The Incentive Effect of Fiscal Equalization Transfers on Tax Policy

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Abstract: A theoretical analysis considers the impact of a typical system of redistributive "fiscal equalization" transfers on the tax effort of local jurisdictions. More specifically, it shows that the marginal contribution rate, *i.e.* the rate at which an increase in the tax base reduces those transfers, might be positively associated with the local tax rate while the volume of grants received is likely to be inversely related to the tax rate. These predictions are tested in an empirical analysis of the tax policy of German municipalities. In order to identify the incentive effect the analysis exploits discontinuities in the rules of the fiscal equalization system as well as policy changes. The empirical results support the existence of an incentive effect, suggesting that the high marginal contribution rates induce the municipalities to set significantly higher business tax rates compared with a situation without fiscal equalization.

Key Words: Fiscal Equalization; Tax Competition; Fiscal Federalism; Incentive Effect of Taxation; Regression Discontinuity

JEL Classification: H71; H77

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1 Introduction

Redistributive fiscal transfers between jurisdictions are a common feature of many federal countries with local taxing autonomy such as Canada, Germany, and Switzerland. Irrespective of whether explicitly labelled "fiscal equalization" or embedded in a system of revenue sharing, the common characteristic is that transfers are inversely related to the tax base or some corresponding measure of "fiscal capacity." As a consequence, those schemes will tend to compensate jurisdictions for the adverse impact of a higher tax effort on the tax base. To put it differently, redistributive transfer schemes tend to lower the marginal cost of raising public funds and might, therefore, induce governments to raise even possibly distorting taxes (Smart, 1998, and Dahlby, 2002). This incentive effect is not only important for the design of redistributive transfer systems but also for its effect on competition. Standard models of tax competition argue that in a decentralized setting the mobility of the tax base will tend to increase the marginal cost of raising public funds for each individual jurisdiction with adverse consequences for the supply of public services. Since redistributive fiscal transfers might have the opposite impact on the marginal cost of raising public funds, recent theoretical research suggests that a redistributive system of interjurisdictional transfers might help to restore efficiency in an otherwise inefficient equilibrium of tax competition (Bucovetsky and Smart, 2002, Koethenbuerger, 2002).

However, beyond theoretical considerations little is known about the significance and strength of incentive effects from fiscal equalization on the taxing policy of local jurisdictions. A paper by Baretti, Huber, and Lichtblau (2002) deals with the case of German states. As these states lack taxing autonomy, the study focuses on the related issue of revenue collection and finds a significant adverse effect of fiscal equalization. Snoddon (2003) investigates the incentive effect of fiscal equalization in Canada. Facing complex interactions in the Canadian system of intergovernmental transfers, the empirical analysis focuses on policy reforms and finds support for incentive effects of fiscal equalization. However, the analysis is concerned with tax revenue, which is only an indirect measure of tax policy. The direct impact of fiscal equalization on tax policy is considered by Dahlby and Warren (2003) using a small dataset of eight Australian states and territories. They find some limited support for an incentive effect on taxing decisions.

This paper adds to the literature by providing an empirical investigation of the incentive effect of fiscal equalization on the local choice of the business tax rate in a dataset of German municipalities. There are several reasons why German municipalities offer a promising case to study. While these jurisdictions have tax autonomy in choosing the local rate of the business tax, a substantial amount of fiscal resources is redistributed among local governments. At the same time, tax autonomy is restricted to the choice of the tax rate since tax bases are defined uniformly across the country and tax collection is centralized at the state level. Even though empirical evidence is lacking, the potential incentive for higher tax rates is mentioned regularly in debates about the equalization system in Germany's state legislatures (*e.g.*, Hardt and Schmidt, 1998: 160) and, occasionally, used even as a motivation for tax reform.[1] Also previous research on the impact of local tax rates on revenue indicates potentially important incentive effects, as local tax rates are shown to exert quite strong tax base effects, indicating that the tax effort of German municipalities is unusually high (Buettner, 2003). A further advantage of the German case is the availability of corresponding data for a large panel of municipalities.

The following theoretical section discusses the choice of the local tax rate on capital in the presence of redistributive transfers. The model explicitly introduces a system of fiscal transfers such that taxing decisions are made conditional upon the rules determining the (net) contribution to the transfer system. The subsequent empirical investigation basically tests whether the predictions of the model are consistent with the data. The empirical analysis employs a panel dataset of municipalities in a major German state, Baden-Wuerttemberg, over a period of 21 years. A special advantage of the dataset is that the system of fiscal equalization treats jurisdictions differently and differs across regions (counties) as well as across the time-period covered by the data; these differences allow us to pursue alternative identification strategies and to compare their results. The first approach taken in the paper exploits the fact that incentives are discontinuous functions of relative fiscal capacity which allows to employ regression discontinuity estimation techniques (*e.g.*, Van der Klauw, 2002, and Angrist and Lavy,

[1] A good example is the 1980 reform in the state of Baden-Württemberg. This reform reduced the contribution rate determining the amount of tax revenue to be transferred into the system, where the legislator explicitly pointed at the incentive effect: *"Um den Gemeinden eine Absenkung der Gewerbesteuerhebesätze zu erleichtern, hat der Gesetzgeber den Anrechnungshebeseatz für die Gewerbesteuer im Finanzausgleich ab 1982 auf 290% abgesenkt,"* cited from Bronner, Faiss and Fürth (1998: 81).

1999). The second approach exploits the variation in incentives due to changes in the system over time. Regardless of the identification approach taken, the empirical results confirm the theoretical expectations. In particular, the marginal contribution rate is found to exert a significant positive impact on the local tax rate, whereas the volume of grants received has a negative effect on tax effort.

The paper proceeds as follows. The following theoretical section derives the basic predictions. Section 3, then, provides a discussion of the investigation approach including a stylized description of the equalization system. Section 4 gives an account of the dataset and is concerned with some specification issues. Section 5 reports the results. Section 6 provides a conclusion.

