u((1 + \rho) S_j), \tag{1}$$

where $u(\cdot)$ is an increasing and concave function, implying a "home bias" in investment. Domestic and foreign incomes being considered as imperfect substitutes, differences in the rate of return between the federation and the ROW can exist even with perfect capital mobility.

The investment decision implies per-investor capital supply $S_j = S(\rho)$, which turns out to be identical across states. Capital supply from state j is thus given by $M_j S$. With Assumption 1, market clearing implies that $\sum_j M_j S(\rho) = \sum_j M_j K(\rho + \tau_j)$ and determines the equilibrium rate of return in the federation. Given Assumption 2, the effect on the rate of return of a change in state j's tax rate is

$$\frac{\partial \rho}{\partial t_j} = \frac{M_j K'}{\sum_j M_j (S_\rho - K')} = p_j \frac{K'}{(S_\rho - K')} < 0, \tag{2}$$

where $p_j = \frac{M_j}{M}$ is the population share of state j. Similarly, the effect on ρ of a change in the tax rates of *all* states is

$$\rho' \equiv \frac{\partial \rho}{\partial t} = \frac{\sum_j M_j K'}{\sum_j M_j (S_\rho - K')} = \frac{K'}{(S_\rho - K')} \in [-1, 0].$$

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allows us to abstract from the mechanism determining the equilibrium federal tax rate and therefore from the objective function of the federal government.

[12] In the interpretation of K as labor, e represents endowments of time which can be "invested" in the labor market.

Hence, $\frac{\partial \rho}{\partial t_j} = p_j \rho'$. This implies that the change in the net-of-tax rate of return with respect to a equidirectional change in all states' tax rate is independent of the distribution of the federal population among the other states (as the distribution of $p_{i \neq j}$, does not feature in $\frac{\partial \rho}{\partial t_j}$).

Publicly provided goods are produced with constant returns, and no tax revenue is wasted. This implies per-capita budget constraints $g_j = t_j K (\rho + \tau_j)$ for the state governments, and $G = \frac{1}{M} \sum_j T M_j K (\rho + \tau_j)$ for the federal government.

Publicly provided goods enter agents' utility function. Total indirect utility for an investor in state j can be written as

$$W_j = (e - S) + \pi (\rho + \tau_j) + u ((1 + \rho) S) + \Gamma (g_j; G), \tag{3}$$

where $\Gamma (g_j; G)$ is increasing and concave in both arguments.[13]

2.2 Government preferences and citizen welfare

The existing literature identifies two polar cases: benevolent governments and purely revenue-maximizing (Leviathan) governments. We assume that intermediate cases are also possible, and that state governments, to the extent that they are benevolent, only consider the utility of their own subjects. This is captured by the following per-capita objective function of state governments:

$$\Omega_j = \left(1 - \mu_j\right) W_j + \mu_j t_j K (\rho + \tau_j), \tag{4}$$

which nests the two polar scenarios as well as intermediate cases.[14] We allow the intensity of Leviathan preferences μ_j to vary among states. For $\mu_j = 0$, the government's objective function coincides with the individual utility function of the state's residents, whereas $\mu_j = 1$ represents a pure Leviathan.[15]

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[13] A possible functional form is $W_j = (e - S_j) + B [(1 + \rho) S_j]^\beta + \pi_j + g_j^\delta G^\gamma$, which we use for our simulations (see below). We shall furthermore impose that $\rho + \tau_j > 0$, allowing us to use conventional functional forms without further transformations.

[14] Note that the solution to the maximization problem of Ω_j is identical to that of the aggregate objective $M_j \Omega_j$, given that M_j is exogenous.

[15] Keen and Kotsogiannis (2003) model the Leviathan by assuming that some exogenously given fraction of tax revenues are used for expenditure that benefits only the government itself. Adopting this modeling approach would not change our main results. Keen (1998) combines benevolent and Leviathan motives by

State governments maximize _j taking into account agents' choices, factor-market clearing and the budget constraints. Using (2), and the fact that $\pi' = -K$, we can write the first-order condition, evaluated at equilibrium and implicitly determining state tax rates as

$$H_j \equiv \left. \frac{\partial \text{ }_j}{\partial t_j} \right|_{t=t^*} = (1-\mu_j) \left\{ \frac{1}{(1+\rho)} S p_j \rho' - K_j (p_j \rho' + 1) + \Gamma_g [K_j + t_j K' (p_j \rho' + 1)] \right. \\ \left. + \Gamma_G [TK' p_j (\rho' + 1)] \right\} + \mu_j [K_j + t_j K' (p_j \rho' + 1)] = 0. \tag{5}$$

where $\frac{1}{1+\rho} = u'$ (see (3)).

This first-order condition implies

$$\left. \frac{\partial (t_j K_j)}{\partial t} \right|_{t=t^*} = \left. \frac{\partial (g_j)}{\partial t} \right|_{t=t^*} = K_j + t_j K' (\rho' + 1) \geq 0. \tag{6}$$

Hence, at equilibrium, tax revenues increase with a symmetric rise in state tax rates; i.e. state governments find themselves on the left-hand side of the Laffer curve. Changes in equilibrium state tax rates are therefore monotonically related to changes in tax revenues and public spending. This implies that our empirical approach, which takes state tax rates as the dependent variable, is consistent with Oates-type specifications, which have involved regressing government size, expressed as tax revenues or public spending, on measures of decentralization or fragmentation.

Given the homogeneity of agents, social welfare is characterized by W_j. Analysis of the symmetric version of this model (e.g. by Keen and Kotsogiannis, 2002, 2004) has shown that, except for knife-edge configurations, independent state-level tax setting leads to socially suboptimal equilibrium state tax rates: a symmetric change in *all* tax rates can be welfare improving. The equivalent in our setup is a marginal change in t. Using the fact that, for state j, the other states' tax rates enter the welfare function only indirectly via their effect on ρ, we can express the effect of such a change as

$$\frac{\partial W_j}{\partial t} = \frac{1}{(1+\rho)} S\rho' - K_j (\rho' + 1) + \Gamma_g [K_j + t_j K' (\rho' + 1)] + \Gamma_G TK' (\rho' + 1). \tag{7}$$

posing the objective function $(1-\mu) v (\rho + \tau) + \Gamma (tK, G)$, where $v()$ represents the citizens' utility from a private good and $\Gamma()$ utility from the public goods. This setup could only be applied to our analysis if federal spending G were taken as fully exogenous, which would assume away vertical externalities.

With $\frac{\partial W_j}{\partial t} > 0$, the state tax rate is too low, while $\frac{\partial W_j}{\partial t} < 0$ implies a state tax rate that is too high in terms of j's welfare.

For less than pure Leviathans ($\mu < 1$), subtracting (5) from (7) yields an expression that lends itself to economic interpretation:

$$\left.\frac{\partial W_j}{\partial t}\right|_{\mu_j < 1} = (1 - p_j) \left[\overbrace{\left(\frac{S}{(1+\rho)} - K_j\right)\rho'}^{\lessgtr 0} + \overbrace{\Gamma_g t_j K' \rho'}^{>0} + \overbrace{\Gamma_G T K' (\rho' + 1)}^{<0} \right. \\ \left. - \frac{\mu_j}{1-\mu_j} \underbrace{\left[K_j + t_j K' (p_j \rho' + 1)\right]}_{>0} \right] \gtrless 0.^{16} \quad (8)$$

The first set of brackets contains three terms. The first of these terms may be called an *asymmetry effect*, due to the fact that in this setting, unlike in the symmetric model, capital supply and demand in state j are not necessarily equal. This effect pushes equilibrium tax rates above or below the social optimum, depending on whether $K_j > S$ or $K_j < S$. The second term represents the *horizontal tax externality*, arising from the interaction between state governments, and driving equilibrium tax rates below the social optimum. The third term represents the *vertical tax externality*, which results from the coexistence of the federal and the state governments. This effect pushes equilibrium tax rates above the social optimum. Finally, the second brackets contain what we call the *Leviathan effect*, representing the deviation from optimal revenue collection induced by Leviathan government preferences. The Leviathan effect implies that the higher is μ_j the greater is the scope for suboptimally high state tax rates.

2.3   State size

We are now in a position to study the effect of a change in state size on the equilibrium state tax rate through a simple exercise in comparative statics. Given Assumption 3, we can abstract from the impact of a small change in the size of one state dp_j on the relative

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[16] The corresponding expression for pure Leviathans is: $\left.\frac{\partial W_j}{\partial t}\right|_{\mu_j = 1} = \underbrace{\left(\frac{S}{(1+\rho)} - K_j\right)\rho' - K_j}_{<0} +$ $\underbrace{(1 - p_j)\Gamma_g K' t_j \rho'}_{>0} + \underbrace{\Gamma_G T K' (\rho' + 1)}_{<0} \gtrless 0.$

size of the other states $(dp_{i \neq j} \cong 0)$.

