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Does fiscal decentralization constrain Leviathan? New evidence from local property tax competition

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Abstract This paper reexamines whether fiscal decentralization constrains Leviathan government. Using panel data for Pennsylvania, we compare actual property tax rates to the Leviathan revenue-maximizing rates for municipalities, school districts, and counties. Using spatial econometric methods we also estimate the degree of spatial dependence at the three levels of local government. We find that fiscal decentralization results in stronger intergovernmental competition and lower tax rates. We also find evidence of collusion among school districts that exhibit high interdependence but also high tax rates. This calls into question the current literature's blind use of spatial dependence as a measure of intergovernmental competition.

Keywords Fiscal decentralization · Leviathan · Tax competition · Spatial dependence

JEL Classification H77 · H73

1 Introduction

The Brennan and Buchanan (1977, 1978, 1980) Leviathan model of government has become a mainstay of the public economics literature. In this framework, the Leviathan government's objective is to maximize its size. In the absence of any constraints, a Leviathan government will set tax rates that maximize tax revenue, and end up operating at the peak of the Laffer curve. According to the model, there are only two possible constraints on the Leviathan

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behavior of governments—constitutional constraints and the presence of intergovernmental competition from competing jurisdictions.[1]

The related fiscal federalism/fiscal decentralization literature spins out of the Tiebout (1956) theory of intergovernmental competition. Oates (1999) describes fiscal federalism as a framework assigning different functions to the different levels of government, usually on the basis of the extent of external (or spillover) costs and benefits. While federalism describes a hierarchy of governments, its byproduct is a large number of competitive jurisdictions at lower levels. It is this 'horizontal' competition on which studies of decentralization and government size are based. As the level of competition between governmental units increases the constraint on Leviathan-type behavior grows stronger. In the extreme, competition between governments may approximate market outcomes (Dowding et al. 1994).

A large body of literature exists that attempts to examine empirically whether the presence of intergovernmental competition constrains the Leviathan behavior of governments. This literature has used the number of local governments as a measure of fiscal decentralization, and the levels of taxing and spending per capita, or as percentages of economic activity. This previous literature has examined local, state, and international data and has found mixed results. For example, Oates (1972, 1985, 1989), Forbes and Zampelli (1989), Anderson and van den Berg (1998), and Heil (1991) all find little or no impact of a larger number of governments on government size, while Zax (1989), Joulfaian and Marlow (1990), Nelson (1986, 1987), Eberts and Gronberg (1988), Grossman (1989), Marlow (1988), Shadbegian (1999), and Stansel (2006) all support the conclusion that fiscal decentralization constrains Leviathan.[2] Finally, Cassette and Paty (2010) show that decentralization decreases spending at the federal level while increasing expenditure at the sub-national level using data from the European Union.

In this literature, several recurrent problems have been identified that may explain the mixed nature of the findings across studies. First, both constitutional constraints and competition tend to constrain the Leviathan behavior of governments and none of these studies attempt to control explicitly for the different constitutional constraints faced by the governments in their samples. This is a significant problem for studies using international, cross-country data as constitutions differ significantly across countries, and is also a problem (although of a lesser extent) for studies using cross-sections of U.S. states or Canadian provinces who also face different constitutional constraints. A second problem in previous studies is the use of various measures of total government size as proxies for the level of competition or constraints on the government rather than data on specific tax rates and how they compare across jurisdictions or levels of government.

The third and final problem identified in this literature, the most important of the three, is that the results for single-purpose governmental units (like school districts or special governmental units offering only fire or water service) seem to be fundamentally different than

[1] It is worth explicitly noting that Brennan and Buchanan (1980) use their model to derive the precise constitutional constraints that best limit the Leviathan power of government. Also, see Holcombe (1994) for an explanation of how constitutions serve as a substitute for mobility in constraining the Leviathan behavior of governments.

[2] In related studies using international data, Arikan (2004) finds that a larger number of governmental units lowers government corruption and Faguet (2004) finds that decentralization increases responsiveness to local demands for public services. Akai and Sakata (2002) find that decentralization increases the rate of economic growth, and Brueckner (2006) presents a theoretical model in which fiscal federalism leads to greater investment in human capital. Thus, these studies all implicitly support the Leviathan model in which decentralization constrains government. Dye and McGuire (1997) provide further indirect evidence in support of the Leviathan model by analyzing changes in fiscal behavior under property tax limits.

the results found using traditional (multi-purpose) jurisdictions such as city, county, or national governments. For single-purpose jurisdictions the theory and evidence seem to suggest that fragmenting them into more units tends to either have no impact or a positive impact on spending (see Boyne 1992; Eberts and Gronberg 1988; Baird and Landon 1972; Chicoine and Walzer 1985; Dowding et al. 1994; and Zax 1988). Once single-purpose districts are thrown out of the analysis, Nelson (1987) and others show that more decentralization clearly leads to more competitive, and smaller, governments.

In this paper we contribute to this literature using panel data on property tax rates for municipalities, counties, and school districts in Pennsylvania. By focusing on one state we are able to avoid problems with differing state or national constitutional constraints (e.g., even local property tax limit laws in the United States are generally imposed on a state-wide basis). While tax limits are imposed on jurisdictions in Pennsylvania, they typically are not strictly binding.[3] In addition, by narrowing our focus we are able to specifically examine tax rates rather than more vague measures of overall government size, which can be misleading due to intergovernmental grants or other factors (see Grossman 1989; Marlow 1988; and Shadbegian 1999 for a discussion of how tests of the Leviathan model can be confounded by intergovernmental grants and intergovernmental collusion). Finally, and perhaps most importantly, we exploit two more recently introduced measures of the competitiveness of governmental units, introduced recently and nowadays being adopted widely, but are not fully understood in terms of how they compare or what they exactly measure. In particular, our measures are: (1) a Laffer-curve based estimate of the extent to which the current tax rate compares to the rate that would maximize tax revenue, and (2) an estimate of spatial dependence across jurisdictions (ρ) that measures the correlations across geographic space in the setting of tax rates.

Our study differs from the previous federalism/Leviathan literature in that we model and empirically test the mechanism through which federalism limits Leviathan. Likewise, we extend the intergovernmental competition literature by providing empirical evidence on its implications for the size of government. In sum, this paper combines the Leviathan, federalism, and government competition literatures into one concise framework based on two models.

Using the Laffer-curve framework, we find that local Pennsylvania jurisdictions do indeed set tax rates below the Leviathan revenue-maximizing levels, and that the more prevalent (and thus more competitive) municipal governments operate further below their revenue-maximizing rates than do less prevalent (and thus less competitive) county governments. In addition, using spatial econometric methods we find that the level of spatial dependence among tax rates is greater (and thus more competitive) among municipal governments than among county governments. Therefore, both measures point to the conclusion that more fiscal decentralization, as measured by a larger number of governments in a given geographic area, leads to a weakened ability for governments to achieve Leviathan outcomes.

Our results for Pennsylvania school districts, which are single-purpose jurisdictions, are even more interesting. Our results confirm the idea from the previous literature that single-purpose governments differ from multi-purpose ones. We find that school districts, which are more prevalent than county governments, but less prevalent than municipal governments, do not fall in the middle of our measures of Leviathan tax rate setting and spatial dependence

[3]For school districts, for example, additional levies above the limit are allowed to pay teachers, rent, and interest on debt. These exceptions effectively eliminate (or at least significantly reduce) the 'constitutional constraint' on taxing power (Hartman and Nelson 2000).

as expected. Instead, school districts seem to be the closest to achieving Leviathan, revenue-maximizing tax rates (suggesting they are the least competitive) while they have the greatest degree of spatial dependence among their tax rates (suggesting, oppositely, that they are the most competitive). This result highlights the fact that the more modern measure of spatial dependence as an estimate of intergovernmental competition may to measure accurately the level of intergovernmental competitiveness. In fact, a high level of spatial dependence in tax rates could be either a sign of competition *or* its opposite, collusion, as collusive behavior also results in high interdependence in the setting of tax rates. We further delve into this result for school districts by attempting to uncover whether it is their single-purpose nature that causes this odd result, along the lines of Nelson (1987) and Eberts and Gronberg (1988), or instead whether this result is due to collusive behavior among school districts, similar to that described by Grossman (1989), Marlow (1988), and Shadbegian (1999). Based on these findings, we propose a new taxonomy that classifies governmental behavior into one of four possible types, and shows the necessity of relying on more than the single measure of spatial dependence to determine the competitiveness of governments.