2 Theoretical Considerations

Consider the tax policy of the local government of municipality i. Let the budget constraint of the government in per-capita terms be

$$z_i = \tau_i k_i + g_i, \tag{1}$$

where z_i is public spending, τ_i is the local tax rate on capital k_i, and g_i is inter-governmental revenue which may or may not be dependent on local policies. Assuming absentee capital-owners and assuming that labor supply corresponds to the size of the population, private consumption c_i is determined by labor income obtained with a linear-homogenous production function, in per-capita terms

$$c_i \quad = \quad f(k_i) - k_i f'(k_i). \tag{2}$$

Let us follow the literature on tax competition (*e.g.*, Wilson, 1999) and assume that capital is mobile such that the net rate of return to capital at each location is equal to a common rate r, formally

$$f'(k_i) - \tau_i = r. \tag{3}$$

In this setting, private consumption is decreasing in the amount of public services provided. While its choice of the tax rate determines which combination of public and private consumption is obtained, the government is assumed to maximize the utility of a representative household, which is determined by a quasi-linear utility function

$$u_i = c_i + \alpha_i v\left(z_i\right), \quad \text{where } v' > 0,\ v'' < 0. \tag{4}$$

This particular choice of the utility function will allow us to focus on a setting where the impact of fiscal equalization on the transformation frontier in terms of public vs. private consumption is dominating tax policy.

Consider a case where g_i reflects block grants received independent of tax policy ($\frac{\partial g_i}{\partial \tau_i} = 0$). The optimal choice of the tax rate is determined by the familiar first order condition that the marginal rate of substitution between public and private consumption equals the marginal rate of transformation or, equivalently, that the marginal benefit from the public service equals the marginal cost of raising public funds

$$\alpha_i v'\left(z_i\right) = \frac{k_i}{k_i + \tau_i \frac{\partial k_i}{\partial \tau_i}}. \tag{5}$$

Note that the marginal cost of raising public funds are larger than unity to an extent that depends on the elasticity of local capital supply.

As Smart (1998) observed, many federal countries have intergovernmental transfer systems, which tend to provide incentives for lower level governments to raise tax effort. To see this, suppose the jurisdiction receives "fiscal equalization" transfers depending on the local tax base or "taxing capacity"

$$g_i = y_i - \vartheta_i k_i. \tag{6}$$

y_i can be referred to as "virtual grants," *i.e.* the amount of grants the jurisdiction would receive if its tax base were actually zero. An implicit contribution is determined by the "marginal contribution rate" ϑ_i defining the extent to which an increase in the tax base results in lower

grants. Given equalization transfers, the first order condition for optimal tax policy (5) becomes

$$\alpha_i v'(z_i) = \frac{k_i}{k_i + (\tau_i - \vartheta_i)\frac{\partial k_i}{\partial \tau_i}}. \tag{7}$$

Obviously, under full equalization, *i.e.* at a marginal contribution rate equal to the tax rate $\vartheta_i = \tau_i$, the marginal cost of raising public funds would be reduced to unity. This would restore efficiency if coordinated capital taxation were non-distortive (Wildasin, 1989). Of course, as emphasized by Bucovetsky and Smart (2002), it is generally not the case that full equalization is efficient. Regardless of full or partial equalization, however, the model implies that fiscal equalization transfers will affect local tax effort. We may summarize these effects by the following two propositions:

Proposition 1 (Impact of the Marginal Contribution Rate)

An increase in the marginal contribution rate ϑ_i of the fiscal equalization system will lower the marginal cost of raising public funds; given the separable utility function (4) and if the tax base elasticity is increasing, the local government will set a higher tax rate.

To see this, note that the RHS of (7) is decreasing in ϑ_i. At the same time, an increase in ϑ_i will reduce equalization grants and, hence, the LHS of (7) is increasing. As a consequence the marginal benefit of public spending increases relative to the marginal cost of raising public funds. From the second-order condition we know that optimality can only be restored at a higher tax rate.

Proposition 2 (Impact of Virtual Grants)

Given the separable utility function (4) and an increasing tax base elasticity, if the virtual grants y_i provided by the fiscal equalization system are increased, the local government sets a lower tax rate.

This proposition follows from the fact that the LHS of (7) is decreasing in y_i as public spending is increasing ($\frac{\partial z_i}{\partial y_i} > 0$). As a consequence, the marginal benefit from public spending declines. Given the second-order condition, optimality is restored at a lower tax rate.

3 Investigation Approach

The empirical investigation below aims at testing the predictions of the theoretical analysis using a panel dataset of municipalities in a German state. In order to analyze the incentive effect of fiscal equalization empirically, it is essential to specify the main determinants of the position and curvature of the budget set. As indicated by the above theoretical discussion, a key determinant of the curvature is the marginal contribution rate of the fiscal equalization system ϑ_i. It is also important to capture the availability of fiscal resources that are independent of the local government's tax policy, as given by virtual grants y_i. Taken together, in the light of the theoretical analysis, local capital taxation will obey

$$\tau_i = \tau\,(\,y_i\,,\,\vartheta_i\,;\,a_i\,)\,,$$

where a_i is a vector of variables capturing further conditions faced by each municipality. The current investigation basically employs a sample of municipalities in order to estimate this equation. However, due to the heterogeneity of municipalities a pure cross-sectional analysis would have to face a host of data and measurement problems. But if one is willing to assume that unobservable local determinants of tax policy are time-invariant, one could pool observations for different periods and estimate the tax equation using panel data. Accordingly, the empirical analysis is concerned with the relationship

$$\tau_{i,t} \;=\; \tau\,(\,y_{i,t}\,,\,\vartheta_{i,t}\,;\,a_{i,t}\,,\,\psi_i\,,\,\phi_t\,)\,, \tag{8}$$

where ψ_i captures a location-specific and ϕ_t a time-specific effect.

While an empirical estimate of equation (8) allows us to quantify the total impact of an increase of the marginal contribution rate ($\frac{\partial\tau}{\partial\vartheta_{i,t}}$) on the tax rate, the observed impact might simply reflect a direct response to the loss of funds. In other words, since an increase in the contribution rate implies a reduction of available funds (*cf.* equation 6), an increase in the tax rate might simply result from the income effect. Only the compensated effect – where revenue from grants is adjusted such that utility is kept constant – is indicative of the incentive effect from changing the marginal cost of raising public funds. However, supposing that the observed response to an increase in virtual grants ($\frac{\partial\tau}{\partial y_{i,t}}$) captures the income effect, we can calculate a compensated

effect of the marginal contribution rate on tax policy by means of a Slutsky decomposition, see Section 5 below.