Let $\mathcal{H}$ denote the system of first-order conditions characterized by (5), $\mathcal{H}_t$ the Jacobian matrix with element i, j equal to $\frac{\partial H_i}{\partial t_j}$ and $\mathcal{H}_{p_j}$ the vector with i-th element $\frac{\partial H_i}{\partial p_j}$. The expression for the vector ∇t_{p_j} with elements $\frac{\partial t_i}{\partial p_j}$ is then given by $\nabla t_{p_j} = -\mathcal{H}_t^{-1} * \mathcal{H}_{p_j}$. Assumption 4 implies that all off-diagonal elements of the negative definite matrix $\mathcal{H}_t$ are positive. Hence all elements of its inverse are negative.[17]

Concerning the sign of $\frac{\partial t_j}{\partial p_j}$ (and $\frac{\partial t_i}{\partial p_j}$), we can therefore concentrate on

$$\frac{\partial H_j}{\partial p_j} = \left(1 - \mu_j\right) \left[\left(\frac{S}{(1+\rho)} - K_j \right) \rho' + \Gamma_g t_j K' \rho' + \Gamma_G T K' \left(\rho' + 1 \right) \right] + \mu_j t_j K' \rho'. \quad (9)$$

This implies that the state tax rate may increase or decrease with state size. The net effect depends on

- the intensity of Leviathan preferences (with stronger Leviathan preferences strengthening the tendency for tax rates to rise with state size), and

- the balance between horizontal and vertical tax externalities (with dominant horizontal externalities strengthening the tendency for tax rates to rise with state size, and vice-versa for dominant vertical externalities).[18]

The relationship between state size and equilibrium tax rates is interesting in itself and can be measured empirically. However, we ultimately strive for statements about welfare effects of tax competition. This requires that we can establish a link between, on the one hand, the observable relationship between state size and the equilibrium tax rate (the "tax rate effect of size"), and, on the other hand, the unobservable relationship between state size and welfare (the "welfare effect of size"). Since relative state size serves as an inverse measure for the intensity of tax competition, the welfare effect of size can be interpreted as an inverse measure of the desirability of tax competition.[19]

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[17] See, for example, Wansbeek and Meijer (2000, Theorem A18).

[18] If state governments act as pure Leviathans, the state tax always increases with state size.

[19] Note that our results, focusing on the change in welfare induced by a change in state size, is not inconsistent with the finding that, with horizontal tax competition and a given distribution of state sizes, smaller states obtain a higher level of welfare in equilibrium than larger states (see e.g. Bucovetsky, 1991).

A look at (3) reveals that welfare is not affected by p_j directly but indirectly via the effect of p_j on t_j. Given Assumptions 3 and 4, the welfare effect of a change in state j's size can therefore be written as

$$\frac{\partial W_j}{\partial p_j} = \frac{\partial W_j}{\partial \mathfrak{t}} \left(\sum_i \frac{\partial t_i}{\partial p_j} \right). \tag{10}$$

Thus, the welfare effect of size is the product of (a) the derivative of state welfare relative to the vector of state tax rates and (b) the tax rate effect of size, summed across all states of the federation.

It is straightforward to show that, with *purely benevolent* governments, intensified tax competition via smaller states will reduce welfare, irrespective of the dominant tax externality.[20] However, it is not possible to derive a *general* analytical solution for the tax rate effect of size, and hence for the welfare effect of size. This reflects the difficulty of linking (observable) tax effects of fragmentation to (unobservable) welfare effects, which in turn represents the central intellectual challenge our analysis seeks to address.

As a first stepping stone towards overcoming the impossibility of a general mapping from tax to welfare effects, we can formally derive one specific but ultimately very helpful result:

Proposition 1 *Suppose $\frac{\partial t_j}{\partial p_j} < 0$. Then $\frac{\partial W_j}{\partial \mathfrak{t}} < 0$ and $\frac{\partial W_j}{\partial p_j} > 0$.*

If $\frac{\partial t_j}{\partial p_j} < 0$, then (8) and (9) imply that $\left[\left(\frac{S}{(1+\rho)} - K_j \right) \rho' + \Gamma_g t_j K' \rho' + \Gamma_G T K' (\rho' + 1) \right] < 0$, and the proposition follows.

To put this simply: if intensified tax competition implied by smaller state size leads to *higher* equilibrium tax rates, then tax competition is unambiguously welfare reducing. The logic of this result is as follows. If equilibrium tax rates rise as states get smaller, this must mean that horizontal tax externalities and the Leviathan effect are dominated by vertical tax externalities, as only the latter pushes towards higher taxes as states get smaller. This in turn implies suboptimally high state tax rates.

Proposition 1 is a stepping stone towards a unique mapping from the tax rate effect of size to the welfare effect of size, for the specific case where we compare jurisdictions

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[20]This mirrors the result of Keen and Kotsogiannis (2004). The formal proof for our setting can be provided on request.

of which some have higher μ_j's than others, and where the tax rate effect of size for the lower-μ_j jurisdictions is negative (i.e. Proposition 1 holds for the more benevolent states). As can be easily gleaned from expression (10), the relationship between the welfare effect of size and the tax rate effect of size in state j hinges on the derivative of state-j welfare with respect to the vector of state-i tax rates ($\frac{\partial W_j}{\partial t}$). If the sign of this derivative can be established, the sign of the relationship between the welfare effect of size and the tax rate effect of size is also determinate. Extensive simulations show that this is indeed possible for the precise scenario sketched above.

Specifically, we track the sign of $\frac{\partial W_j}{\partial t}$ as μ_j changes, for a large number of parameter combinations and with different starting values of μ_j (details are given in the Appendix). We constrain the domain of investigation by considering only cases that are compatible with Proposition 1, i.e. where $\left. \frac{\partial W_j}{\partial t} \right|_{\overline{\mu}_j} < 0$, with $\overline{\mu}_j$ denoting the starting value. In other words, we explore how state governments' becoming less benevolent affects $\frac{\partial W_j}{\partial t}$ if taxes are too high initially. Table A2 shows that $\left. \frac{\partial W_j}{\partial t} \right|_{\mu_j > \overline{\mu}_j} < 0$ without exception for all parameter configurations that yield a solution: if the initial state tax rate is too high and the state government becomes less benevolent, the state tax rate will remain too high.[21]

If at $\overline{\mu}_j$ the tax rate effect of size is negative (i.e. $\frac{\partial t_i}{\partial p_j} < 0$) then we know from Proposition 1 that $\frac{\partial W_j}{\partial t}$ must be negative too. Since, for a given p_j, higher μ_j implies upward pressure on t_j, $\frac{\partial W_j}{\partial t}$ will then be also be negative for all $\mu_j > \overline{\mu}_j$, *ceteris paribus*. If we thus were to observe that, at some higher value of μ_j the tax rate effect of size turns positive, this will imply a negative welfare effect of size: tax competition will be good for citizen welfare.

We can summarize this in the following proposition.

Proposition 2 *Suppose Proposition 1 holds for* $\mu_j = \overline{\mu}_j$. *Then* $\left. \frac{\partial W_j}{\partial t} \right|_{\mu_j > \overline{\mu}_j} < 0$. *Thus,* $\left. \frac{\partial t_j}{\partial p_j} \right|_{\mu_j = \overline{\overline{\mu}}_j > \overline{\mu}_j} > 0$ *implies that* $\left. \frac{\partial W_j}{\partial p_j} \right|_{\mu_j = \overline{\overline{\mu}}_j} < 0$.

Hence, if the vertical tax externality dominates in a state under relatively benevolent government, then if a decrease in this state's size under a less benevolent government will lower equilibrium tax rates this decrease in state size increases welfare: tax competition is welfare improving. This is the main result informing our empirics and allowing us to

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[21] Table A3 shows that the reverse result holds too: if the inital state tax rate is too low, and the state government becomes more benevolent, the state tax rate will remain too low.

make welfare statements based on observed relationships between tax rates, state sizes and government types.

A corollary of this proposition is that, as long as $\frac{\partial W_j}{\partial t} < 0$ at some interior value of μ_j, there exists a pivotal level μ_j^*, determined by setting (9) equal to 0, above which the welfare effect of state size turns negative (i.e. tax competition becomes welfare improving). This pivotal level is given by:

$$\mu_j^* = \frac{\left(\frac{S}{(1+\rho)} - K_j\right)\rho' + \Gamma_g t_j K'\rho' + \Gamma_G T K'(\rho' + 1)}{\left(\frac{S}{(1+\rho)} - K_j\right)\rho' + \Gamma_g t_j K'\rho' + \Gamma_G T K'(\rho' + 1) - t_j K'\rho'}.$$

Both the numerator and the denominator of this ratio are negative, such that $\mu_j^* \in [0, 1]$. Weak horizontal externalities, or conversely strong vertical externalities, imply a low μ_j^*.

In sum, if comparing two states that differ only in terms of their μs, we observe that $\frac{\partial t_i}{\partial p_j}\Big|_{\mu_j = \overline{\mu}_j} < 0$ and $\frac{\partial t_i}{\partial p_j}\Big|_{\mu_j = \overline{\overline{\mu}}_j > \overline{\mu}_j} > 0$, then this implies that $\overline{\mu}_j < \mu_j^* < \overline{\overline{\mu}}_j$, i.e. the two observed states with different levels of μ are on either side of the critical value, with the welfare consequences outlined in Proposition 2.