Taken together, our results provide compelling evidence that fiscal decentralization does constrain Leviathan behavior, and that measures of spatial dependence in tax rates are likely imperfect measures of intergovernmental competition in the face of collusive behavior and/or single-purpose jurisdictions, relative to measures based on Laffer-curve estimates of how close governments are to achieving revenue maximization.

2 Data

We use a panel of annual data on property tax rates and tax revenue for all levels of local governments in Pennsylvania from 1995 through 2005 to estimate our models. Our unique data set includes three distinct levels of government: municipalities, school districts, and counties. In total there are 2,522 municipalities, 501 school districts, and 66 counties in our sample. Based on the fiscal decentralization literature one would expect that municipalities would be the most competitive (as they are the most numerous), while counties would be the least (as they are the least numerous), with school districts somewhere in between.[4]

While we are able to use the full sample for our Laffer-curve type estimates of how close each government's tax rate is to the revenue-maximizing level, our spatial dependence measures require the estimation of a balanced panel. Our balanced panel consists of 1,730 municipalities, 58 counties, and 500 school districts for the ten-year period 1995–2004. To ensure that the differences in the estimates from the two different approaches are not driven by the different samples, we estimate our Laffer-curve type model on both the balanced and unbalanced panels. Descriptive statistics for all variables used in our paper are found in Appendix.

For county and municipal governments we obtain property tax rates from the Pennsylvania Department of Community and Economic Development's Municipal Statistics. The tax rates used in this study are millage rates, expressed as taxes paid per $1,000 of assessed value. The rate at which property is assessed relative to its market value varies by county and year. We use the 'common-level ratio' (CLR) computed by the Pennsylvania State Tax Equalization Board to adjust for this. Our definition of the effective tax rate is thus the

[4]While this is the view taken in the majority of the literature, Epple and Zelenitz (1981) present a theoretical model showing that increasing the number of jurisdictions does not necessarily completely eliminate governmental inefficiency.

product of the statutory tax rate and its corresponding CLR (the rate at which property is assessed relative to its market value). Per-capita property tax revenue is also obtained from the aforementioned Municipal Statistics, and we adjust it for inflation using the Consumer Price Index (CPI).

School district property tax rates and revenues are from the Pennsylvania Department of Education. Differences in assessment rates are again corrected by using information from the State Tax Equalization Board. The computation of annual revenue on a per capita basis for school districts, however, is not possible because unlike municipal and county populations, which are available annually, school district populations are available only once per decade in census data. We therefore employ two measures. First, the number of students enrolled in each school district is available annually, so we can compute property tax revenue per student. Second, as a check for robustness, we also estimate annual school district populations to compute property tax revenue per capita (rather than per student) by assuming that the ratio of school district-to-county population remains unchanged. We then use annual county level population changes to extrapolate annual changes in population within school districts starting from the actual school district head counts taken from the 2000 census school district population.

3 Laffer curves and Leviathan: theoretical model

The Laffer curve shows the inverted U-shaped relationship that exists for a government between the tax rate it sets and the tax revenue it receives (see, for example, Laffer 2004). Tax revenues are the smallest at either very low or very high tax rates, and are at their maximum somewhere in between. This tax rate that maximizes tax revenue is the rate a Leviathan government would set in the absence of constitutional constraints or intergovernmental competition. Mathematical models of this relationship, used by Brennan and Buchanan (1980), Garrett (2001), Sobel (1999), and others, allow estimation of the tax rate that maximizes tax revenue for a given government. This revenue-maximizing rate can then be compared to the actual tax rates to derive a measure of the extent to which a government is able to achieve its Leviathan goals. The further the current tax rate is below the revenue-maximizing tax rate, the more the government is being constrained by either formal constitutional constraints or by intergovernmental competition.[5]

This methodology has been used extensively in the literature, and we specifically follow Garrett (2001) and Sobel (1999) in developing a Leviathan model that subsequently can be estimated on our data. For government i at time t, total tax revenue, R_{it} is given by the product of the tax rate (τ_{it}) and the level of the tax base, B_{it}. The tax base is a function of the tax rate in that higher rates shrink the tax base, thus necessitating a functional form of $B_{it}(\tau_{it})$ for the tax base to show that it is a function of the tax rate.[6]

$$R_{it} = \tau_{it} B_{it}(\tau_{it}) \tag{1}$$

[5] Our model is based on the Leviathan theory of Brennan and Buchanan (1977, 1978, 1980) which assumes government's objective is to maximize its size. In this model, only strict constitutional rules or intergovernmental competition can constrain government. Other fundamentally different theories of government exist, including median voter models (which assume that voter demand drives government action) and so-called 'benevolent dictator' models (which assume that governments weigh costs and benefits with an objective of maximizing social welfare).

[6] Consistent with other models of taxation in a federal system, see for example Sobel (1997), we model each level of government as setting tax rates holding constant the rates of the other levels of government.

A first-order linear approximation of the impact of the tax rate on the tax base can be given by:

$$B_{it} = \alpha + \beta\tau_{it} \tag{2}$$

where $\alpha > 0$ and $\beta < 0$. Substituting (2) into (1) yields:

$$R_{it} = \alpha\tau_{it} + \beta\tau_{it}^2 \tag{3}$$

The Leviathan revenue-maximizing tax rate is then found by differentiating (3) with respect to τ_{it} and solving the first-order condition:

$$\partial R_{it}/\partial\tau_{it} = \alpha + 2\beta\tau_{it} = 0 \tag{4}$$

which results in a solution for the tax rate that maximizes tax revenue, τ_{it}^{revmax}:

$$\tau_{it}^{revmax} = -\frac{\alpha}{2\beta} \tag{5}$$

An unconstrained Leviathan government seeking to maximize revenue will set its tax rate equal to the one shown in (5).[7] Thus, an approximation for the degree to which a government is able to achieve this Leviathan outcome can be measured as the ratio of its current tax rate, τ_{it}, to the revenue-maximizing rate, τ_{it}^{revmax}. This relationship, which we dub the 'Leviathan ratio,' is thus given by:

$$\mathit{Leviathan\ Ratio} = \frac{\tau_{it}}{\tau_{it}^{revmax}} \tag{6}$$

In theory this Leviathan ratio should take on values between zero and one with higher values indicating less competitive behavior.[8] The Leviathan ratio will take the value of one if the government is currently achieving revenue maximization, while it will be less than one (but greater than zero) if it is not. The lower is this ratio, the more the government is being constrained from reaching its Leviathan goals.

Empirically, this revenue-maximizing tax rate to which the actual tax rate is to be compared can be found by first estimating the revenue equation given in (3) to obtain the values of α and β necessary to compute the revenue-maximizing rate using (5). Including cross-section (Z_i) and time-period (Y_t) fixed effects as well as an error term yields the equation to be estimated:

$$R_{it} = \alpha\tau_{it} + \beta\tau_{it}^2 + \mu_1 Z_i + \mu_2 Y_t + \varepsilon_{it} \tag{7}$$

where R_{it} is defined as real per capita tax revenue to adjust for inflation and jurisdiction size.[9]

[7] Our empirical model focuses only on property tax rates and revenue and does not consider other types of optional taxes or usage fees.

[8] A value greater than one is mathematically possible, but would suggest the government is setting a tax rate above the revenue-maximizing rate, in the 'prohibitive range' of the Laffer curve.

[9] This specification estimates the relationship between effective property tax rates and revenue for the average jurisdiction. Accurately estimating the revenue-maximizing tax rate for each individual jurisdiction would require a time series longer than the ten years available in our data. Since the vast majority of governments set tax rates well below this average revenue-maximizing rate, comparisons to individual revenue-maximizing rates would likely produce similar results.