Note that the level of virtual grants and the marginal contribution rate are both indexed with the jurisdiction, which reflects their dependence on local conditions. Since these conditions might well be correlated with the tax rate, investigating the relationship (8) empirically raises questions about the identification of incentive effects. In order to highlight sources for identification in the present context, the following subsection briefly summarizes the German system of fiscal equalization among municipalities before the identification issue is discussed in more detail.

3.1 Elements of Municipal Fiscal Equalization in Germany

Following the classification by Boadway (2004) the system of municipal fiscal equalization in Germany can be characterized as a "gross scheme" involving not just the redistribution of revenue among municipalities but also significant transfers to and from the federal and state levels.[2] Two basic elements can be distinguished: fiscal equalization grants and fiscal capacity dependent contributions.

1. Fiscal equalization grants are designed to reduce the difference between what the system considers as fiscal need and as fiscal capacity. While fiscal need is basically determined by the population size of a municipality and a basic allowance of fiscal resources per-capita, fiscal capacity[3] is determined by the tax base of the local business tax and other revenue sources, mainly the local share of the statewide income tax revenue.[4] Given the definitions of fiscal capacity and fiscal need, the system of fiscal equalization distinguishes municipalities with low, medium, and high fiscal capacity. The first group receives additional transfers to ensure that

[2]While some of the institutional details vary between states the basic structure is very similar across states. In the following, we focus on the case of Baden-Wuerttemberg.

[3]Since we focus on the business tax we use "taxing capacity" in order to denote that part of revenue sources that refers to the business tax. "Fiscal capacity" refers to the broader concept of all revenue sources which enter the determination of equalization grants and contributions.

[4]A fixed part of the statewide income tax revenues is distributed to the municipalities basically according to the local residents' share of total tax payments according to the triennial revenue statistics.

revenues are at at least equal to 60% of fiscal need, the last group does not receive any fiscal equalization transfers.

2. Whether they receive fiscal equalization grants or not, municipalities have to make several contributions out of their local tax revenues. More specifically, municipalities are obliged to make transfers depending on their fiscal capacity – to the state in order help finance the equalization grants but also to the county to share the cost of providing county services.[5] Moreover, there is direct revenue sharing in the business tax with the state and the federal level.

Though the basic structure is simple, the combined effect of the different elements is not straightforward. This is due, in particular, to the fact that grants and contributions are to some extent taken into account in the definition of fiscal capacity. As further explained in the appendix, the whole system can, nevertheless, be summarized by a linear function relating grants to the tax base as depicted in equation (6). The marginal contribution rate, which determines the reduction in transfers at an increase in the tax base, is given by

$$\vartheta_i \equiv \tau^{rs} + (\tau_0 - \tau^{rs}) \left(\theta_i^{local} + \theta_i^{state} + \theta_i^{equal} \left(1 - \theta_i^{local} - \theta_i^{state} \zeta \right) \right), \tag{9}$$

where τ^{rs} is a uniform tax rate which determines the transfer obligation under the general revenue sharing with state and federal government. τ_0 is a standardizing tax rate used to determine the taxing capacity with regard to the business tax. Note that the immediate revenue sharing contributions are deducted. θ_i^{local}, θ_i^{state}, and θ_i^{equal} are contribution rates out of fiscal capacity determining to what extent an increase in fiscal capacity will result in higher contributions or lower equalization grants. θ_i^{local} determines the contributions to the county, θ_i^{state} defines the contributions to the state and, finally, θ_i^{equal} is the contribution rate implied by the equalization grant formula. Note that in contrast to tax equalization in Canada or Australia based on so called *representative national average standards* or related schemes, in our case the standardizing parameters at which taxing capacity and fiscal need are calculated

[5]The vertical structure of government in Germany is a four tier system with a federal and state as well as county and municipal governments. The latter are the smallest units of government. With the exception of some larger cities, each municipality is assigned to a county, which usually comprises about 20 to 30 municipalities. While most functions of the local government are carried out by the municipalities, the counties are concerned with the provision of welfare aid, waste management, and some part of the road infrastructure.

are directly fixed in the law or set by the state.[6]

Virtual grants y_i are determined by

$$y_i \equiv x_i + \xi_i n_i \left(1 - \theta_i^{local} - \theta_i^{state}\zeta\right) - \left(\frac{\vartheta_i - \tau^{rs}}{\tau_0 - \tau^{rs}}\right) x_i, \tag{10}$$

where n_i is fiscal need and x_i is other revenue. ξ_i introduces some further redistributive element as it differs for municipalities with low, medium, and high fiscal capacity (see appendix). Note that the marginal contribution rate enters into the determination of virtual grants only with some modification: the last term captures the contribution out of other revenue which is independent of the standardizing and revenue sharing tax rates τ_0 and τ^{rs}.

As several of the parameters, indexed with the region, differ across municipalities, the marginal contribution rate and virtual grants show some notable differences across municipalities. In our analysis, the system of fiscal transfers has been fully implemented in the database. Table 1, which provides some descriptive statistics for the year 2000, indicates that fiscal need only shows modest variation. Conversely, fiscal capacity and, in particular, taxing capacity show strong variation across jurisdictions. About 93% of the jurisdictions show a fiscal capacity below fiscal need, and, thus, are recipients of fiscal equalization grants. More than a third of the jurisdictions have a relative fiscal capacity that is considered as low, such that they are subject to higher equalization grants and, thus, face particularly large marginal contribution rates. The upshot of the equalization system is provided in the last four rows. Throughout the sample, marginal contribution rates and virtual grants vary substantially. However, the statutory tax rate is always higher than the marginal contribution rate, such that the rate of equalization (ϑ_i/τ_i) in the sample is between 50% and 96.7%.