The essence of our theoretical results is illustrated in Figure 1, which plots the deviation of equilibrium state tax rates from their optimum $(t - t^{opt})$ against different levels of small-ness.[22] When governments are benevolent $(\mu = 0)$ and there is no fragmentation (smallness $= 0$), the state tax rate is optimal $(t = t^{opt})$. The interesting cases are where equilibrium tax rates fall in smallness, because such a relationship is traditionally interpreted as evidence of "Leviathan taming". It turns out that taxes fall in smallness irrespective of government preferences, in all cases where horizontal externalities dominate. In those configurations, increasing smallness (i.e. tax competition) can be a good or a bad thing, depending on whether t is above or below t^{opt}. Traditional "Oates regressions" are predicated on the assumption that t is above t^{opt}, but this is not something that can be ascertained empirically. Hence the usefulness of the case where equilibrium tax rates rise in smallness for μ up to μ^*, but fall in smallness for μ above μ^*. In that case, smallness (i.e. tax competition) is an unambiguous force for good for all $\mu > \mu^*$, as t is monotonically lowered by increasing

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[22]Simulations suggest that the relationships depicted in Figure 1 are mostly convex with respect to small-ness. In addition, the crossing points of the t functions for different levels of μ under dominant vertical externalities may occur at varying levels of smallness. We abstract from such details of functional form, the figure serving a purely expositional purpose.

smallness towards t^{opt}, but t never falls below t^{opt}. The condition for this to hold is that the equilibrium tax rate under dominant vertical externalities is never lower than the first-best tax rate t^{opt}, or, in terms of Figure 1, that   is never below the horizontal axis. Proposition 2 states that this condition holds.

2.4 Fragmentation

The key variable driving the intensity of tax externalities in our model is state size p_j, whereas the related empirical literature uses two different exogenous variables, fragmentation and centralism.

State size relates closely to *fragmentation*. If we define the "smallness" of a state by $n_j = 1 - p_j$, this can be taken as a representation of fragmentation, as, from the point of view of an individual state, a fragmented federation implies relatively small states. We have seen that, from (9), suitably transformed, fragmentation can lead to lower equilibrium tax rates for $\mu < 1$, even including $\mu = 0$ (i.e. with benevolent government). This shows that observed inverse relationships between tax rates and fragmentation are not sufficient to infer Leviathan governments. Moreover, Proposition 2 represents an analytically rigorous version of the popular view that intensified competition from increased fragmentation can "tame the Leviathan". The empirical Leviathan literature has paid rather more attention to *centralism*, i.e. the allocation of fiscal powers between the federal and state government levels, than to fragmentation. This is represented by the ratio of expenditures g/G, which, with balanced budgets, is related (albeit not necessarily equal) to the ratio of average tax rates t/T. The parameters that determine the equilibrium state tax rate and the equilibrium federal tax rate will also determine the ratio t/T. This means that equilibrium level of centralism depends in part on citizens' fiscal preferences. Unlike fragmentation, the degree of centralism should not therefore be considered as an exogenous determinant of the intensity of tax competition.[23]

What about the exogeneity of p_j? Jurisdictional definitions may be endogenous with respect to taxation in certain settings, especially in the context of single-purpose districts

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[23]See also Wilson and Janeba (2005), who study how the choice of t/T may be used strategically by the central government to minimize the distortions arising from the interplay of horizontal and vertical tax externalities. Note that, notwithstanding Assumption 4, T is likely to be influenced by t.

(Hoxby, 2000). Our analysis is based on general-purpose jurisdictions with historically predetermined boundaries, such that jurisdictions' smallness in geographic terms can reasonably be taken as exogenous. Smallness in population terms, however, may in reality be to some extent influenced by tax rates. We return to this issue in the empirical part.

3 Empirical setting

3.1 The regression model

Equations (5) and (9) imply:

$$t_{jk} = f\left(n_{jk}, \mu_{jk}, T_k, \mathbf{t}_{-j,k}\right)\big|_{\rho_k, K'_k}, \tag{11}$$

where k denotes different federations.

A negative relationship between state tax rates and smallness ($n_{jk} = 1 - p_{jk}$) could reflect either (a) the dominance of horizontal externalities and with relatively benevolent governments, or (b) the presence of Leviathan state governments. According to Proposition 1, a positive relationship would in turn point unambiguously to dominant vertical externalities.

If underlying state government objectives (μ_{jk}) are measurable, the natural empirical specification becomes:

$$t_{jk} = \beta_0 + \beta_1 n_{jk} + \beta_2 \mu_{jk} + \beta_3\left(n_{jk} * \mu_{jk}\right) + \beta_4 T_k + \gamma \bar{t}_{-j,k} + \mathbf{X}_{jk}\boldsymbol{\delta} + u_{jk}, \tag{12}$$

where j again indexes states, $\bar{t}_{-j,k}$ is a weighted average of neighboring state tax rates, X_{jk} is a vector of additional controls, and u_{jk} is a stochastic disturbance.

The estimated coefficient $\widehat{\beta}_1$ represents the (inverse of the) tax effect of size for relatively benevolent governments ($\mu_j = \overline{\mu}$). If $\widehat{\beta}_1 > 0$, vertical externalities dominate at $\overline{\mu}$, and Proposition 1 applies. The coefficient $\widehat{\beta}_3$ then quantifies the differential effect of smallness on state tax rates for Leviathan governments. This will be our main coefficient of interest.

According to Proposition 2, if $\widehat{\beta}_1 > 0$, $\widehat{\beta}_3 < 0$, and $\widehat{\beta}_1 + \widehat{\beta}_3 < 0$, we can infer that tax competition tames the Leviathan and increases social welfare. We call this "*strong Leviathan*

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taming": stiffer tax competition from increased smallness improves welfare in Leviathan states. Another possible parameter configuration is $\widehat{\beta}_1 > 0$, $\widehat{\beta}_3 < 0$, but $\widehat{\beta}_1 + \widehat{\beta}_3 \leq 0$. We refer to this as "*weak Leviathan taming*". In this case, stiffer tax competition from increased smallness is less harmful in Leviathan states than in relatively benevolent states.

Some additional issues:

- Estimation of (12) requires variation in μ and in n_{ik} (N). This is most likely to be found in a comparison of multiple federations, which ideally should be similar to each other in all other relevant respects.

- The model assumes states to be identical except for their size. Empirical estimation needs to control for relevant asymmetries across states, such as population, preferences for public goods, tax base elasticities and locational advantages. Hence, state-level control variables $\mathbf{X}_{jk}$ are included in (12).

- Proposition 2 is independent of the way the federal tax rate is set. However, the federal tax rate T_k is unlikely to be independent from state tax rates - be it via strategic interactions between the two governments levels, or through state- and federation-specific exogenous features that drive both t and T. Likewise, t_j and t_{-j} will be interdependent. We will address this issue by instrumenting T_k and $\overline{t}_{-j,k}$.

- t_{jk} could be spatially correlated in a way that is not explained by the model, i.e. via spatial dependence among u_{jk}. We therefore use the spatial GMM estimator proposed by Conley (1999), which applies a distance weighting up to some bound to the off-diagonal elements of the covariance matrix while allowing us to keep instrumenting the endogenous regressors.[24]

- We consider the inclusion of federations' *centralization ratios* as an additional control variable, by way of a robustness check and for comparability with the relevant empirical literature (but without being warranted by the theory). Centralization is measured as the ratio of state revenues to consolidated (state + federal) revenues. In view of the evident endogeneity issue, we instrument this variable.

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[24] We choose a distance bound of 15 km. Sensitivity tests show the value of this bound to be unimportant for our qualitative results.

- We express all non-dichotomous variables in natural logs, so that the estimated coefficients can be interpreted as elasticities.

3.2 Switzerland: a laboratory for research on tax competition

Switzerland presents a uniquely propitious empirical setting in which to estimate the model of this paper. The Swiss fiscal constitution distinguishes three largely autonomous jurisdictional layers (national, cantonal and municipal). Each jurisdictional layer collects a roughly equal share of total tax revenues.[25] We will concentrate on the cantonal and municipal levels. Direct taxation at both these levels of government encompasses four conventional tax bases: personal income and wealth, and corporate income and capital.[26] Personal income is by far the most important tax base, accounting for over 70% of municipal and over 60% of cantonal tax revenues. Summary statistics are given in Tables 1 and 2.

Several institutional features make Switzerland particularly well suited to our study:

- *Multiple federations*: The three-tier fiscal constitution implies that Switzerland can be considered as a federation of federations. We will take cantons to represent the federations (k) of our empirical model, while municipalities represent the states (i, j). Switzerland is divided into 26 cantons, which in turn contain between 3 (Basel Stadt) and 404 (Berne) municipalities.[27]

- *Different degrees of direct democracy*: There is substantial variation across municipalities and cantons in the intensity of direct democratic involvement in the tax setting process. The institutional settings used can be classified in three categories: "*assembly*" municipalities that set taxes via show of hands at town hall meetings of the entire citizenry; "*referendum*" municipalities whose constitutions feature compulsory referenda on fiscal decisions above certain thresholds; and a residual "*Leviathan*" category of municipalities where fiscal matters are largely under the control of elected executives. The basic assumption is that municipalities with more direct democratic

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[25] Since 1985, revenue shares have remained at approximately 30, 40 and 30 percent for the national, cantonal and municipal government levels, respectively (Feld *et al.*, 2003).