Table 1 Laffer curve models. Dependent variable: real per capita property tax revenue

	Municipality	County	School district
Years	1995–2005	1995–2004	1995–2005
Effective Property Tax Rate (α)	6.576***	32.293***	276.143***
	(6.723)	(6.138)	(28.515)
Effective Property Tax Rate Squared (β)	−0.094***	−1.280**	−3.458***
	(−4.794)	(−2.094)	(−17.417)
Calculated Revenue-Maximizing Rate ($\alpha/-2\beta$)	35.12	12.62	39.93
Number of Observations (N, T)	26391 (2522, 11)	649 (66, 10)	5511 (501, 11)
R-squared	0.90	0.92	0.98

Note: All models include cross-section and time period fixed effects, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%

4 Laffer curve results

We estimate Laffer-curve models for each level of local government independently. Our Laffer-curve estimates are summarized in Table 1. The coefficients for both effective tax rate and effective tax rate squared are statistically significant in all three specifications and have signs consistent with our model, with $\alpha > 0$ and $\beta < 0$.

The third row of Table 1 includes the estimated revenue-maximizing rate, calculated in accordance with (5). The estimated revenue-maximizing effective property tax rate is 35.12 mills for municipalities, 12.62 mills for counties, and 39.93 mills for school districts.

As detailed in Sobel (1999) and Garrett (2001), these point estimates of the revenue-maximizing rates found by taking the ratio of the two coefficient estimates are not actually the 'best' estimate as they ignore the covariance between the estimates of α and β. That is, the expected value of the ratio of two coefficients is not identical to the ratio of the expected values of each individual coefficient. To account for this, we follow the procedure used in Sobel (1999) and originally described by Jeong and Maddala (1993) of using Monte Carlo simulations based on the point estimates and covariance matrices for each jurisdiction to compute empirical distributions of the estimated revenue-maximizing tax rates. The means of these distributions, along with the associated 90% and 95% confidence intervals are summarized in Table 2. These rates provide a more accurate approximation of the revenue-maximizing rates for each jurisdiction. The municipality and school district simulation estimates are nearly identical to the original regression estimate, while the county rate taken from the empirical distribution is higher.

To determine how close individual jurisdictions are to behaving like revenue-maximizing Leviathans, we compare actual tax rates to our simulation estimates by computing the Leviathan ratio given in (6). Simply comparing these estimated revenue-maximizing rates with the average rates set by each level of government suggests that, on average, all levels set tax rates well below revenue-maximization. The average municipality in our sample has an effective tax rate set at only 5% of the revenue-maximizing rate. Similarly, the average county sets a rate equal to 24% of revenue maximization. Interestingly, school districts set rates nearest to revenue-maximization, with the average district tax rate 53% of the Leviathan rate. Thus, using these ratios to rank different levels of government implies that municipalities are the most competitive and least able to achieve Leviathan goals, followed by counties, with school districts as the least competitive and closest to achieving the Leviathan outcome of unconstrained revenue maximization.

Table 2 Revenue-maximizing tax rates

	Municipality	County	School district
Revenue-Maximizing Tax Rate: Regression Point Estimate ($\alpha/-2\beta$)	35.12	12.62	39.93
Revenue-Maximizing Tax Rate: Monte Carlo Simulation Estimate of Mean of the Empirical Distribution	35.71	14.41	39.99
Lower 90% Confidence Interval	29.95	8.61	38.43
Upper 90% Confidence Interval	43.75	34.52	41.72
Lower 95% Confidence Interval	29.03	8.04	38.19
Upper 95% Confidence Interval	46.18	51.74	42.11
Number of Observations			
Number < 90% CI	26388	649	5486
Number within 90% CI	4	0	20
Number > 90% CI	3	0	5
Number < 95% CI	26388	649	5482
Number within 95% CI	4	0	24
Number > 95% CI	3	0	5
Percentage of Observations			
% < 90% CI	99.97%	100.00%	99.55%
% within 90% CI	0.02%	0.00%	0.36%
% > 90% CI	0.01%	0.00%	0.09%
% < 95% CI	99.97%	100.00%	99.47%
% within 95% CI	0.02%	0.00%	0.44%
% > 95% CI	0.01%	0.00%	0.09%
Leviathan Ratio: *Ratio of Actual to Revenue-Maximizing Tax Rate*			
Mean Actual Tax Rate	0.05443	0.24152	0.53291
Mode Actual Tax Rate	0.03193	0.21867	0.47263

Note: The regression point estimate is based on a calculation using the coefficient estimates from the model, a nonlinear combination of expected values; the mean of the empirical distribution is the expected value of the nonlinear combination, which differs because of the covariance between the coefficient estimates. Estimates are derived from 3,000 Monte Carlo simulations. Because of the skewness of the distributions, the upper and lower confidence ranges were switched appropriately (see Hall 1992; Jeong and Maddala 1993)

These averages, however, can mask differences across jurisdictions. Thus, it is necessary to compare each jurisdiction's tax rate individually against the estimated revenue-maximizing rate. In addition, with our estimated Monte Carlo distributions we can ask whether the rates set by any given jurisdiction are *significantly* below the revenue-maximizing rate. All 649 county observations lie below the revenue-maximizing rate, and outside of the associated confidence interval. Overall, 99.97% of municipalities have tax rates below those that would maximize revenue with only seven of the 26,388 observations lying either within or above the confidence limits. School districts have the highest percentage of jurisdictions within or above the confidence interval of revenue maximization, but still have 99.55% of observations falling below the Leviathan rate.

Figure 1 shows the relative frequency distribution of the Leviathan ratio for each individual local government for all three levels of government. The distribution for municipalities

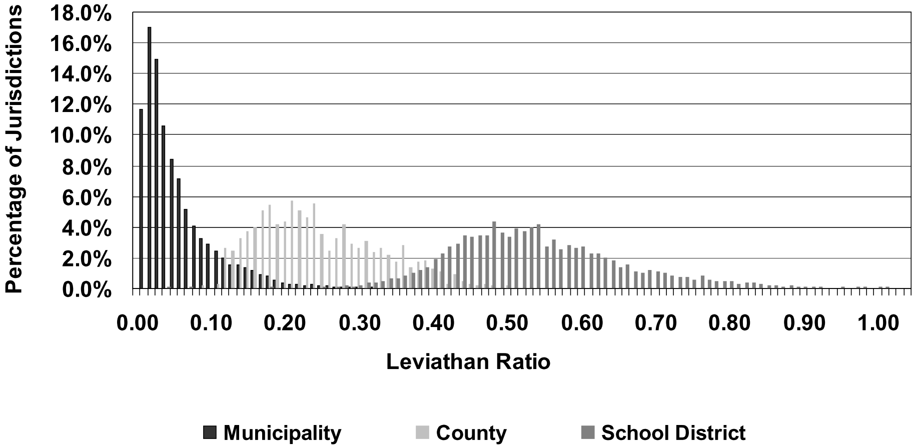

Fig. 1 Relative frequency distribution: Leviathan ratio

shows that they are clearly the furthest from achieving revenue maximization, followed by counties, with school districts being the closest to maximizing revenues. As is visible in Fig. 1, some school districts actually approach a Leviathan ratio of 1, implying that their actual tax rates are close to the revenue-maximizing rate.

The results from this Laffer-curve based estimation suggest that municipalities are indeed more competitive than counties, or alternatively, that counties are closer to achieving Leviathan outcomes than municipalities. With more municipalities than counties, this is consistent with the idea that greater decentralization leads to more intergovernmental competition and, hence, a lesser ability to maximize tax revenues. School districts, on the other hand, do not fit this model, as they seem to be more able to achieve Leviathan goals than counties even though the former are more numerous. Simply based on the number of governments, one would have expected the Leviathan ratios for school districts to fall somewhere between those for municipalities and counties. We revisit this issue after presenting our results of competitiveness based on spatial dependence in tax rates.

5 Spatial competition and interdependence: theory

Following the tradition of Tiebout (1956), a number of studies have attempted to model and empirically test strategic interaction across competing jurisdictions. Inter-jurisdictional tax competition has theoretical foundations in Mintz and Tulkens (1986), Oates and Schwab (1988), Kanbur and Keen (1993), and Brueckner (2000). Brueckner (2003) provides a survey of the empirical methodologies employed in these types of studies. Typically, the empirical specifications are based on policy best response functions derived from models assuming that at least one factor of production (e.g. labor or capital) is mobile. One such paper by Brueckner and Saavedra (2001) finds evidence of strategic property-tax competition in a sample of Boston metropolitan jurisdictions. Other tax competition studies based on this reaction function approach include Hayashi and Boadway (2001), Buettner (2001), and Brett and Pinkse (2000).