While the figures presented in Table 1 point to substantial cross-sectional variation, it should be noted that the underlying parameters show variation also over time. This refers, first of all, to revenue sharing (τ^{rs}) and the county contribution share (θ_i^{local}) which vary from year

[6] As discussed in Courchene and Beavis (1975), Dahlby (2002), and Dahlby and Warren (2003), the reliance on national averages in the Canadian and Australian equalization systems gives rise to additional disincentive effects. However, Dahlby (2002) and Dahlby and Warren (2003) note that the disincentive effect due to a compensation of revenue losses which is the focus of our study, and which has been discussed, recently, by Smart (1998) and Bucovetsky and Smart (2003), is also present in the Canadian and Australian systems.

Table 1: Descriptive Statistics for the Equalization Transfer System in 2000

			Mean	Std Dev	Min	Max
Fiscal need	€ per capita	n_i	782	59	740	1368
Fiscal capacity	€ per capita	$(\tau_0 - \tau^{rs})\, k_i + x_i$	537	205	258	3556
Taxing capacity	€ per capita	$(\tau_0 - \tau^{rs})\, k_i$	145	174	1	2861
Taxing to fiscal capacity	ratio	$(\tau_0 - \tau^{rs})\, k_i / [(\tau_0 - \tau^{rs})\, k_i + x_i]$	.230	.134	.004	.845
Rel. fiscal capacity	ratio	$\gamma_i \equiv [(\tau_0 - \tau^{rs})\, k_i + x_i] / n_i$	.685	.250	.349	4.26
Low fiscal capacity	binary		.401	.490	0	1
Medium fiscal capacity	binary		.532	.499	0	1
High fiscal capacity	binary		.066	.249	0	1
Rev. sharing tax rate	in %	τ^{rs}	4.15	0		
Standardizing tax rate	in %	τ^0	14.5	0	14.5	14.5
County contribution rate		θ_i^{local}	.292	.047	.000	.370
State contribution rate		θ_i^{state}	.210	.009	2.05	.275
Implied equal. contribution rate		θ_i^{equal}	.774	.252	0	1
Virtual grants	€ per capita	y_i	591	106	228	1453
Marginal contribution rate	in %	ϑ_i	13.4	1.24	8.92	14.5
Statutory tax rate	in %	τ_i	16.7	1.24	14.5	21.5
Rate of equalization	ratio	ϑ_i / τ_i	.800	.078	.500	.967

Sample size consists of 1024 jurisdictions in the state of Baden-Wuerttemberg.

to year either at state or at county level. Moreover, in the period between 1980 and 2000, analyzed below, there have been several reforms and changes in the law: with regard to the definition of low fiscal capacity jurisdictions, the inclusion of other fiscal revenue into fiscal capacity, the level of the standardizing tax rate, or the contributions to the state and the size of the corresponding contribution rates.

3.2 Identification of Fiscal Incentives

As the brief description of the system of fiscal equalization among German municipalities has shown, there are basically three sources of empirical variation in the incentives:

1. The incentives faced by an individual jurisdiction vary with local fiscal conditions. Therefore, incentives vary across jurisdictions and time.
2. Some parameters of the system of intergovernmental transfers vary across groups of jurisdictions (counties), implying different incentives across groups and time.
3. Reforms in the system of intergovernmental transfers create changes in the incentives over time, which tend to affect jurisdictions differently depending on their initial fiscal conditions.

The first source raises the issue of how one could separate the incentive effect of the fiscal equalization system from other characteristics which drive tax policy but are possibly unobserved. In the present case, this creates a situation where differences in incentives cannot be treated as exogenous, statistically, because they could reflect other relevant variations in the determinants of tax policy. In other words, municipalities which have high tax rates for whatever reason are more likely to have a low tax base, and face a higher marginal contribution rate and higher virtual grants. If we are unable to control for all determinants of tax policy, a simultaneity bias may arise. A useful interpretation of this bias is provided by the literature on labor market programs, where the key problem is to control for the selection of program participants (for a survey see Heckman, Lalonde, and Smith, 1999). Accordingly, in the present context we might consider the incentive effect of the fiscal equalization system as a "treatment effect." Since

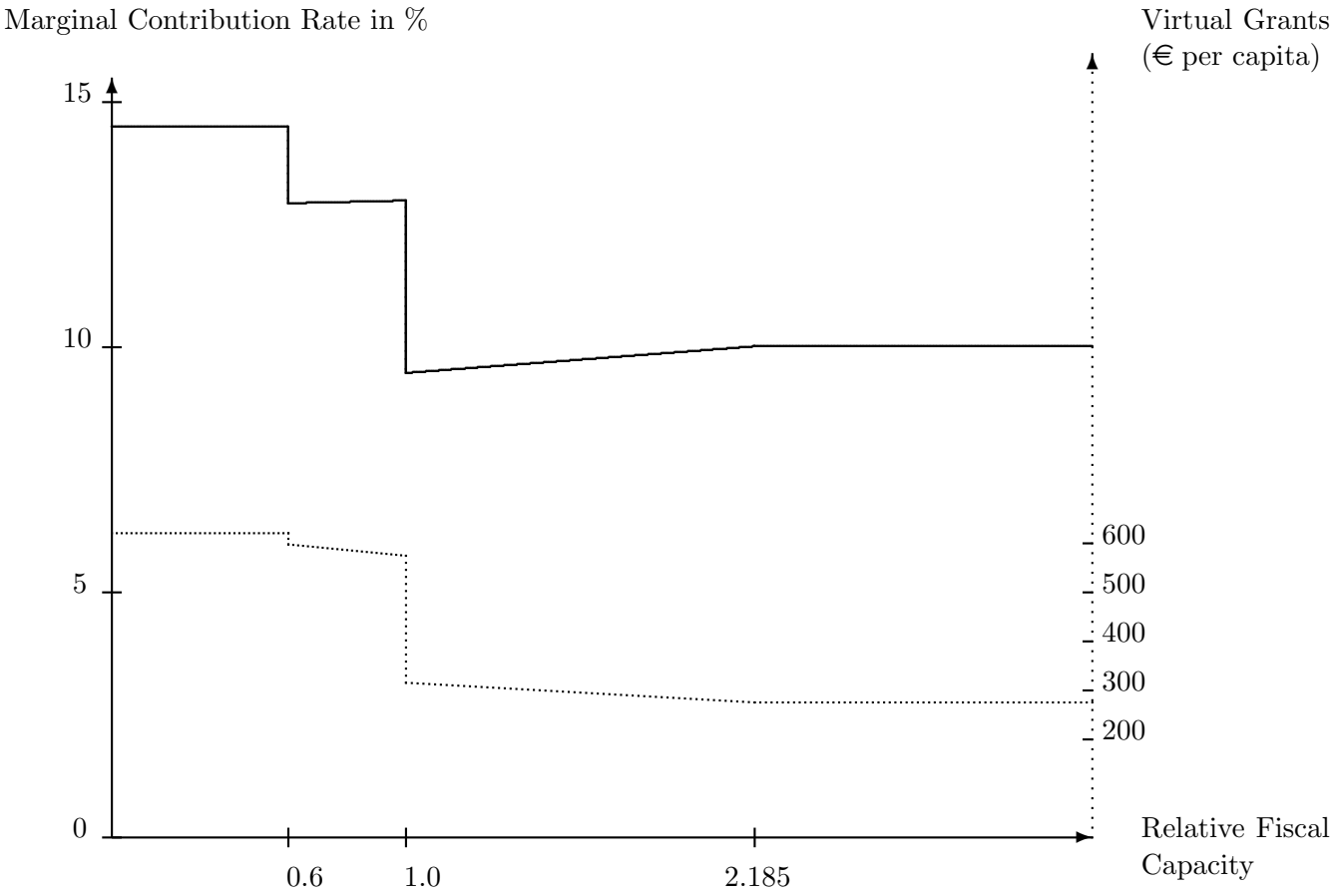
differences in the treatment by the equalization system result from differences in fiscal conditions, without further assumptions it is not possible to assess to what extent differences in the tax policy are due to the "treatment effect" from fiscal equalization or, alternatively, whether they reflect differences in the fiscal conditions. The second and the third source of empirical variation in incentives are less problematic as it is not a change in local fiscal conditions which is driving the variation in incentives.