[26] In contrast to many other countries, property taxation is small even at the local level.

[27] These numbers refer to 1995. The total number of municipalities is in slow decline, as micro-municipalities (some with populations below 100) are encouraged to merge. Since our sample includes only the 131 largest municipalities, such changes do not affect our data.

participation in the tax setting process are more likely to behave benevolently, whereas more indirect democratic control enhances the scope for Leviathan governments.

- *Overlapping tax bases*: Tax bases are identical within each canton, since they are determined by the cantonal tax law. Moreover, even across cantons, tax bases are very similar, as the information to determine the national tax base is drawn from tax forms used to report to the cantonal authorities.

- *Fiscal autonomy*: In spite of considerable harmonization of tax *bases* across cantons, cantonal authorities enjoy full autonomy in choosing tax *rates*. Most cantons use the following procedure to set taxes. The cantonal tax law determines a tax schedule on the four tax bases. This schedule determines the level and progressivity of each tax instrument. The cantonal authorities annually decide on a multiplier that shifts the base tax schedule, determining the effectively applied cantonal tax. Most cantons fix a single multiplier across all tax bases. Similarly, most municipalities annually set a single multiplier, which, applied to the cantonal tax schedule, determines the effectively applied municipal tax. This particular procedure implies that cantonal and municipal authorities concentrate their decisions on tax bases with the highest impact on tax revenue (i.e. personal income taxes). Reflecting the high degree of cantonal and municipal tax setting autonomy, tax rates and schedules vary substantially across cantons and municipalities. For example, the highest municipal income tax rate recorded in our database exceeds the lowest one by a factor of five, for a given level of income (see also the standard deviations reported in Table 2).

- *Small transfers*: Although vertical and horizontal fiscal transfers do exist in Switzerland, they are small. According to national statistics, net average vertical transfers represent less than 2 percent, and net horizontal transfers less than 4 percent, of total municipal revenue.

3.3 Data

We have collected a panel data set of municipal and cantonal tax rates and control variables for the years 1985, 1991, 1995, 1998 and 2001. The dataset covers up to 131 municipalities.

We quantify μ via two alternative dummy variables, that we denote by $\widetilde{\mu}$: in the assembly definition, the dummy variable is set to 0 for all assembly municipalities, and to 1 for Leviathan (i.e. non-assembly and non-referendum) municipalities; while in the referendum definition, the dummy variable is set to 0 for all assembly or referendum municipalities, and to 1 for the Leviathan municipalities. 38 sample municipalities are attributed to the assembly category, while the referendum category comprises 75 municipalities.

The information underlying our categorization of municipalities is taken from a survey conducted in the mid-1990s.[28] Since $\widetilde{\mu}$ features as a regressor in our empirical model, it is implicitly assumed to be an exogenous feature. As pointed out e.g. by Besley and Case (2003), institutions are ultimately endogenous too. $\widetilde{\mu}$ could depend on, or be simultaneously determined with, t in two evident ways. On the one hand, local communities might push for more direct democracy if delegated governments chronically overspend, in which case high (lagged) t is associated with low $\widetilde{\mu}$. On the other hand, the predominantly conservative mentality of certain local electorates could simultaneously induce lower t and a lower $\widetilde{\mu}$. One way to address this issue would be to draw on intertemporal changes in decision-making institutions, and to control for lagged and time-invariant location specific effects. Democratic institutions, however, have a habit of being highly persistent. No changes in the decision-making systems of our sample municipalities had occurred at least up to 2000 (Micotti and Bützer, 2003). Additional evidence on the stability over time of direct democratic institutions in Swiss cantons is provided by Feld and Matsusaka (2003). The durability of the institutional structure to some extent mitigates concerns about endogeneity. Moreover, the controls in our regression models capture the main fault lines in Swiss political culture (different language groups, young versus old voters, rural versus urban regions, and low-lying versus mountain regions).[29]

Since most municipalities set a single multiplier on the cantonal tax schedule, our main focus is on a revenue-weighted average of standardized versions of a representative set of effective tax rates. We call this aggregate the "*tax index*". Both municipal and cantonal tax indices have mean zero by construction. Specifically, the tax index is constructed as

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[28] We are very grateful to Lars Feld for the generous provision of these data.

[29] Feld and Matsusaka (2003), in regressions at canton level, furthermore control for the parliamentary strength of left-wing parties, to control for "ideology"; and they instrument $\widetilde{\mu}$. Neither of these extensions affects their results in any substantial way.

the revenue weighted mean of effective average tax rates for nine representative tax payers, covering both personal income and wealth and corporate income and capital.[30]

The *smallness* of a municipality is defined relative to its canton as $n_{jk} = 1 - \frac{P_{jk}}{P_k}$, where P_{jk} is the population of municipality j in canton k, and P_k is the respective cantonal population. For the population measures, we consider only residents with Swiss citizenship, since what we seek to represent is municipalities' political weight in the canton.

A range of control variables are included in all estimated equations (see Table 1 for summary statistics).

- Theory suggests that we should control for the respective *cantonal tax rates*, the equivalent of T. In addition, we control for the spatially weighted *tax rates of other municipalities*, $\bar{t}_{-j}$, so as to capture direct strategic interactions among municipalities. $\bar{t}_{-j}$ is constructed as the average tax index of all municipalities excluding j, weighted by the inverse of the square of their euclidean distance from j.[31] Both these variables are instrumented via two-stage least squares with three identifying canton-level variables, the canton population living in urban areas, cantonal area and the canton's number of municipalities. The instrument sets furthermore include spatially weighted averages of all exogenous municipality-level variables.

- Further controls are warranted to allow for differences in municipalities' public revenue needs. We include regressors measuring municipal *population*, the share of *population under 20*, the *share of population over 65*, municipal *area*, and a dummy for municipalities that represent *urban centers*. Municipal area captures two effects: it implies revenue needs for transport and communication services, and it is strongly positively correlated with the mountainousness of municipalities.

- Variables are added to control for differences in municipalities' locational attractiveness, and thus their inherent appeal to potential tax payers: *distance to the nearest*

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[30] We used ANOVA to represent the levels and shapes of tax schedules with a parsimonious set of representative tax payers. Three representative cases were identified to represent tax schedules on personal income, two cases were identified for wealth taxes, three cases were identified for corporate income taxes, and one case was identified for capital taxes. See Brülhart and Jametti (2006) for further details.

[31] Application of linear spatial weights changes none of our qualitative findings. We prefer square weights given previous findings on spatial decay functions based on intra-national migration (e.g. Schwartz, 1973) and commuting (e.g. Harsman and Quigley, 1998).

freeway, *distance to the nearest international airport*, and *length of lake shore within the municipality*.

- A dummy for the *Latin* (i.e. French and Italian speaking) cantons controls attitudinal differences between those cantons and the German speaking majority.

- Although most municipalities enjoy complete autonomy in setting their tax rates, there are some exceptions. Five of the 26 cantons have *harmonized municipal tax rates* on corporate income and capital, whilst leaving municipalities' freedom to set personal taxes unconstrained. We therefore include a dummy that equals one for the relevant cantons and taxes.[32]

4 Results

4.1 Baseline regressions

Our baseline spatial GMM estimation results of the empirical model (12) are shown in Table 3, separately for the referendum definition and for the assembly definition of $\widetilde{\mu}$. In order to facilitate the comparison of effect sizes, we also report standardized (beta) coefficients. The diagnostic tests for overidentifying restrictions and weak instruments, reported in the last three rows of Table 3, are satisfactory.

We first concentrate on the results based on the referendum definition, (first results column of Table 3), which encompasses our full data set. The model performs well. All statistically significant coefficients on the control variables conform with expectations: urban centers and remote municipalities (measured by distance to the nearest airport) have relatively high taxes; while municipalities with long lake shores and those located in the Latin regions have relatively low taxes.[33] The positive coefficient on spatially weighted tax rates of surrounding municipalities suggests that tax rates are strategic complements, consistent with Assumption 4.

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[32] We deliberately do not include canton fixed effects, since such fixed effects would pick up most of the variability in T_k and thus introduce endogeneity bias. However, some institutional idiosyncrasies require additional controls. We include a dummy for the canton of Geneva, which features joint taxation and a special revenue sharing arrangement between cantonal and municipal authorities; and for the canton Basel-Land, which places restrictions on municipal tax autonomy.

[33] While consolidated (municipal plus cantonal) tax rates are generally higher in the Latin cantons, municipal taxes tend to be lower, reflecting a higher degree of centralism in those cantons.