These models generally assume a mobile factor for which governments compete by the setting of tax or expenditure policy.[10] Since the factor's choice of location depends both on the policy of a given jurisdiction as well as the policy in competing jurisdictions, each government's policy is a function of its neighbors' policies. Note that this intergovernmental competition for the factor provides a theoretical explanation for the inverse relationship between tax base and tax rate shown in (2). Once the optimal policy as a function of exogenous variables is derived for a given jurisdiction's neighbors, its best-response function may be obtained.

We follow Brueckner and Saavedra (2001), who derive an empirical version of jurisdictions' reaction functions for property taxation:

$$\tau_i = \rho \sum_{j \neq i} \omega_{ij} \tau_j + X_i \beta + \varepsilon_i \tag{8}$$

where τ_i is the effective property tax rate in jurisdiction i, ε_i is a vector of error terms, and $\rho \sum_{j \neq i} \omega_{ij}$ is a weighting scheme that determines how neighboring jurisdictions' tax rates influence jurisdiction i's policy. The vector X_i contains demographic and policy variables for jurisdiction i which also affect the effective tax rate. The policy variables account for factors which directly impact the choice of τ_i while the demographic characteristics proxy for the preferences of consumer-voters. The weighting parameters ω_{ij} are chosen arbitrarily to quantify 'neighboring' jurisdictions. Traditionally, weight matrices have been based on contiguity or some function of distance (see LeSage and Pace 2009). Our initial analysis uses a contiguity weight matrix while additional specifications are explored as a test for robustness in a subsequent section of the paper.[11]

When (8) is extended to account for multiple time periods, it can be expressed as the panel model:

$$\tau_{it} = \rho \sum_{j \neq i} \omega_{ij} \tau_{jt} + X_{it} \beta + Z_i + Y_t + \varepsilon_{it} \tag{9}$$

with Z_i and Y_t again representing cross-section and time-period fixed effects. Once all jurisdictions are considered, and represented as vectors, (9) can be represented as

$$\tau_t = \rho W \tau_t + X_t \beta + \mu + \varepsilon_t \tag{10}$$

where τ_t is the vector of effective property tax rates such that $\tau_t = (\tau_{1t}, \ldots, \tau_{Nt})$, $X_t = (X_{1t}, \ldots, X_{Nt})$, $\varepsilon_t = (\varepsilon_{1t}, \ldots, \varepsilon_{Nt})$, W is the spatial weight matrix, and μ is a matrix of time and cross-section fixed effects. The weight matrix is made up of elements ω_{ij} from (7) and zeroes on the main diagonal. Since the geographic arrangement of jurisdictions does not change, the elements of W are time invariant. As before, the inclusion of fixed effects accounts for omitted variables which are invariant either through time or across space. Further, as noted by Elhorst and Fréret (2009) time-period fixed effects help correct for spatial interaction in the error term.

[10] Papke (1991) presents empirical evidence in support of this assumption by showing that new firm births in a given state are negatively related to effective business tax rates.

[11] Contiguity at the county level is first-order queen. School district and municipality contiguity is based on Delaunay triangles using latitude/longitude coordinates. Specifically, we use the 'xy2cont' function for MatLab from James P. LeSage's spatial econometrics toolbox.

Equation (10) is the spatial autoregressive (SAR) model to be estimated using maximum likelihood techniques.[12] The parameter of interest is ρ which measures the degree of spatial dependence. If governments are in competition with one another, one would anticipate a positive dependence among their tax rates. When one jurisdiction lowers its rates, nearby governments must lower tax rates as well to remain competitive. The larger is the degree of spatial dependence (ρ) the greater is the degree of competition. A value of zero would imply that governments act independently, either due to an absence of true competition or the presence of strict constitutional constraints that, for example, set tax rates at fixed levels.

In the estimation of (10), we include additional socio-economic variables similar to Brueckner and Saavedra (2001), with some variation due to data availability. These extra control variables are real per-capita expenditure, real median household income, the proportion of the population that is African American, the student proportion of the population, real per-capita state and federal grants, population, and population density. Per-capita expenditure is collected from the Municipal Statistics data for counties and municipalities and the National Center for Education Statistics (NCES) for school districts. One problem with including expenditures as an independent variable in determining tax rates is the possibility that they are endogenous in that tax revenues actually determine expenditures. To keep with the existing literature we include expenditures with a lag. However, in our robustness tests (detailed in Sect. 7), we estimate the model omitting this variable and find similar results. The expected sign for expenditure is positive as jurisdictions will set higher rates, ceteris paribus, as their expenditure needs grow. Data for state and federal grants is also obtained from Municipal Statistics for counties and municipalities, and from NCES for school districts. As grants increase we would expect to see a fall in effective tax rates. As before, these variables are adjusted for inflation using the Consumer Price Index (CPI). Finally, the population data come from the Municipal Statistics for counties and municipalities and the NCES for school districts.

Data for median household income, the proportion African American, the proportion student-aged among the population, and population density are all obtained from Census estimates at the county level. For the municipality and school district models these county variables are considered to be reasonable proxies for jurisdictional characteristics. The expected sign for income is negative since higher incomes likely translate into higher property values which means the same level of public goods can be provided by the jurisdiction at lower rates, ceteris paribus. The proportion of the population that is African American captures any differences in demand for policy that results from larger minority populations. Similarly, population density captures differences in tax policy resulting from the urban/rural characteristics of the jurisdiction. Finally, we include the proportion of the population that is made up of students to control for differences in the age distribution.

6 Spatial dependence results

Our spatial autoregressive (SAR) model estimates are summarized in the first three columns of Table 3 (the final column is a robustness check to be discussed in the next section). The models fit well, with R-squared measures of 0.71, 0.89, and 0.92. We find positive,

[12] Specifically, we use the "sar_panel_FE" function for MatLab written by J. Paul Elhorst. A full treatment of the estimation technique can be found in Elhorst (2009). To calculate the total effect estimates (see LeSage and Pace 2009) we use an updated version of the routine written by Donald Lacombe and available at http://www.rri.wvu.edu/lacombe/~lacombe.htm.

Table 3 Spatial autoregressive models. Dependent variable: effective property tax rate, 1995–2004

	Municipality	County	School district	School district (alternate)
Rho (Spatial Dependence)	0.201***	0.155***	0.544***	0.528***
	(77.162)	(2.804)	(33.461)	(31.804)
Real Per Capita Expenditure (Lagged)	−0.002	0.685**	0.228***	1.297***
	(−0.783)	(2.546)	(7.481)	(7.082)
Real Median Household Income	−0.006**	−0.011**	−0.021**	−0.021**
	(−2.084)	(−2.309)	(−2.327)	(−2.414)
Proportion African American	−0.440	−3.656	18.141***	20.871***
	(−0.180)	(−0.958)	(4.584)	(5.542)
Proportion Student	0.280	2.422	12.539**	13.170**
	(0.170)	(0.729)	(2.190)	(2.423)
Real Per Capita State & Federal Grants	0.053	−1.279***	−0.313*	−5.632***
	(0.500)	(−3.067)	(−1.838)	(−5.373)
Population	−0.014	0.036***	1.802***	0.287***
	(−0.680)	(3.373)	(8.259)	(5.526)
Population Density	0.001	−0.022	0.009***	0.010***
	(1.400)	(−3.484)	(3.440)	(4.059)
Number of Observations (N, T)	17300 (1730, 10)	580 (58, 10)	5000 (500, 10)	5000 (500, 10)
R-squared	0.71	0.89	0.92	0.92

Note: All models include cross-section and time period fixed effects; estimates for constant and fixed effect coefficients not shown, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%. Total effect estimates [direct plus indirect effects, see LeSage and Pace 2009] shown for explanatory variables

statistically significant spatial dependence at all three levels of local government. This indicates that jurisdictions of all types base a portion of their tax policy on the policies of their neighbors—that is, there is spatial competition between jurisdictions, the extent of which differs across government levels. The estimates shown for the explanatory variables are the total effect estimates (which include direct and indirect effects), following LeSage and Pace (2009).