In this situation, depending on the source of empirical variation, two alternative approaches are followed in order to gain identification. A first approach exploits the fact that the incentives vary discontinuously with the underlying fiscal conditions. A second approach treats the discontinuity as nuisance and focuses on the variation of incentives due to changes in policy.

3.2.1 Exploiting the Differences across Regimes

As we have seen above, even within a county and within a year the incentives created by the system of fiscal equalization are not uniform but vary strongly with local fiscal conditions. An important characteristic is that both the level of virtual grants and the marginal contribution rate vary discontinuously with relative fiscal capacity. This is depicted in Figure 1 which reports simulated figures using parameters for 2000. What is particularly noteworthy is that we can distinguish three regimes which introduce discontinuities in marginal contribution rate and virtual grants as relative taxing capacity is gradually increasing. Accordingly, the marginal contribution rate follows a "saw tooth" pattern, showing discontinuous drops at the threshold levels of relative fiscal capacity, which distinguish jurisdictions with low, medium, and high fiscal capacity, while increasing slightly or staying constant within the regimes. Similarly, the level of virtual grants differs between these regimes. Thus, at the threshold levels of taxing capacity even a tiny change in relative fiscal capacity results in strongly different incentives, which is precisely a situation where regression discontinuity estimators could yield identification. This approach, originally proposed by Campbell (1969), has recently been reintroduced in applied econometric work by Van der Klaauw (2002) and Angrist and Lavy (1999). In our case, there are two major discontinuities since below a certain upper threshold a jurisdiction is considered as favorably endowed with fiscal capacity, whereas below a lower threshold, jurisdictions are considered as having particularly low fiscal capacity. Note that the rules of the

Figure 1: Relative Fiscal Capacity and Marginal Contribution Rate



—— Marginal contribution rate simulated at revenue sharing rate and average county contribution rate in 2000.

····· Virtual grants simulated using average figures for 2000.

fiscal equalization system precisely define the threshold levels of relative fiscal capacity. This suggests following a "sharp design" in specifying the estimation problem.

Consider the following specification of the above tax equation

$$\tau_{i,t} = \beta_1 y_{i,t} + \beta_2 \vartheta_{i,t} + \beta_3 S(\gamma_{i,t}) + \beta_4 x_{i,t} + \psi_i + \phi_t + \epsilon_{i,t}. \tag{11}$$

The possible impact of relative fiscal capacity $\gamma_{i,t}$ on tax policy is captured by some potentially nonlinear function $S(\gamma_{i,t})$. While $y_{i,t}$ and $\vartheta_{i,t}$ are also determined by $\gamma_{i,t}$, the control for $\gamma_{i,t}$ ensures that only the discontinuities are used to identify the impact of fiscal incentives. Intuitively, in controlling for other differences between jurisdictions including fiscal capacity, we make the tax policy of jurisdictions comparable. Despite their similarity, the discontinuities ensure that the jurisdictions are nevertheless subject to very different regimes in the equalization system, which allows us to estimate the impact of fiscal equalization on tax policy. Note that in contrast to the coefficients for $\vartheta_{i,t}$ and $y_{i,t}$ the coefficients for the other parameters do not necessarily have a behavioral interpretation.

A separate issue is whether the incentive faced by the government as the optimizing agent is dependent on its own choice.[7] Such a dependence could certainly undermine a causal interpretation. But as we have seen above, in contrast to equalization systems based on representative national averages such as the Canadian system, a direct impact of the tax policy on the treatment by the equalization system is precluded in our case. Some indirect influence could arise since local tax policy exerts an impact on the tax base, which enters the derivation of relative fiscal capacity. However, the selection into one of the three regimes of fiscal equalization is not done on the basis of taxing capacity but on the broader concept of fiscal capacity, which includes other revenue sources, mainly the local share of the statewide income tax revenue.[8] Moreover, the selection into the three regimes of fiscal equalization is based on fiscal capacity as reported two years before. Of course, even though fiscal capacity is predetermined, the analysis could potentially still suffer from simultaneity bias, due to some combination of higher order autocorrelation in tax policy and slow adjustment in the tax base. However, basically,

[7] This problem has been encountered in the empirical analysis of incentive effects of taxation on labor supply. For recent surveys see Blundell and MaCurdy (1999), Slemrod (1999), and Triest (1999).