Our main parameters of interest are those represented in the first three rows of the table. We find the main effect of smallness to be positive (although not statistically significant). This is consistent with the scenario underlying Propositions 1 and 2: for relatively benevolent municipalities ($\widetilde{\mu} = 0$), vertical externalities dominate ($\frac{\partial t_j}{\partial p_j} < 0$).[34]

Our estimation also confirms that direct-democratic fiscal powers represent a valid proxy variable for revenue maximization: the coefficient on the Leviathan dummy ($\widetilde{\mu}$) is statistically significantly positive. This means that at the point where smallness is zero, i.e. where intra-cantonal tax competition cannot exist, less direct-democratic municipalities have significantly higher average tax rates than more direct-democratic ones. The size of this effect is considerable, as it implies that, without intra-cantonal tax competition, Leviathan municipalities' average tax rate is 45 percent ($= e^{0.37} - 1$) higher than that of otherwise identical benevolent municipalities.[35]

Our third and most important empirical result is that we find a negative coefficient on the interaction variable between $\widetilde{\mu}$ and smallness. Hence, greater scope for Leviathan government reduces the tax-raising effect of smallness. Stated in reverse: fragmentation, while yielding inefficiently high equilibrium tax rates for benevolent municipalities, acts as a counterweight to the desire for high taxes on the part of Leviathan municipalities. The coefficient on the interaction between $\widetilde{\mu}$ and smallness being larger in absolute value than the coefficient on smallness suggests the presence of what we have termed "strong Leviathan taming", which in turn implies that fragmentation is (second-best) welfare improving in so far as the Leviathan municipalities are concerned. In a statistical sense based on a Wald test of $\widehat{\beta}_1 + \widehat{\beta}_3 = 0$, however, we cannot reject the null that Leviathan taming is merely of the "weak" form: stiffer tax competition induced by increased smallness is at least less harmful for Leviathan municipalities than for benevolent municipalities.

The second data column of Table 3 displays results for regressions with the narrower

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[34] The negative coefficient on the harmonized-tax dummy provides additional evidence for the existence of vertical externalities: canton-wide tax harmonization drives municipal tax rates down rather than up.

[35] Looking at raw means in the full data set (Table 1), we observe that Leviathan municipalities, have slightly *lower* average tax rates than benevolent municipalities. This may seem paradoxical, but it is of course entirely consistent with a model where differences in tax levels are determined also by different exogenous revenue needs and interdependencies among jurisdictions. Inference should therefore be based on an empirical model that controls for relevant covariates. Our result is consistent with corresponding findings made elsewhere. Evidence that direct democracy reduces *canton*-level expenditure in Switzerland is provided by Feld and Matsusaka (2003), and comparable evidence for the US is surveyed by Matsusaka (2004).

definition of "benevolence", where $\widetilde{\mu}$ is set to zero only for municipalities that make fiscal decision via a vote by an assembly of the entire citizenry, and municipalities with intermediate (i.e. referendum based) systems are left out. We observe that this changes our main results in the expected way. The coefficient on smallness increases by a factor of more than three and becomes statistically significant. The main effect of the Leviathan dummy is again statistically significantly positive, and its magnitude is considerably larger, which is in line with the starker difference between $\widetilde{\mu} = 0$ and $\widetilde{\mu} = 1$ under the assembly definition. The estimated coefficient implies that a municipality which faces no intra-cantonal tax competition will raise its tax rate by fully 148 percent $(= e^{0.91} - 1)$ if it switches from a system based on compulsory fiscal referenda to a system with delegated fiscal authority. Our main interest again concerns the slope-shifting effect of $\widetilde{\mu}$. This coefficient increases by a factor of 2.4 (from -2.95 to -7.19), and it remains statistically significantly negative. The interaction effect also remains larger in absolute terms than the main effect of smallness, which is consistent with strong Leviathan taming, although this difference again is not statistically significant. The results obtained for the assembly definition confirm those found in the larger data set underlying the referendum definition, and they are somewhat crisper still. This is in line both with our mapping of decision-making systems to μ and with the predictions of the theory, as the institutional distance between $\widetilde{\mu} = 0$ and $\widetilde{\mu} = 1$ is larger with the assembly definition than with the referendum definition.

4.2   Extensions

We consider a number of extension to the baseline estimations of Table 3, concentrating on the full sample data sample delineated by the referendum definition.

First, we consider a number of alternative specifications using spatial GMM. One might reasonably suspect reverse causality to affect smallness, if population flows were sufficiently sensitive to tax differentials that in practice smallness were to a significant extent determined by tax burdens. We address this issue alternatively by replacing the population-based measure of smallness by its area-based equivalent (Table 4, first data column), and by instrumenting smallness and its interaction term (second data column). Our qualitative results turn out not to be affected. Point estimates on smallness and on the interaction

terms of smallness with $\widetilde{\mu}$ retain their signs but are larger in absolute value. The net effect of smallness for Leviathan municipalities remains negative, which is consistent with strong Leviathan taming. This effect is statistically significant when we instrument for smallness.[36]

A second extension is to augment our baseline specification with instrumented centralization ratios (Table 4, third and fourth data columns). Inclusion of this variable is not warranted by the theory, but we consider it by way of a robustness test and for comparability of our results to those of related empirical studies. While the coefficients on centralization themselves are not statistically significant, the main effect and the interaction effect of smallness again retain their signs. Strong Leviathan taming continues to be supported. We therefore conclude that the centralism variable is not itself significant and does not qualitatively change our results.

As a further robustness check, we estimate the baseline model using two-stage least squares, which remains unbiased in the presence of spatial autocorrelation in u_{jk} but is less efficient than spatial GMM. The results are shown in Table 5. Moran's I, computed on the residuals and reported in the bottom row of Table 5, strongly supports the presence of spatial error dependence, validating our choice of spatial GMM as the principal estimator. As expected, most coefficients are less precisely estimated with two-stage least squares than with spatial GMM. None of our qualitative results, however, depends on the choice of estimator: point estimates and standard errors are similar to those of our baseline regressions in Table 3 and to the additional specification reported in Table 4. We again find evidence that is consistent with strong Leviathan taming, which in two cases is statistically significant.

Finally, we estimate the baseline model separately for the nine representative tax bases that underlie the construction of our tax indices. Although most municipalities decide on a single multiplier that shifts tax schedules symmetrically for all tax bases, it might be interesting to specify the regressions as if the municipal choices were independent across tax bases. Table 6 reports the main and interaction effects of smallness and $\widetilde{\mu}$ for the assembly and referendum definitions of $\widetilde{\mu}$ respectively. We continue to find satisfactory statistics

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[36]When we instrument smallness with its area-based equivalent, the first-stage F statistics for the interaction term are small, suggesting weak instruments. Results for this specification therefore ought to be interpreted with some caution.

on overidentifying restrictions, but first-stage F tests suggest weak instrument problems for a majority of regression runs. The estimated coefficients for the three representative personal income taxes (which, we recall, account for about 70% of municipal tax revenues) are qualitatively similar. They all suggest that vertical externalities dominate the tax choices of municipalities governed by citizens' assemblies, implying inefficiently high tax rates of relatively small municipalities, while the remaining (Leviathan) municipalities see their tax rates reduced by smallness, suggesting a salutary effect of tax competition in their case. In five out of the six regression runs concerning tax rates on personal income, we find statistically significant evidence of strong Leviathan taming, the sum of the coefficients on smallness and $\widetilde{\mu}$*smallness being statistically significantly negative.

5   Conclusions

We find that, relative to a benchmark sample, Swiss municipalities which delegate fiscal authority to elected executives on average set lower taxes the smaller their share of their canton's population. In a sense, this mirrors the result found in a number of previous "Oates regressions", whereby jurisdictional fragmentation is associated with lower tax rates. Traditionally, it has been difficult to read a clear interpretation into these results, because a negative partial correlation between fragmentation and tax rates could represent either (second-best efficient) Leviathan taming via horizontal tax competition, or a race to the bottom away from the socially optimal tax rates. We argue that, in our case, this ambiguity can be overcome, and our finding can be interpreted as evidence of welfare-enhancing Leviathan taming through tax competition.

The main novelty of our approach is that we can enlist extraneous information on the preferences of municipal decision makers in a federal setting. A sizeable subsample of Swiss municipalities set tax rates by show of hands in an assembly of the entire citizenry. This arguably amounts to the closest possible approximation of "benevolent government" among conceivable real-world decision-making processes. We take these as the benchmark municipalities, and we find that, for them, the basic relationship between relative "smallness" and average tax rates is positive: the smaller they are, the higher their tax rates. This is consis-

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tent with dominant vertical externalities in a model of tax competition in federal systems, and it suggests that, in our empirical setting, uncoordinated tax decisions of benevolent municipalities yields suboptimally high equilibrium taxes.

Most importantly, we find that, other things equal, the relationship between fragmentation and tax rates turns negative (or at least not significantly different from zero) for the municipalities with delegated fiscal authority. Hence, we can infer that tax rates fall (or at least do not rise) in fragmentation *because* these municipalities offer some scope for Leviathan government behavior. According to the theory, tax-rate reducing competition among jurisdictions with some degree of Leviathan government preferences is welfare improving if, in the same setting, competition among more benevolent jurisdictions would have raised equilibrium tax rates. We therefore interpret our findings not only as evidence of Leviathan taming via jurisdictional fragmentation but also as a manifestation of welfare-enhancing tax competition.

The flip side of this result, of course, is that the significant impact of fragmentation on the taxes of direct-democratic municipalities suggests welfare-reducing distortions from (vertical) tax externalities. Our results therefore imply that tax competition via jurisdictional fragmentation is beneficial only to the extent that governments are Leviathans. Coordinated tax setting by benevolent governments remains the first-best policy.