Our point estimates indicate that counties in our sample exhibit less spatial dependence (0.155) than do municipalities (0.201), implying that the former face weaker competitive forces. Alternatively stated, municipalities appear less able to achieve Leviathan goals than counties. This is the same result found using the Leviathan ratio estimates in the previous section. Thus, both estimation methods appear to indicate that with a much larger number of competing governments within the given geographic area, municipalities are less able to be Leviathans than are counties. However, it is worth noting that while the point estimate of spatial dependence for municipalities is larger, it is not significantly different from the value for counties using a t-test.

The estimate of ρ for school districts (0.544) is statistically much higher than the values for either municipalities or counties, implying that school districts exhibit the greatest degree of spatial interaction. If the degree of spatial dependence measures competitiveness, then this result would seem to suggest that school districts are the most competitive, and least able to achieve Leviathan goals. Not only is this conclusion inconsistent with the ordering predicted based on the number of governments (as school districts should have fallen between municipalities and counties), but it is the opposite result obtained from the Leviathan ratio estimates. Our Leviathan tax rate estimates suggested that school districts were the least competitive, and most able to achieve Leviathan goals, with their tax rates being the closest of all levels to revenue-maximization. The spatial results, however, suggest that the reverse is true. This high degree of spatial dependence, coupled with more Leviathan-like tax rates appears to be a contradiction. Whether this is due to school districts being single-purpose and thus fundamentally different, as was found in previous Leviathan literature, or whether it is an indicator of collusion (which would also result in a high degree of spatial dependence, but not be reflective of competition) is something we will return to after presenting our robustness checks.

Turning to our control variables and their performance, only income is statistically significant in the municipality specification, which may indicate that tax policy is set mostly as a function of neighboring policy. This is consistent with a high level of competition at the municipality level. Lagged per capita expenditure is positive and statistically significant in the county and school district models, although the estimated coefficient is numerically small (and economically insignificant). Similarly, income is negative and statistically significant in the county and school district models, with a trivially small coefficient estimate. The proportion of the population that is African American is positive and significant in the school district specification. Unsurprisingly, the population proportion of students is positive and significant in the school district model. Per capita grants are negatively related to tax rates, also as predicted. For both the county and school district specifications, population is positive and significant, while density is negative in the county specification and positive in the school district model.

7 Robustness checks

To estimate the revenue-maximizing property tax rates we used unbalanced panels for each level. However, our spatial autoregressive models required balanced panels of data due to the time invariant nature of the weight matrix. As such, in order to estimate the spatial models we were forced to drop a year of data for the municipality and school district models and a number of cross-section observations at each level. To ensure that the difference between our Leviathan revenue-maximizing rate results and the spatial dependence results is not caused by the slightly different samples used in the estimations, we re-estimate our Laffer curve models using the same sample used in our spatial model. The results are presented in the first three columns of Table 4. Despite losing observations, the point estimates for each revenue-maximizing tax rate remain largely unchanged. Moreover, the new estimates are within the computed confidence intervals presented earlier. We also recalculate the Leviathan ratio at each governmental level using the new point estimates. Again, the results (also shown in Table 4) are largely unchanged, with only the county Leviathan ratio increasing slightly but remaining well below the school district ratio. Thus, the difference in the samples is not responsible for the different results, particularly for school districts, found in our earlier specification.

Our second robustness check involves our inability to get annual data on school district populations to use in the computation of per capita measures (population at the school district level is only available in the once-per decade census numbers). In our results presented earlier we use the number of students in the school district (which is available annually) in the computation of the per capita values for school districts. Here, as a check for robustness,

Table 4 Laffer curve models: balanced panel estimates. Dependent variable: real per capita property tax revenue

	Municipality	County	School district	School district (alternate)
Years	1995–2004	1995–2004	1995–2004	1995–2004
Effective Property Tax Rate (α)	4.828***	31.953***	259.580***	37.291***
	(6.475)	(5.718)	(28.433)	(20.484)
Effective Property Tax Rate Squared (β)	−0.073***	−1.304**	−3.148***	−0.345***
	(−5.383)	(−1.990)	(−16.713)	(−9.175)
Calculated Revenue-Maximizing Rate ($\alpha/-2\beta$)	33.40	12.25	41.23	54.11
Number of Observations (N, T)	17300 (1730, 10)	580 (58, 10)	5000 (500, 10)	5000 (500, 10)
R-squared	0.83	0.91	0.99	0.97

Note: All models include cross-section and time period fixed effects, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%

we estimate annual school district population to compute property tax revenue per capita (rather than per student). By assuming that the ratio of school district-to-county population remains unchanged, it becomes possible to use annual county level population changes to extrapolate annual changes in population within school districts starting from the numbers reported in the 2000 census for school district population.

The fourth column of Table 4 includes a Laffer curve model using the alternative measure of population for school districts discussed above. The point estimate of the revenue-maximizing tax rate using this alternative measure is much higher than that we found earlier using per-student data. The estimate of 54.11 is also large enough to lie outside of our simulated confidence intervals. Since school districts were already setting tax rates much lower than our previous estimate of revenue-maximization, this result shows that school districts are even further below their revenue-maximizing rates than we found previously. Using this new point estimate, the average school district is setting a tax rate of only 39.38% of the rate that would maximize estimated per-capita revenue. Though this Leviathan ratio is much lower than the previously estimated ratio of 53.29%, it still remains higher than that the ratios for either counties or municipalities. Thus, even with this alternative measure, school districts are setting tax rates nearer to revenue maximization than either counties or municipalities.

For completeness, we also estimate our spatial autoregressive model using the alternative school district population measure. These results are shown in the last column of Table 3. The measure of spatial dependence remained positive, of a magnitude similar to previous results and statistically significant. The new value of ρ, 0.528, remains larger and statistically different from the county or municipality estimates. The signs and significances of the independent variables do not vary between the two specifications, and all total effects are of roughly the same size.

The tax competition literature, which motivates our SAR model, is based on the assumption that some mobile factor (labor, capital, etc.) considers all neighboring tax rates when location choices are made. While this clearly implies spatial dependence in tax-setting, it also suggests the possibility that a jurisdiction's tax revenue is not only a function of its own tax rate, but also a function of neighboring rates. Thus, as a check for robustness, we re-estimate our Laffer curve models including the weighted average of neighboring property

Table 5 Laffer curve models: alternative specification. Dependent variable: real per capita property tax revenue

	Municipality	County	School district
Years	1995–2004	1995–2004	1995–2004
Effective Property Tax Rate (α)	5.281***	35.387***	271.994***
	(7.029)	(5.863)	(27.033)
Effective Property Tax Rate Squared (β)	−0.142***	−1.225*	−3.090***
	(−7.105)	(−1.866)	(−16.332)
Average Neighbor Effective Property Tax Rate	0.387***	−1.075	−0.500***
	(4.706)	(−1.495)	(−2.924)
Calculated Revenue-Maximizing Rate ($\alpha/-2\beta$)	18.62	14.44	44.01
Number of Observations (N, T)	17300 (1730, 10)	580 (58, 10)	5000 (500, 10)
R-squared	0.83	0.91	0.99

Note: All models include cross-section and time period fixed effects, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%

tax rates as an additional explanatory variable. This variable is constructed using the effective property tax rate multiplied by the contiguity weight matrix developed for our SAR models. Including this measure of neighboring tax rates in (2) yields

$$B_{it} = \alpha + \beta\tau_{it} + \gamma\tau_{it}^{neighbor} \tag{11}$$

while the equation to be estimated becomes

$$R_{it} = \alpha\tau_{it} + \beta\tau_{it}^2 + \gamma(\tau_{it} \times \tau_{it}^{neighbor}) + \mu_1 Z_i + \mu_2 Y_t + \varepsilon_{it} \tag{12}$$

Table 5 presents the results of these specifications. The signs, significances, and magnitudes of the tax rate and tax rate squared variables remain largely unchanged from our previous estimates. Further, the calculated revenue-maximizing tax rates are also nearly identical. The statistical significance and sign of the effect of the average neighboring tax rate variable varies across jurisdiction type. At the municipality level, increases in neighboring tax rates lead to increases in property tax revenue. This is consistent with our hypothesis of highly competitive municipal governments: ceteris paribus, increases in competitor taxes likely lead to increases in the amount of tax base choosing to locate in a given municipality. At the county level, an increase in neighboring tax rates has no statistically significant effect on property tax revenue. This result lends credence to county governments being less competitive. Finally, school district property tax revenues fall as neighboring school districts raise rates, ceteris paribus. This result is clearly not consistent with a model of competitive jurisdictions, providing further evidence of noncompetitive behavior at the school district level. In sum, while neighboring tax rates do seem to be significant drivers of property tax revenue at the municipality and school district levels, the Laffer curve relationship and calculated revenue-maximizing tax rates predicted by our original model are robust to the inclusion of this variable.[13]

[13] An additional specification for municipalities which included the rates levied by the overlapping school district and county governments as explanatory variables yielded similar results.