[8] The average share of tax capacity in fiscal capacity is about 23 %, *cf.* Table 1.

this problem is not conceptually different from the above identification problem of how to separate the incentive effect from other characteristics of jurisdictions and can be dealt with in the current regression discontinuity approach using lagged explanatory variables.[9] As we will see below, the results are, in fact, robust with respect to the inclusion of lags among the conditioning variables.

3.2.2 Exploiting the Changes within Regimes

The regression discontinuity approach focuses on the differences in fiscal incentives across regimes, irrespective of whether these reflect temporary variation in fiscal capacity due to some cyclical effects or medium or long-term developments, which represent lasting changes in fiscal conditions. As it seems possible that temporary switches between the regimes may have less clear-cut responses than the above static theory necessarily suggests, we also follow an alternative approach exploiting significant changes in the equalization system over time.

In order to focus on changes of incentives within each of the three regimes we transform equation (11) into first differences

$$\begin{aligned} \Delta\tau_{i,t} \;&=\; \beta_1\Delta y_{i,t} \;+\; \beta_2\Delta\vartheta_{i,t} \;+\; \beta_3 S\left(\Delta\gamma_{i,t}\right) \;+\; \beta_4\Delta x_{i,t} \;+\; \phi_t \;+\; \epsilon_{i,t}, \qquad (12) \\ &\quad \text{if } R\left(\gamma_{i,t}\right) \;=\; R\left(\gamma_{i,t-1}\right), \end{aligned}$$

where $R\left(\gamma_{i,t}\right)$ is an index reflecting the classification of relative fiscal capacity $\gamma_{i,t}$ as being "low," "medium," or "high." While *per se* being just a transformation, first differencing allows us to focus attention on those observations where there is no regime switch with regard to the previous period. With the condition $R\left(\gamma_{i,t}\right) = R\left(\gamma_{i,t-1}\right)$ we dismiss all observations where a regime switch occurs with regard to the previous period and the remaining variation in incentives arises mainly from policy changes.

For the sample used below, Figure 2 depicts the remaining variation in the marginal contribution rate over time. Evidently, in most periods some municipalities are not at all affected

[9] Heckman and Robb (1986: 163) suggest specifying the estimation equation in the presence of a lagged dependent variable as a reduced form expression of exogenous variables.

by policy changes, while others experience increases or reductions. But there are also periods where no municipality experiences a reduction or, alternatively, an increase.

4 Data and Specification

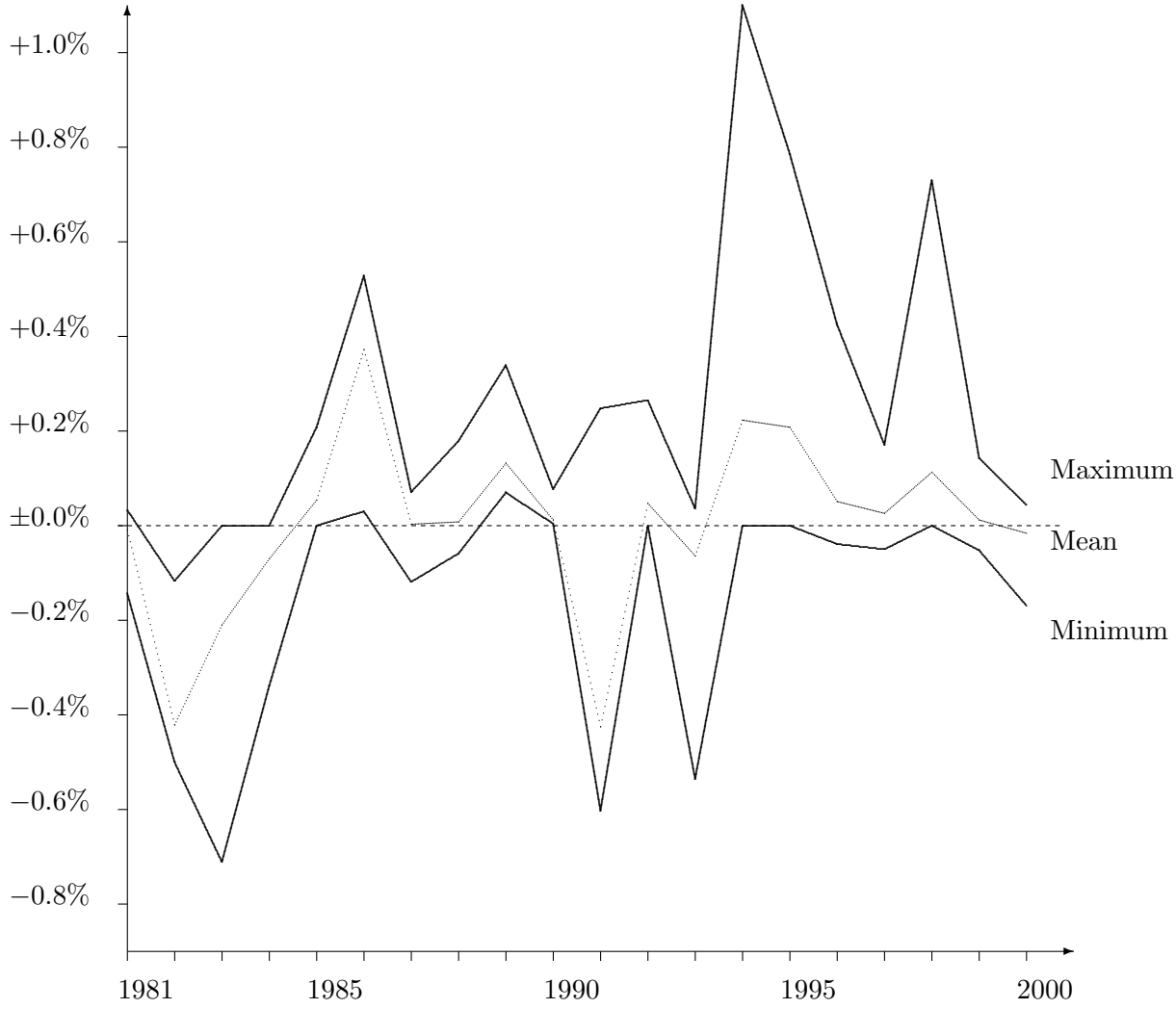
The basic dataset consist of the complete set of municipalities in a major German state (Baden-Wuerttemberg). However, many of these municipalities are rather small with population sizes below 10,000 inhabitants (see Appendix). Due to their smallness, these jurisdictions are subject to substantial fluctuations in taxing capacity.[10] For several small municipalities even negative tax revenues are reported for individual years reflecting periods where rebates exceed payments.[11] Furthermore, in terms of tax incentives there is a clear distinction between the majority of municipalities which belong to a county, on the one hand, and independent cities, on the other. As there are only few independent cities in the state, we restrict attention to the sub-sample of 185 municipalities which are incorporated in a county and which have at least 10,000 residents. Table 2 provides some descriptive statistics.