It is in order to question the generality of our findings. In terms of research methodology, it would be desirable that our results could at least potentially be validated in alternative data sets. Although the extent of sub-national institutional diversity observed in Switzerland may well be unique in the world, this study could potentially be replicated for other countries. Farnham (1990), for example, has exploited differences in the availability of citizens' initiatives at the level of US communities in a study of local expenditure levels. As an alternative, one might use the closeness of local election results as an inverse proxy for the leeway local politicians enjoy in making decisions that diverge from the median voter's preferences.[37]

Regarding the generality of the welfare-relevant result, it is important to recall that

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[37]It is interesting in this context to note the results found by Besley and Case (2003), whereby stronger party competition in US state legislatures yield lower tax burdens; and those obtained by List and Sturm (2006), whereby more narrowly elected state governors try harder to satisfy the preferences (in terms of environmental spending) of their electorate.

competition-induced downward pressure on tax rates set by sub-federal Leviathan governments is not necessarily desirable, as it unambiguously improves welfare only if vertical externalities dominate in the tax decisions of comparable benevolent governments. Vertical externalities are more likely to dominate the smaller is the sub-federal fiscal share. Average revenues of Swiss municipalities amount to some 70% of corresponding cantonal revenues, which is a relatively high sub-federal fiscal share in international comparison.[38] The scope for vertical externalities should therefore be rather higher in many other federations. In addition, even the "Leviathan" governments in our data set are subject to direct-democratic controls via voluntary referendums, which means that elected officials still enjoy comparatively little leeway to pursue their self-serving aims. In sum, other nations' sub-federal jurisdictions may exhibit greater scope both for vertical externalities and for revenue maximization, which leads us to believe that our results hold relevance well beyond the Swiss case.

There are of course limits to the generality of our study. By adopting a representative-agent framework with a single tax base, our analysis has abstracted from welfare effects arising through Tiebout sorting and through policy interactions concerning multiple tax bases. Moreover, explicit consideration of horizontal and vertical fiscal transfers might be warranted in alternative empirical settings. We leave these extensions for future work.

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[38] According to taxpolicycenter.org , 2002 US state tax revenue corresponded to 29% of federal tax revenue, while the relative size of local tax revenue to state tax revenue ranged from 25% (Delaware) to 118% (Colorado).

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A   Appendix: Simulations

Some aspects of our model are not analytically tractable. Therefore, we perform a series of simulations.

Functional forms must be compatible with Assumptions 1 to 4. The production function used is

$$F(K_j) = AK_j - \frac{2}{\alpha}K_j^2.$$

Profit maximization determines capital demand $K_j = \alpha(A - (\rho + \tau_j))$, its slope $K' = -\alpha$ and the rent function $\pi_j = \frac{1}{2\alpha}K_j^2$. We adopt

$$W_j = (e - S) + B[(1 + \rho)S]^\beta + \pi_j + g_j^\delta G^\gamma$$

as the expression for aggregate indirect utility, which in turn determines the capital supply $S(\rho, \tau_j)$, and, using capital demand, ρ'.[39] Introducing the state government's objective function, using the budget constraints, we obtain

$$
\begin{aligned}
_j = (1 - \mu_j)\Big\{ &(e - S) + B[(1 + \rho)S]^\beta + \pi_j \\
&+ (t_j K_j)^\delta \left(\textstyle\sum_j p_j TK_j\right)^\gamma \Big\} + \mu_j\{t_j K_j\},
\end{aligned}
$$

with the corresponding first-order condition H_j.

The simulation exercise allows us to investigate whether the equilibrium tax rate can indeed be too high or too low ($\frac{\partial W_j}{\partial t} \lessgtr 0$) for any value of μ_j. Furthermore, Proposition 2 is based on simulation results, which uses the expressions obtained for $\frac{\partial W_j}{\partial t}$ for different values of μ_j.

We perform a grid search across a range of parameter values (using Maple). The model parameters are p_j, A, B, α, δ, γ, T and μ_j. We work with a total of three states, $j = 1, 2, 3$, assuming that $p_2 = \frac{1}{3}$, $p_1 \in (0.05, 0.15, 0.25)$ and $p_3 = 1 - p_1 - p_2$. Additionally, we simulate all possible permutations for three different and evenly spaced values of all the parameters except μ_j. This implies a total of 6,561 runs per simulation. Then we repeat the simulation for four values of $\mu_j \in \left(0, \frac{1}{3}, \frac{2}{3}, 1\right)$.

The program solves, in each run, for the equilibrium values of the state tax rates t_j and the rate of return in the federation ρ, and it then evaluates H_{t_j} (and K_j, π_j and $\frac{\partial W}{\partial t}$) at this solution.

For the parameters A and B we take 1 as the starting value and add increments of 1; whereas T takes on the values 0.05, 0.15, 0.25. The production function parameter α is set to 0.5, 1 and 1.5. For the parameters β, δ and γ, which range between zero and one, the program starts at 0.3 with two increments of 0.3. We impose $\rho = 0$ as the starting value for the solution algorithm. This may be considered a natural starting point, as it implies that the federation rate of return equals that in the rest of the world. Some parameter combinations yield no solutions. Inspection of those cases shows that this occurs when the exogenous parameters are incompatible (high γ and low T). Furthermore, some solutions imply equilibrium state tax rate outside the plausible interval [0,1]. Since, these solutions correspond only to a small subset and (more importantly) conform with the patterns found for the plausible solutions, we do not report them separately.

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[39]Note that in this specification $S_\tau = 0$.

Table A1 presents a basic description of the simulation results, while Tables A2 and A3 report the results leading to Proposition 2. For space reasons we present the results for state 1 only. Table A2 is key: if state tax rates are initially too high, they remain too high when μ increases, without exception.

* * * * *
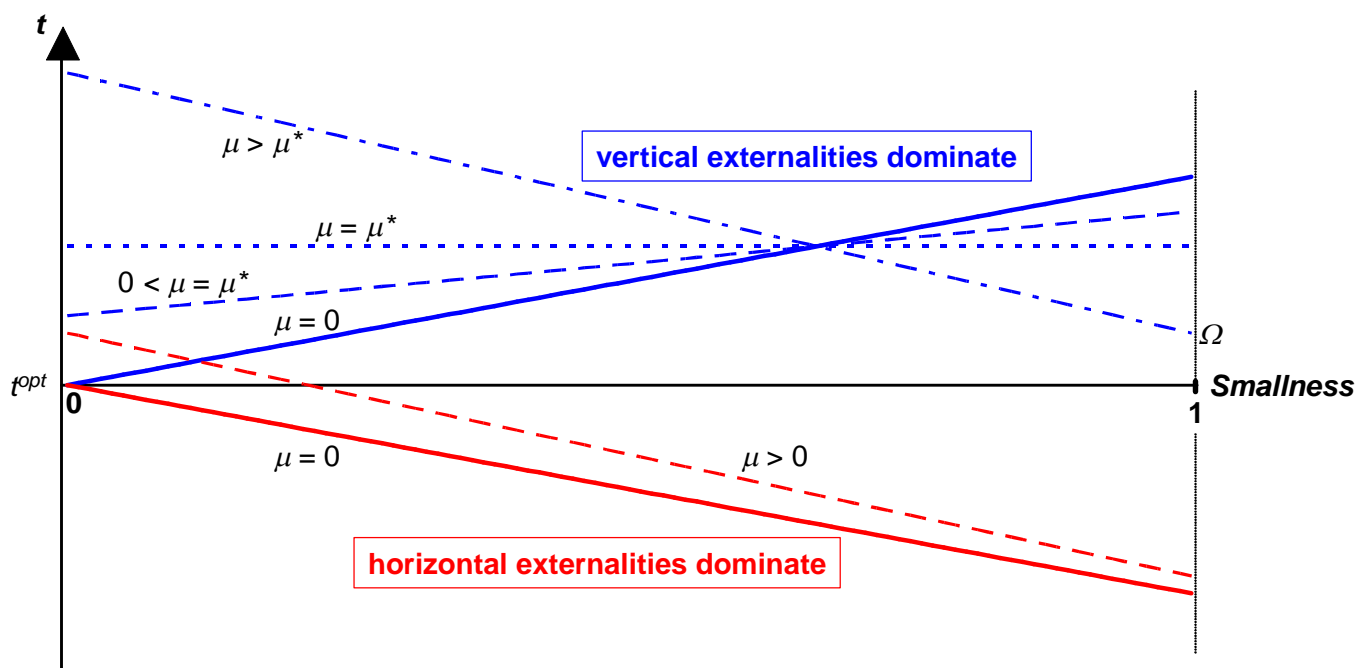
Figure 1: Smallness, Leviathan, and equilibrium tax rates

Variable	Obs.	Mean	Std. dev.	Mun. or cant. with min.	Mun. or cant. with max.
Municipality-level variables					
`Tax index`	635	0.00	0.84	Freienbach (SZ)	Porrentruy (JU)
`Tax index` ($\mu = 0$)	370	0.12	0.83	Freienbach (SZ)	Porrentruy (JU)
`Tax index` ($\mu = 1$)	265	-0.18	0.82	Carouge (GE)	La Chaux-de-Fonds (NE)
μ	650	0.42	0.49	(*several*)	(*several*)
Smallness	650	0.93	0.11	Basel (BS)	Nidau (BE)
Population	650	23,570	39,180	Appenzell (AI)	Zürich (ZH)
Share of pop. under 20	650	0.16	0.04	Lugano (TI)	Einsiedeln (SZ)
Share of pop. over 65	650	0.19	0.03	Volketswil (ZH)	Riehen (BS)
Area (hectares)	650	1,945	2,608	Nidau (BE)	Davos (GR)
Urban center dummy	650	0.41	0.49	(*several*)	(*several*)
Distance to freeway (km)	650	4.04	6.67	Morges (VD)	St. Moritz (GR)
Distance to airport (km)	650	48.48	38.06	(*several*)	St. Moritz (GR)
Lake shore (meters)	650	2,173	4,490	(*several*)	Einsiedeln (SZ)
Canton-level variables					
`Tax index`	650	0.00	0.87	Schwyz	Geneva
Latin dummy	650	0.27	0.44	(*several*)	(*several*)
Harmonized-tax dummy	650	0.22	0.41	(*several*)	(*several*)
Urbanized population	650	412,345	355,027	(*several*)	Zürich
Area (hectares)	650	220,772	192,636	Basel Stadt	Graubünden
Number of municipalities	650	177.50	126.74	Basel Stadt	Berne

Table 1: Summary statistics

Tax index of log tax rates. Government objectives (μ) according to referendum definition.