Table 6 Spatial autoregressive models: alternative specification. Dependent variable: effective property tax rate, 1995–2004

	Municipality	County	School district	School district (alternate)
Rho (Spatial Dependence)	0.199***	0.149***	0.546***	0.528***
	(17.220)	(2.681)	(33.522)	(31.655)
Real Median Household Income	−0.006**	−0.011**	−0.021**	−0.021***
	(−2.067)	(−2.524)	(−2.359)	(−2.451)
Proportion African American	−0.402	−4.868	17.381***	20.240***
	(−0.163)	(−1.289)	(4.321)	(5.239)
Proportion Student	0.262	3.700	11.632**	13.996***
	(0.160)	(1.101)	(2.082)	(2.566)
Real Per Capita State & Federal Grants	0.046	−1.126***	−0.148	−4.720***
	(0.433)	(−2.775)	(−0.877)	(−4.529)
Population	−0.014	0.036***	1.721***	0.286***
	(−0.696)	(3.416)	(7.849)	(5.573)
Population Density	0.001	−0.022***	0.010***	0.011***
	(1.355)	(−3.499)	(3.671)	(4.162)
Number of Observations (N, T)	17300 (1730, 10)	580 (58, 10)	5000 (500, 10)	5000 (500, 10)
R-squared	0.71	0.89	0.91	0.91

Note: All models include cross-section and time period fixed effects; estimates for constant and fixed effect coefficients not shown, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%. Total effect estimates [direct plus indirect effects, see LeSage and Pace 2009] shown for explanatory variable

As mentioned previously, the inclusion of lagged expenditures in our spatial autoregressive models may introduce problems of simultaneity. Thus, we estimate these models without the expenditure control as a check for robustness. These results are presented in Table 6. The results are nearly identical, both in terms of magnitude and statistical significance. Most importantly, the estimated level of spatial dependence does not change significantly at any level. These results provide evidence that the inclusion of expenditures in the previous specification does not bias our results.

As a final check for robustness of our spatial autoregressive model, we explore the use of different weight matrices. The weight matrix is chosen arbitrarily, so specifying alternative weighting schemes helps ensure that our previous findings are not an artifact of the definition of 'neighbor' imposed on the model. Our previous specification (shown in Table 3) employed the most frequently used weight matrix, based on first-order contiguity. A popular alternative is the use of distance-based 'nearest neighbor' weight matrices. These matrices assign to each jurisdiction a common number of neighbors (based on distance) regardless of whether the jurisdictions actually share a common border, while contiguity matrices are not so constrained and count any bordering jurisdiction as a neighbor.

Table 7 presents results from the estimation of our SAR model using two such weight matrices. W_5 denotes a specification using a weight matrix based on five nearest neighbors, while W_7 denotes a weight matrix based on seven nearest neighbors.[14] Spatial dependence at each level remains statistically significant and largely unchanged in terms of magnitude. The

[14]The determination of nearest neighbors is based on distance calculated using latitude and longitude coordinates.

Table 7 Spatial autoregressive models: alternative weight matrices. Dependent variable: effective property tax rate, 1995–2004

	Municipality		County		School district		School district (alternate)	
Weight Matrix:	W_5	W_7	W_5	W_7	W_5	W_7	W_5	W_7
Rho (Spatial Dependence)	0.235***	0.236***	0.172***	0.153**	0.528***	0.594***	0.528***	0.582***
	(84.014)	(72.404)	(2.744)	(2.077)	(35.513)	(38.388)	(35.226)	(36.773)
Real Per Capita Expenditure (Lagged)	−0.002	−0.002	0.709**	0.687**	0.207***	0.250***	1.199***	1.335***
	(−0.797)	(−0.781)	(2.522)	(2.422)	(7.034)	(7.519)	(6.580)	(6.386)
Real Median Household Income	−0.006**	−0.006**	−0.011**	−0.010**	−0.020**	−0.021**	−0.021***	−0.021**
	(−2.084)	(−1.988)	(−2.292)	(−2.211)	(−2.394)	(−2.062)	(−2.420)	(−2.129)
Proportion African American	0.062	−0.146	−3.996	−3.660	16.545***	18.479***	19.567***	21.423***
	(0.024)	(−0.057)	(−1.042)	(−0.971)	(4.378)	(4.265)	(5.221)	(4.972)
Proportion Student	0.114	−0.032	1.915	2.065	12.997**	11.284*	13.307**	11.792*
	(0.065)	(−0.019)	(0.571)	(0.624)	(2.390)	(1.835)	(2.482)	(1.936)
Real Per Capita State & Federal Grants	0.043	0.046	−1.295***	−1.277***	−0.237	−0.160	−5.208***	−5.177***
	(0.384)	(0.412)	(−3.058)	(−3.011)	(−1.461)	(−0.847)	(−4.992)	(−4.487)
Population	−0.011	−0.013	0.036***	0.036***	1.845***	1.970***	0.293***	0.306***
	(−0.540)	(−0.614)	(3.383)	(3.365)	(8.725)	(8.196)	(5.769)	(5.273)
Population Density	0.001	0.001	−0.022***	−0.022***	0.009***	0.010***	0.011***	0.011***
	(1.326)	(1.292)	(−3.448)	(−3.405)	(3.606)	(3.387)	(4.256)	(4.081)
Number of Observations (N, T)	17300 (1730, 10)	17300 (1730, 10)	580 (58, 10)	580 (58, 10)	5000 (500, 10)	5000 (500, 10)	5000 (500, 10)	5000 (500, 10)
R-squared	0.71	0.71	0.89	0.89	0.92	0.92	0.92	0.92

Note: All models include cross-section and time period fixed effects; estimates for constant and fixed effect coefficients not shown, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%. Total effect estimates [direct plus indirect effects, see LeSage and Pace 2009] shown for explanatory variables county-level ρ estimate is slightly higher in the W_5 specification (0.171) but still remains lower than either the municipality or school district estimates. School district spatial dependence is higher in the W_7 specification. The parameter estimates for all control variables retain the same signs and statistical significances from the previous specification.

Table 8 presents SAR results using two more weight matrices. The W_d specification employs a weight matrix based on distance (the nearer a jurisdiction is, the more heavily it is weighted) and allows for the possibility of jurisdictions responding to all others at the same governance level. The W_p weight matrix is the contiguity weight matrix used in our original specification, scaled by population. This technique, discussed in Baicker (2005), attributes more 'weight' to larger neighboring jurisdictions and is motivated by the traditional gravity model. As before, we observe few changes in our estimates of spatial dependence despite the use of these alternative weighting schemes. While the W_d specification predicts greater dependence at the county level (0.209), it also predicts greater dependence at the municipality (0.256) and school district (0.683) levels, preserving the ordering found in our previous specifications. The population-scaled weight matrix results are largely identical to previous specifications as well. In sum, our spatial dependence results are robust to a variety of weighting specifications.

8 Revisiting school districts: collusion vs. single-purpose jurisdictions

Our results for counties and municipalities correspond to what one might have expected. There are a much larger number of municipalities (2,522) than counties (66) in our data set for Pennsylvania, and based on the fiscal decentralization hypothesis, we should expect municipalities to be more competitive and thus less able to pursue Leviathan revenue-maximization goals. Our results from both our Laffer-curve, Leviathan models and the spatial dependence models showed the expected result: counties set tax rates closer to revenue-maximizing levels than do municipalities, and municipalities exhibit more spatial dependence across jurisdictions.