The basic estimation follows equation (11) and controls for regional and time effects by means of a fixed effects approach emphasizing the variation of incentives within groups of observations, *i.e.* within observations for a specific jurisdiction or period. The basic specification includes, first of all, the marginal contribution rate and the level of virtual grants. Following the regression discontinuity approach, as the marginal contribution rate and virtual grants are dependent on relative fiscal capacity, we include the latter among the conditioning variables. As it is important to control for possible nonlinearities in the effect of the smooth triggering variable (*e.g.*, Heckman, Lalonde, and Smith, 1999), several alternative specifications are used, including linear, quadratic, and cubic specifications in $\gamma_{i,t}$ as well as linear and quadratic specifications with splines (interacted with the classification of $\gamma_{i,t}$ as being "low," "medium," or

[10]The business tax is a tax on profits which is a rather instable tax base in particular in smaller jurisdictions, where shocks to individual firms are not offsetting each other. The instability of the tax base is aggravated by substantial tax allowances.

[11]Based on the previous period's assessment, the business tax is payable in advance on a quarterly basis. This gives rise to rebates, in particular, due to cyclical reductions in business earnings or firm specific events like bankruptcies.

Figure 2: Changes in the Marginal Contribution Rate excl. Regime Changes



Statistics for the subsample of municipalities associated with a county with average population above 10,000 and without regime switches w.r. to the previous period, see text.

Table 2: Descriptive Statistics

		Mean	Std Dev	Min	Max
Levels					
Statutory tax rate	in %	16.29	0.922	14.00	19.75
Statutory tax rate, spatial lag	in %	16.05	0.493	15.00	17.47
Virtual grants	€ 1,000 per cap.	0.715	0.136	-0.007	1.122
Marginal contribution rate	in %	12.78	1.325	6.646	15.10
Relative fiscal capacity	in %	0.691	0.144	0.346	1.394
Low relative fiscal capacity	binary	0.172	0.378	0	1
Medium relative fiscal capacity	binary	0.783	0.412	0	1
Grants excl. equalization grants	€ 1,000 per cap.	0.782	0.121	0.386	1.257
Debt service	€ 1,000 per cap.	0.065	0.076	-0.296	0.529
Population	in 1,000	21.98	16.04	10.01	102.9
First Differences					
Statutory tax rate	in %	0.069	0.241	-1.500	2.000
Statutory tax rate, spatial lag	in %	0.059	0.073	-0.085	0.730
Virtual grants	€ 1,000 per cap.	-0.005	0.093	-0.694	0.803
Marginal contribution rate	in %	0.015	1.025	-5.577	5.841
Relative fiscal capacity	in %	0.001	0.062	-0.371	0.400
Low relative fiscal capacity	binary	0.008	0.320	-1.000	1.000
Medium relative fiscal capacity	binary	-0.008	0.357	-1.000	1.000
Grants excl. equalization grants	€ 1,000 per cap.	0.005	0.021	-0.159	0.181
Debt service	€ 1,000 per cap.	-0.003	0.025	-0.175	0.152
Population	in 1,000	0.140	0.304	-3.110	4.641

Levels: 3885 Observations: 185 cities over 21 years (1980-2000), first differences: 3700 observations: 185 cities over 20 years (1981-2000).

"high").

Even though the basic estimation equation already takes account of regional and time effects, it seems possible that further differences between jurisdictions obscure the empirical relationship between tax policy and incentives. This refers, first of all, to grants, other than unconditional, which extend the amount of fiscal resources available, irrespective of fiscal equalization and revenue sharing. We might, therefore, include other conditional grants explicitly – but since matching grants are immediately dependent on local policies, it seems reasonable to focus on conditional, non-matching grants. Whereas the theoretical discussion neglected any intertemporal relations in fiscal policy, the empirical analysis might also take into account that a part of the revenue is needed to service the current level of debt such that the amount of fiscal resources available for the supply of public services is reduced. Thus, some specifications also include the net debt service as a control variable.

Another potentially important intertemporal aspect is the possible dependency on taxing decisions made in previous periods. More specifically, one might argue that current tax policy considerations are affected by the level of taxation already enacted, and that a partial-adjustment model which includes the lag of the tax rate as a conditioning variable would be a more appropriate specification. However, following Heckman and Robb (1986) an alternative to the explicit inclusion of the lagged dependent variables is to specify a reduced form equation employing lags of conditioning variables on the right-hand side.

In addition, we might also want to take account of the fact that the tax rate in one municipality could be affected by the tax rates in competing jurisdictions. Following standard practice, this would suggest including a spatial lag of the tax rate, which is, basically, a weighted average of tax rates in neighboring jurisdictions.[12] While competition is not solely determined by geographic proximity, the empirical literature has shown that the latter is an empirically significant dimension of tax competition (see Brueckner, 2003, for an overview). However, simply conditioning on neighbors' tax policy is not a viable solution due to the spatial simultaneity bias (Anselin, 1988). Similar to the case of time lags, a simple solution is to condition on

[12]The spatial lag of a variable is obtained by a spatial transformation which replaces the observed values x_i $i = 1, ..., n$ by a weighted average of values in neighboring jurisdictions $\overline{x}_i = \sum_{j=1}^{n} \mathbf{w}_{i,j} x_j$, where $\mathbf{w}_{i,j}$ is positive if jurisdictions i and j are considered as neighbors. See the appendix for a description of the weighting scheme.

spatial lags of other explanatory variables, of course, taking account of municipalities which are not included in the current subsample.[13]