Variable	Obs.	Mean	Std. dev.	Mun. or cant. with min.	Mun. or cant. with max.
`Personal income tax rate`					
single, median inc.	650	4.13	1.10	Freienbach (SZ)	Le Locle (NE)
married, median inc.	650	3.53	1.18	Freienbach (SZ)	Le Locle (NE)
married, high inc.	650	10.52	2.33	Freienbach (SZ)	Amriswil (TG)
`Personal wealth tax rate`					
wealth = CHF200,000	640	0.11	0.07	Baar, Zug (ZG)	Glarus (GL)
wealth = CHF5,000,000	640	0.31	0.06	Freienbach (SZ)	Solothurn (SO)
`Corporate income tax rate`					
2% profitability	635	3.62	1.50	Herisau (AR)	(*several*)
9% profitability	635	5.14	1.75	Freienbach (SZ)	Porrentruy (JU)
32% profitability	635	7.58	2.72	Freienbach (SZ)	Solothurn (SO)
`Corp. capital tax rate`	635	0.22	0.11	Zug (ZG)	Glarus (GL)

Table 2: Tax rates

Tax rates in percent. Municipalities in the canton of Appenzell Innerrhoden and Basel Stadt do not levy corporate taxes; municipalities in the canton of Basel do not levy personal wealth taxes.

dependent var. = log municipal tax index	Referendum definition	Assembly definition
Smallness (main effect)	1.66 (0.18) 1.08	5.50*** (0.45) 1.85
Leviathan dummy ($\widetilde{\mu}$, main effect)	0.37** (0.22) 0.18	0.91*** (0.59) 0.27
$\widetilde{\mu}$*Smallness (interaction effect)	−2.95** (−0.21) 1.18	−7.19** (−0.42) 3.09
Cantonal tax index (T, instrumented)	0.33 (0.34) 0.20	0.37** (0.34) 0.18
Neighbors' avg. tax index ($\bar{t}_{-j}$, instrumented)	0.79* (0.25) 0.42	0.43 (0.07) 0.90
Population of municipality	−0.05 (0.04) 0.11	−0.37* (−0.28) 0.19
Share of mun. pop. under 20	0.28 (0.08) 0.26	0.23 (0.07) 0.22
Share of mun. pop. over 65	0.24 (0.05) 0.31	0.10 (0.02) 0.40
Area of municipality	0.10 (0.10) 0.07	0.30*** (0.31) 0.09
Urban center dummy	0.25** (0.15) 0.13	0.51*** (0.33) 0.19
Distance to freeway	−0.06 (−0.07) 0.05	−0.01 (−0.01) 0.08
Distance to airport	0.24*** (0.29) 0.09	0.32** (0.44) 0.13
Lake shore	−0.03*** (−0.16) 0.01	−0.03*** (−0.18) 0.01
Latin dummy	−0.53* (−0.29) 0.28	−1.43*** (−0.63) 0.33
Harmonized-tax dummy	−0.29* (−0.14) 0.16	0.18 (0.09) 0.14
Number of observations	635	310
Wald χ^2: Smallness main + interaction = 0	2.07 0.15	0.70 0.40
Wald χ^2: $\boldsymbol{\beta} = \mathbf{0}$	337.29 0.00	592.26 0.00
Hansen J statistic	5.65 0.58	7.72 0.36
1st-stage instr. F statistic, Cantonal tax	15.45	48.81
1st-stage instr. F statistic, Neighbors' tax	27.09	21.86

Table 3: Baseline tax index regressions (spatial GMM)

Beta coefficients in parentheses, standard errors below. *** significant at 1%, ** at 5% and * at 10%.
Two-tail P values below χ^2 and J statistics. Regressions include intercept and dummies for Geneva and
Basel-Land. All variables mean-differenced by year; non-dichotomous variables in natural logs. Cantonal
tax indices and neighboring municipal tax indices instrumented using all exogenous regressors plus canton
urban population, canton area, canton number of municipalities and weighted averages of municipal
variables as instruments. First-stage F statistics robust to spatial autocorrelation.

dep. var. = log munic. tax index	Smallness in terms of area	Smallness instrumented	Control for centralism	Control for centralism, Smallness instrumented
Smallness (main effect)	4.74 3.87	2.12 1.35	1.44 1.56	2.92 2.25
Leviathan dummy ($\widetilde{\mu}$, main eff.)	0.44** 0.21	0.37* 0.19	0.35* 0.19	0.38** 0.18
$\widetilde{\mu}$*Smallness (interaction)	−9.73 7.62	−4.19*** 1.52	−2.74* 1.52	−5.37** 2.20
Cantonal tax index (T, instrum.)	0.34* 0.19	0.28 0.19	0.36 0.28	0.18 0.32
Neighbors' avg. tax index ($\bar{t}_{-j}$, instrumented)	0.59 0.48	0.70* 0.42	0.76* 0.45	0.69* 0.41
Centralization ratio (instrum.)	(n.a.)	(n.a.)	−0.12 0.75	0.26 1.04
Population of municipality	−0.08 0.11	−0.09 0.10	−0.06 0.13	−0.08 0.13
Share of mun. pop. under 20	0.29 0.29	0.17 0.28	0.28 0.26	0.13 0.30
Share of mun. pop. over 65	0.25 0.33	0.23 0.31	0.23 0.33	0.25 0.31
Area of municipality	0.12 0.10	0.12 0.08	0.10 0.07	0.12 0.08
Urban center dummy	0.23* 0.12	0.24* 0.13	0.25* 0.13	0.21* 0.12
Distance to freeway	−0.06 0.05	−0.08 0.05	−0.07 0.05	−0.08* 0.05
Distance to airport	0.26*** 0.09	0.25*** 0.09	0.24*** 0.09	0.25*** 0.09
Lake shore	−0.03** 0.01	−0.04*** 0.01	−0.03** 0.01	−0.04** 0.02
Latin dummy	−0.56** 0.28	−0.48* 0.28	−0.53* 0.28	−0.46* 0.27
Harmonized-tax dummy	−0.25 0.17	−0.32** 0.16	−0.27 0.19	−0.38 0.24
Wald χ^2: Smalln. main + int'n = 0	0.50 0.48	3.00 0.08	2.09 0.15	3.93 0.05
Wald χ^2 (F): $\boldsymbol{\beta} = \mathbf{0}$	332.40 0.00	334.24 0.00	336.08 0.00	335.42 0.00
Hansen J statistic	6.70 0.46	5.32 0.62	5.43 0.61	5.87 0.56
1st-stage F stat., Cant. tax	17.22	22.49	15.45	22.49
1st-stage F stat., Mun. tax	25.70	25.48	27.09	25.48
1st-stage F stat., Centr. ratio	(n.a.)	(n.a.)	18.03	17.34
1st-stage F stat., Smalln. main eff.	(n.a.)	11.73	(n.a.)	11.73
1st-stage F stat., Smalln. int'n.	(n.a.)	2.21	(n.a.)	2.21

Table 4: Alternative tax index regressions (spatial GMM)

All regressions based on referendum definition (635 observations). Standard errors below coefficients. *** significant at 1%, ** at 5% and * at 10%. Two-tail P values below χ^2 and J statistics. Regressions include intercept and dummies for Geneva and Basel-Land. All variables mean-differenced by year; non-dichotomous variables in natural logs. Instrument sets include variables listed in notes to Table 3, plus area-based Smallness. Spatial GMM first-stage F statistics robust to spatial autocorrelation.