The results for school districts, however, did not fit this mold. While school districts number somewhere between the other two (501), the evidence showed these tax rates to be closest to revenue-maximization (suggesting the least competitive or most Leviathan-like), but ironically they also exhibit the highest degree of spatial dependence (suggesting alternatively that they are the most competitive or least Leviathan-like). If these two measures of governmental competitiveness were measuring the same thing, one would have not expected school districts to have, simultaneously, the highest degree of spatial dependence and also tax rates closer to Leviathan levels than the other two levels of government. This leads us to one of two possible explanations for this seemingly odd result.

First, it is possible that the single-purpose nature of school districts simply causes them to be different. School districts provide a single good, while municipal and county governments provide a bundle of services. Recall that previous Leviathan literature finds that single-purpose governmental units (like school districts or special governmental units offering only fire or water service) seem to be fundamentally different than traditional (multi-purpose) jurisdictions such as city, county, or national governments. The previous literature argues that for single-purpose jurisdictions, fragmenting them into more units tends to have either no impact or a positive impact on spending (see Boyne 1992; Eberts and Gronberg 1988; Baird and Landon 1972; Chicoine and Walzer 1985; Dowding et al. 1994; and Zax 1988).

The nature of the provision of education may have unique characteristics making school districts fundamentally different from other levels of government. While many of the ser-

Table 8 Spatial autoregressive models: alternative weight matrices. Dependent variable: effective property tax rate, 1995–2004

	Municipality		County		School district		School district (alternate)	
Weight Matrix:	W_d	W_p	W_d	W_p	W_d	W_p	W_d	W_p
Rho (Spatial Dependence)	0.256***	0.201***	0.209***	0.155***	0.683***	0.544***	0.668***	0.528***
	(13.610)	(77.162)	(4.222)	(2.804)	(35.880)	(33.461)	(34.146)	(31.804)
Real Per Capita Expenditure (Lagged)	−0.002	−0.003	0.783***	0.684***	0.343***	0.229***	1.820***	1.297***
	(−0.792)	(−0.783)	(2.674)	(2.462)	(7.228)	(7.496)	(6.465)	(7.027)
Real Median Household Income	−0.005*	−0.006**	−0.011**	−0.011**	−0.030**	−0.021**	−0.029**	−0.021***
	(−1.923)	(−2.086)	(−2.267)	(−2.347)	(2.254)	(−2.269)	(−2.279)	(−2.403)
Proportion African American	0.037	−0.465	−4.101	−3.665	31.906***	18.127***	34.457***	20.897***
	(0.014)	(−0.191)	(−1.007)	(−0.970)	(5.342)	(4.606)	(6.034)	(5.503)
Proportion Student	−0.035	0.307	3.283	2.452	8.379	12.434**	8.299	13.121***
	(−0.019)	(0.185)	(0.936)	(0.747)	(1.013)	(2.209)	(1.051)	(2.356)
Real Per Capita State & Federal Grants	0.048	0.049	−1.367***	−1.272***	−0.122	−0.312*	−6.511***	−5.624***
	(0.421)	(0.464)	(−3.180)	(−3.050)	(−0.499)	(−1.863)	(−4.292)	(−5.434)
Population	−0.018	−0.014	0.036***	0.036***	2.199***	1.804***	0.333***	0.286***
	(−0.803)	(−0.014)	(3.257)	(3.469)	(6.701)	(8.134)	(4.392)	(5.445)
Population Density	0.001	0.001	−0.023***	−0.022***	0.005	0.009***	0.007*	0.010***
	(1.283)	(1.394)	(−3.342)	(−3.572)	(1.275)	(3.495)	(1.796)	(4.127)
Number of Observations (N, T)	17300 (1730, 10)	17300 (1730, 10)	580 (58, 10)	580 (58, 10)	5000 (500, 10)	5000 (500, 10)	5000 (500, 10)	5000 (500, 10)
R-squared	0.71	0.71	0.89	0.89	0.91	0.92	0.91	0.92

Note: All models include cross-section and time period fixed effects; estimates for constant and fixed effect coefficients not shown, t-statistics in parentheses: * indicates statistical significance at the 10% level, ** at 5%, *** at 1%. Total effect estimates [direct plus indirect effects, see LeSage and Pace 2009] shown for explanatory variables vices provided by municipal governments exhibit some public good characteristics, a number of these services are contracted to private providers (e.g. trash collection). This may indicate that municipal governments are more inclined to act competitively. However, the sheer number of private schools suggests that at least some quantity of education (the good provided by school districts) can be provided privately. Thus, this mix of private and public characteristics seems to exist at all levels of local government, and is not unique to school districts.

Further, even if the single-purpose jurisdiction argument were true, one would still expect our two measures to *both* show either high (or low) degrees of competition (which they did not). Thus, given school districts' divergent results on the two measures, the single-purpose jurisdiction argument cannot explain our findings.

The second explanation is that the Leviathan ratio measures and the measures of spatial dependence simply do not *both* measure the degree of intergovernmental competition. Recall that other papers in this literature suggest that collusive behavior among governments, particularly through the use of intergovernmental grants, is important in explaining why some studies have found different results than others (see Grossman 1989; Marlow 1988; and Shadbegian 1999). In essence, one way governments can escape competitive pressures on tax levels is to get a higher level government to levy the taxes for them and redistribute the revenue back to the lower (colluding) level of government. This explanation is at least partially borne out by the data in that state and federal grants as a share of revenue are 21% for municipalities, 30% for counties, and 45% for school districts in our sample.

There are several additional reasons for suspecting that school districts are uniquely able to engage in cooperation or collusion. First, school districts in Pennsylvania are organized under a single Department of Education. Further, school districts must negotiate with a single large teachers' union which has the ability to bargain for all teachers at the state level. In other words, by definition a number of costs (such as teacher salaries) are set collectively. Additionally, school districts tend to rely on the property tax as a primary source of revenue whereas other local governments have additional revenue sources available. As such, competition on property tax rates between school districts leading to a 'race to the bottom' would likely lead to serious revenue consequences as the districts do not have a ready substitute source of revenue. Finally, the state's Department of Education manages a subsidy program for "Basic Education Funding" which distributes funds to school districts based on the districts' spending relative to an 'adequacy target,' further collectivizing the fiscal decision-making of school districts (Pennsylvania Department of Education).

The problem collusion creates for the spatial dependence measure is that the intergovernmental correlations in tax rates are high not only when governments compete, but also when they collude. This fundamentally calls into question the current literature's blind use of the spatial dependence estimate as a measure of tax competition. Interestingly, while the spatial dependence measure is affected by collusion, the Leviathan ratio measure is not. Low rates relative to revenue maximization can only imply competition, not collusion. On the other hand, high rates relative to the revenue-maximizing rate imply a lack of competition regardless of whether the competition is simply absent or whether it is collusive behavior that limits the competition.

As an analogy, if one were to try to measure the level of competitiveness of a private industry by examining measures of interdependence in pricing among firms, a high degree of interdependence could be a sign of either competition or collusion. To know the difference requires knowledge, for example, of how much prices are marked up over marginal cost (a similar measure to our Leviathan ratio).

To better understand our argument, Fig. 2 shows a four quadrant diagram depicting the four possible pairings of measures from the spatial dependence measure and the Leviathan

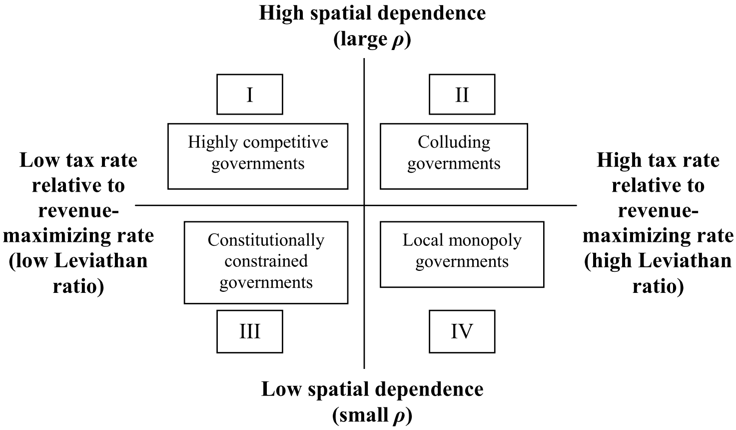

Fig. 2 Spatial dependence vs. Leviathan tax rates

ratio tax rate measure. In the figure, the vertical axis shows the degree of spatial dependence while the horizontal axis shows the degree to which tax rates correspond to the Leviathan revenue-maximizing rates.

Quadrant I, in the upper left, is the case of a government characterized by a high degree of spatial dependence (large ρ) while simultaneously choosing tax rates that are low relative to the revenue-maximizing rate (low Leviathan ratio). These are highly competitive governments by both measures, and this is the quadrant in which our estimates for both municipalities and counties in Pennsylvania fall. On the other hand, while governments in Quadrant II (the upper right) also exhibit a high degree of spatial dependence, they are able to levy tax rates nearer to the revenue-maximizing rate. This would be the sign of collusion among the governments, and this is the quadrant in which our estimates for Pennsylvania school districts fall. The lower left quadrant, Quadrant III, is home to governments facing a lower degree of spatial dependence (small ρ) and setting tax rates that are well below the revenue-maximizing rate. These are governments that show no sign of interaction or competition with neighboring jurisdictions but yet maintain low tax rates despite the lack of competitive pressures. Because constitutional constraints are the alternative to competition in keeping Leviathan at bay, this quadrant best reflects these types of governments. Obviously a government whose tax rates are set constitutionally (and thus inflexibly) at low levels would fall in this quadrant.

Finally, Quadrant IV, in the lower right, is the case of a government characterized by a low degree of spatial dependence and a high Leviathan ratio. Like with Quadrant III, the lack of significant spatial dependence suggests a lack of either competition or collusion, and is more suggestive of independent action. However, the high tax rate relative to the revenue-maximizing rate suggests that this independent action is not governed by strict constitutional constraints, but the lack of such constraints. This quadrant is more reflective of a true Leviathan government that sets high rates and seems immune to competitive pressures, similar to the case of a 'local monopoly' in a product market. Most importantly, however, the theory we outline in Fig. 2 casts substantial doubt on the ability of spatial econometric estimates of spatial interdependence, by themselves, to capture the effects of inter-jurisdictional competition.

9 Conclusion

There is no shortage of empirical studies attempting to determine whether or not decentralization constrains the Leviathan behavior of governments. This literature, however, has found very mixed results and has been plagued by hard to measure issues related to collusion among governments, differing constitutional constraints on the governments in the sample, single-purpose jurisdictions, and the use, by necessity, of aggregate revenue or government size data. Further, the widespread adoption of spatial econometric techniques in recent years has led to a proliferation of new research on intergovernmental competition using estimates of spatial dependence as measures of such competition. While all of these previous studies are useful, they each provide an incomplete picture.

Studies that focus on decentralization's impact on government size assume strategic interaction without explicitly testing for it. Similarly, studies using spatial methods and finding evidence of significant spatial dependence blindly assume it is due to intergovernmental competition and ignore the fact that high interdependence can be caused, alternatively, by collusion. Thus, models testing only for intergovernmental competition ignore its consequences by not explicitly examining whether the actual tax rates set by these governments are 'high' or 'low' relative to the Leviathan revenue-maximizing levels. Our paper joins these two approaches into one framework. No previous paper has explored both sides within the same study. These models, when looked at together, provide a coherent framework for studying how intergovernmental competition which follows from a fiscally decentralized federal system can lead to constraints on Leviathan behavior.

We investigate the role of fiscal federalism as a constraint on Leviathan by estimating two models on a unique panel of data for local jurisdictions in Pennsylvania. Importantly, we are able to collect information on the actual tax rates of these jurisdictions and therefore did not rely on aggregate measures of revenue or government size as has been done in prior Leviathan studies. We examine separately a measure of Leviathan rate-setting behavior, and a measure of the degree of intergovernmental interdependence, for municipal governments, school districts, and county governments. Previous literature has used some measure of the number of governments as a measure of decentralization or intergovernmental competition, and by this standard municipalities (of which there are 2,522 in our sample) should be more competitive than school districts (of which there are 501 in our sample), which in turn should be more competitive than counties (of which there are 66 in our sample).

First, we use a Laffer curve methodology to 'search' for Leviathan behavior at each level of local government. We obtain point estimates of the tax rates that would maximize tax revenue for these governments, and then calculate a measure of how far each government is below these unconstrained Leviathan rates. Our Laffer curve-based Leviathan ratio estimates reveal that all local jurisdictions (municipalities, counties, and school districts) set tax rates well below revenue-maximization. As predicted based on the number of governments, these estimates show that counties are able to set rates closer to Leviathan levels than are municipalities. School districts, however, do not fit in this ordering; while they should have fallen in the middle, they are found to have rates closest to Leviathan revenue maximization among all levels of government, suggesting that they are the least competitive.

We then turn to a model of spatial dependence to determine the level of strategic interaction at each level. The spatial model has traditionally been used in the literature as a measure of intergovernmental competition. We employ it here in this same context, and our results indicate the presence of significant spatial dependence within all three levels of government. As predicted based on the number of governments, these estimates also show that counties are less interdependent than are municipalities (i.e., suggesting that municipalities are more competitive than counties). School districts, however, do not fit this ordering as they are found to have the highest degree of spatial interdependence—suggesting that they are the most competitive. This is an interesting finding as the Leviathan/Laffer curve estimates suggested that school districts were the least competitive.

Overall our findings are important for two reasons. First, based on our county and municipality results, we are able to confirm the positive role of intergovernmental competition and fiscal decentralization in constraining the Leviathan behavior of governments. The more decentralized municipal governments show both more spatial dependence (i.e., intergovernmental competition) and lower tax rates (compared to the revenue-maximizing tax rates) than do the less decentralized county governments. Second, based on our results for school districts we call into question the popular use of measures of spatial dependence as a measure of intergovernmental competition. High spatial dependence can be either a sign of competition or its opposite, collusion.

We outline a new theory using both of our measures that incorporates four possible categories of results. In our framework, high spatial dependence coupled with significantly lower than revenue-maximizing tax rates is reflective of intergovernmental competition, while high spatial dependence coupled with tax rates closer (or equal to) revenue-maximizing tax rates is reflective of intergovernmental collusion. Similarly, low spatial dependence (a sign of independent action) coupled with significantly lower than revenue-maximizing tax rates is reflective of strong constitutional constraints, while low spatial dependence coupled with tax rates closer (or equal to) revenue-maximizing tax rates is reflective of a 'local monopoly'-type government that is a true Leviathan insulated from competition. Taken together our results provide evidence that while federalism, and the competing governments inherent within it, can limit the ability of government to achieve Leviathan goals, a more complete model is required to ensure observed intergovernmental interaction is not in fact collusive in nature.

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Appendix: Descriptive statistics

	Municipality	County	School district
Effective Tax Rate (*Mills*)			
Mean	1.94	3.48	21.31
Mode	1.14	3.15	18.90
Standard Deviation	2.28	1.18	4.88
Minimum	0.0001	1.30	1.00
Maximum	81.31	7.17	49.8
Per Capita Property Tax Revenue			
Mean	71.87	132.08	3656.14 (581.03)
Standard Deviation	272.69	48.38	2060.36 (288.82)
Real Per Capita Expenditures (*Lagged, $ 1000s*)			
Mean	0.40	463.03	8.55 (1.45)
Standard Deviation	4.31	199.51	2.07 (0.35)

	Municipality	County	School district
Real Per Capita State/Federal Grants (*$ 1000s*)			
Mean	0.07	160.54	4.05 (0.70)
Standard Deviation	0.14	127.69	1.55 (0.30)
Population (*1000s*)			
Mean	4.38	165.70	3.60 (24.41)
Standard Deviation	23.85	209.11	9.80 (70.90)
Real Median Household Income (*$ 1000s*)			
Mean	–	37.49	–
Standard Deviation	–	7.31	–
Proportion African American			
Mean	–	0.03	–
Standard Deviation	–	0.03	–
Proportion Student			
Mean	–	0.16	–
Standard Deviation	–	0.02	–
Population Density			
Mean	–	278.79	–
Standard Deviation	–	482.83	–

Note: Variables calculated using alternative school district population in parentheses

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