dep. var. = log munic. tax index	Baseline regression	Smallness instrumented	Control for centralism	Control for centralism
Smallness (main effect)	1.80* 1.00	1.85 1.29	2.25 1.54	2.28 2.96
Leviathan dummy ($\widetilde{\mu}$, main eff.)	0.16 0.16	0.23 0.17	0.17 0.16	0.22 0.17
$\widetilde{\mu}$*Smallness (interaction)	−2.47** 1.15	−4.31** 1.67	−2.77* 1.54	−4.65 3.17
Cantonal tax index (T, instrum.)	0.17 0.18	0.20 0.19	0.09 0.27	0.13 0.39
Neighbors' avg. tax index ($\bar{t}_{-j}$, instrumented)	0.53 0.34	0.53 0.34	0.57 0.36	0.57 0.40
Centralization ratio (instrum.)	(n.a.)	(n.a.)	0.37 0.95	0.21 1.39
Population of municipality	0.01 0.11	−0.10 0.12	0.05 0.13	−0.07 0.15
Share of mun. pop. under 20	0.13 0.27	0.13 0.30	0.12 0.27	0.10 0.32
Share of mun. pop. over 65	0.23 0.33	0.17 0.33	0.29 0.36	0.23 0.40
Area of municipality	0.08 0.08	0.08 0.08	0.08 0.08	0.08 0.08
Urban center dummy	0.20 0.14	0.19 0.14	0.18 0.15	0.18 0.15
Distance to freeway	−0.07 0.05	−0.09 0.05	−0.06 0.06	−0.09 0.05
Distance to airport	0.28*** 0.09	0.28*** 0.10	0.28*** 0.09	0.28*** 0.10
Lake shore	−0.04*** 0.01	−0.04*** 0.01	−0.04*** 0.01	−0.04** 0.02
Latin dummy	−0.31 0.27	−0.38 0.28	−0.34 0.29	−0.37 0.28
Harmonized-tax dummy	−0.27* 0.15	−0.29* 0.16	−0.31* 0.17	−0.32 0.24
Wald χ^2: Smalln. main + int'n = 0	0.69 0.41	2.74 0.09	0.38 0.53	2.82 0.09
R^2	0.59	0.59	0.57	0.57
Hansen J statistic	7.85 0.35	7.04 0.43	7.46 0.28	6.48 0.37
1st-stage F stat., Cant. tax	81.30	75.98	81.30	75.98
1st-stage F stat., Mun. tax	110.87	94.55	110.87	94.55
1st-stage F stat., Centr. ratio	(n.a.)	(n.a.)	69.33	72.31
1st-stage F stat., Smalln. main eff.	(n.a.)	115.28	(n.a.)	115.28
1st-stage F stat., Smalln. int'n.	(n.a.)	43.52	(n.a.)	43.52
Moran's I (spatial autocorr.)	0.28 0.00	0.25 0.00	0.27 0.00	0.24 0.00

Table 5: Alternative tax index regressions (2-Stage Least Squares)

All regressions based on referendum definition (635 observations). Standard errors below coefficients. *** significant at 1%, ** at 5% and * at 10%. Two-tail P values below χ^2 and J statistics. Regressions include intercept and dummies for Geneva and Basel-Land. All variables mean-differenced by year; non-dichotomous variables in natural logs. Instrument sets include variables listed in notes to Table 3, plus area-based Smallness. Standard errors and first-stage F statistics based on heteroskedasticity consistent standard errors, clustered by municipality. Moran's I based on 15 km distance bands, P value below.

dep. var. = log tax rate on...	Smallness	$\widetilde{\mu}$	$\widetilde{\mu}$*Smallness	# of obs.	Wald χ^2	J stat.	F stat. T	F stat. $\bar{t}_{-j}$
Referendum definition								
Personal Income								
single median. inc.	0.36* 0.20	0.05 0.06	−0.58 0.20	650	10.36 0.00	3.93 0.79	10.11	793.53
married median inc.	0.44*** 0.17	0.07 0.06	−0.69*** 0.17	650	12.13 0.00	5.31 0.62	6.98	549.69
married high inc.	0.79 0.73	0.05 0.07	−0.87 0.72	650	2.00 0.16	6.79 0.45	8.83	2,012.95
Wealth								
200k	−1.17 0.73	0.08 0.10	−0.32 0.95	640	3.03 0.08	6.96 0.43	4.80	376.24
5m	0.38* 0.21	0.03 0.04	−0.12 0.24	640	2.19 0.14	4.92 0.67	13.54	574.55
Corporate Income								
2% profit	−0.37 0.46	−0.02 0.10	0.72 0.52	635	0.96 0.32	9.15 0.24	8.67	50.90
9% profit	−0.88* 0.50	0.12 0.09	0.94 0.58	635	0.04 0.84	9.66 0.21	9.87	52.78
32% profit	0.17 0.41	0.26*** 0.06	−0.33 0.47	635	0.28 0.60	11.39 0.12	6.62	108.72
Capital	−2.22*** 0.61	0.06 0.07	1.26* 0.72	635	4.14 0.04	11.38 0.12	13.81	110.77
Assembly definition								
Personal Income								
single median inc.	0.80** 0.33	0.18*** 0.04	−1.03*** 0.37	325	12.47 0.00	8.16 0.31	15.95	3,780.34
married median inc.	0.66* 0.36	0.15*** 0.05	−0.81** 0.38	325	3.76 0.05	5.99 0.54	13.78	1,512.34
married high inc.	2.24** 0.90	0.31*** 0.08	−2.49*** 0.95	325	11.88 0.00	8.21 0.31	20.96	9,622.86
Wealth								
200k	−0.53 1.34	0.19 0.44	0.01 5.63	315	0.01 0.92	2.95 0.89	4.96	300.03
5m	1.04*** 0.32	0.20*** 0.07	−1.58*** 0.53	315	1.26 0.26	7.09 0.42	16.95	918.97
Corporate Income								
2% profit	0.14 0.69	0.20* 0.11	−0.31 1.20	310	0.05 0.82	5.19 0.64	6.80	516.10
9% profit	0.96* 0.57	0.23*** 0.07	−0.67 0.79	310	0.47 0.50	5.60 0.59	7.50	1,044.38
32% profit	1.81*** 0.50	0.29*** 0.09	−1.49* 0.90	310	0.34 0.56	3.02 0.88	6.75	640.70
Capital	−0.95 1.86	0.17 0.20	0.50 2.25	310	0.06 0.80	2.57 0.92	8.18	417.40

Table 6: Regressions for individual tax instruments (spatial GMM)

Standard errors below coefficients. *** significant at 1%, ** at 5% and * at 10%. χ^2 statistics of Wald test of H0: Smallness main + interaction = 0; two-tail P values below. Non-reported controls are identical to Table 3; except harmonized-tax dummy, which is not included for personal taxes. Cantonal tax indices (T) and other municipal tax indices ($\widehat{t}_i$) instrumented using all exogenous regressors plus identifying instruments (see notes to Table 3). First-stage F statistics robust to spatial autocorrelation.

μ	Runs with $\sum_i \frac{\partial W_1}{\partial t_i} < 0$ (state taxes too high)	Runs with $\sum_i \frac{\partial W_1}{\partial t_i} > 0$ (state taxes too low)	no solution
0	3,111	3,370	80
$\frac{1}{3}$	5,624	922	15
$\frac{2}{3}$	6,361	200	0
1	6,445	116	0
Sum	*21,541* *(82.1%)*	*4,608* *(17.6%)*	*95* *(0.1%)*
$\Delta\mu$	Runs with $\frac{\Delta t}{\Delta \mu} < 0$ (Leviathan has lower taxes)	Runs with $\frac{\Delta t}{\Delta \mu} > 0$ (Leviathan has higher taxes)	No solution
0-$\frac{1}{3}$	0	6,481	80
$\frac{1}{3}$-$\frac{2}{3}$	0	6,546	15
$\frac{2}{3}$-1	1,218	5,343	0
Sum	*1,218* *(6.2%)*	*18,370* *(93.3%)*	*95* *(0.5%)*

Table A1: Basic simulation results

Simulations are described in the Appendix. Each simulation run covers 6,561 different parameter configurations. Some solutions imply equilibrium state tax rates outside [0,1].

μ	Runs with $\sum_i \frac{\partial W_1}{\partial t_i} < 0$ (state taxes too high)	Runs with $\sum_i \frac{\partial W_1}{\partial t_i} > 0$ (state taxes too low)
0	3,111	n.a.
$\frac{1}{3}$	3,111	0
$\frac{2}{3}$	3,111	0
1	3,111	0
$\frac{1}{3}$	5,624	n.a.
$\frac{2}{3}$	5,624	0
1	5,624	0
$\frac{2}{3}$	6,361	n.a.
1	6,361	0

Table A2: Simulation results: reducing government benevolence when taxes are initially too high

Simulations are described in the Appendix. Only runs where $\left.\frac{\partial W_j}{\partial t}\right|_{\overline{\mu}} < 0$ are considered. Some solutions imply equilibrium tax rates outside [0,1].

μ	Runs with $\sum_i \frac{\partial W_1}{\partial t_i} < 0$ (state taxes too high)	Runs with $\sum_i \frac{\partial W_1}{\partial t_i} > 0$ (state taxes too low)
1	n.a.	116
$\frac{2}{3}$	0	116
$\frac{1}{3}$	0	116
0	0	116
$\frac{2}{3}$	n.a.	200
$\frac{1}{3}$	0	200
0	0	200
$\frac{1}{3}$	n.a.	922
0	0	922

Table A3: Simulation results: increasing government benevolence when taxes are initially too low

Simulations are described in the Appendix. Only runs where $\left.\frac{\partial W_j}{\partial t}\right|_{\overline{\mu}} > 0$ are considered. Some solutions imply equilibrium tax rates outside [0,1].