Whether or not we use fixed effects or first differences, for purposes of inference it seems important to control for autocorrelation. Since the estimation allows for fixed time and regional effects, some basic cross-sectional and time-series dependence is removed. To take account of additional spatial dependence, a heteroskedasticity and spatial-dependence consistent covariance matrix is used following Conley (1999). Additional dependence of residuals across time is taken into account by combining the spatial dependence consistent estimate of the covariance matrix with the autocorrelation consistent estimate suggested by Newey and West (1987).[14]

5 Results

Table 3 reports some basic results following the regression discontinuity approach. Aside from the key variables of interest, virtual grants and the marginal contribution rate, specifications (1) to (3) are controlling for relative fiscal capacity in various non-linear forms.[15] In all specifications the sign of the effects is in accordance with the theoretical expectation as the marginal contribution rate is associated with a higher tax rate whereas the level of virtual grants is

[13]Note that a model with a spatially lagged dependent variable can be transformed into a model with spatial lags in the explanatory variables (Anselin, 1988). As a first approximation we focus on first order spatial lags.

[14]The estimate of the covariance matrix is given by

$$\mathbf{S} = \sum_{m=0}^{p} \left(1 - \frac{m}{p+1}\right) \mathbf{S}_m,$$

where p is the maximum lag length and

$$\mathbf{S}_m = (1/NT) \sum_t \sum_i \sum_j 0.5K\left(i,j\right) \left[\mathbf{z}_{i,t}\hat{u}_{i,t}\hat{u}_{j,t-m}\mathbf{z}'_{j,t-m} + \mathbf{z}_{j,t-m}\hat{u}_{j,t-m}\hat{u}_{i,t}\mathbf{z}'_{i,t}\right],$$

where N is the number of observations, T is the number of periods, $\hat{u}_{i,t}$ is the first-step estimate of the residual, and $\mathbf{z}_{i,t}$ is the vector of instruments. Following Conley (1999) $K\left(i,j\right)$ is a two-dimensional Bartlett kernel defined over a regular lattice field with a distinct address for each of the N jurisdictions. For $K\left(i,j\right) = 0$ if $j \neq i$ the covariance matrix follows Newey and West (1987). Conversely, for $p = 0$ the covariance matrix follows Conley (1999). The analysis sets the spatial kernel such that the extension in each direction is about 30km (18.65 miles), p is set to 3.

[15]With results for virtual grants and the contribution rate quite similar to (1) but with lower adjusted R^2, results from linear specifications are suppressed.

Table 3: Basic Regression Results (Dep. Variable: Tax Rate)

Variable \ Specification	(1)	(2)	(3)	(4)
Virtual grants	-1.37 ⋆	-1.36 ⋆	-1.45 ⋆	-1.36 ⋆
	(.282)	(.291)	(.382)	(.272)
Marginal contribution rate	.075 ⋆	.074 ⋆	.189 ⋆	.223 ⋆
	(.017)	(.018)	(.067)	(.064)
Other grants				-1.73 ⋆
				(.496)
Debt service				1.68 ⋆
				(.260)
Relative fiscal capacity	quadratic	cubic	quadratic spline	quadratic spline
Sample size			3885	
Mean of dep. var.			16.3	
R^2 (adjusted)	.8115	.8115	.8137	.8201

All specifications include time- and region-specific fixed effects as well as controls for relative fiscal capacity as indicated. Robust standard errors in parentheses. Significance at 10% level is marked with a star.

associated with a lower tax rate. According to the adjusted R-squared, the specifications using more complicated non-linear-specifications of relative fiscal capacity show a slightly better fit, although the coefficients are less precisely estimated. Note that the table reports standard errors which are corrected for heteroskedasticity and autocorrelation across time and space. The best fit is found for the quadratic spline specification (3). Its results point to a substantial effect of fiscal equalization, suggesting that an increase in the marginal contribution rate by 1 percentage point is associated with an increase in the tax rate by about 0.189 percentage points. An increase in virtual grants by € 1000 per capita is associated with a reduction in the tax rate by 1.45 percentage points.

Specification (4) provides results where not only the basic variables but also two further conditioning variables are employed: the level of other grants received and the level of (net) debt service. Whereas both variables prove significant, indicating that tax rates tend to be higher if the debt burden is larger and the level of other grants is smaller, the other results show only small differences compared to specification (3). The impact of the marginal contribution rate in the reported best-fitting specification using a quadratic spline in relative fiscal capacity, however, is increased to a figure of 0.223.

Table 4: Regression Results with Lags in Time and Lags in Space (Dep. Variable: Tax Rate)

Variable \ Specification	(1)	(2)
Virtual grants	-1.30 ⋆	-1.16 ⋆
	(.271)	(.254)
Marginal contribution rate	.228 ⋆	.209 ⋆
	(.062)	(.060)
Sample size	3700	
Mean of dep. var.	16.3	
R^2 (adjusted)	.8252	.8274

Time and regional fixed effect included. Further explanatory variables are relative fiscal capacity (quadratic spline specification), debt service, and other grants. (1) employs these variables also as lagged values, (2) employs spatial lags in addition. Robust standard errors in parentheses. Significance at 10% level is marked with a star.

Specification (1) of Table 4 provides results of an estimation which additionally conditions on lagged control variables, specification (2) also includes spatial lags. While the adjusted R^2 is increased, in both cases the results show only minor differences compared to specification (4) of Table 3.

While the results support the theoretical predictions, there is some uncertainty about the size of the effects, since the inclusion of non-linear terms of relative fiscal capacity has been found to exert some relatively strong effect on the size of the coefficients. This may reflect the difficulty in distinguishing between temporary fluctuations and permanent changes in fiscal capacity. As we have discussed above, the alternative approach focusing on changes in the rules of the system should be less affected by temporary switches. Table 5 reports the corresponding results obtained from quadratic specifications of relative fiscal capacity as well as from estimations using a simpler linear specification which shows a slightly better fit. However, the results for the marginal contribution rate and the level of virtual grants proved to be quite stable across alternative specifications of relative fiscal capacity.

To facilitate comparisons, the set of control variables used in specifications (1) and (2) of Table 5 is the same as in Table 3. While the sign is confirmed, the estimated coefficients are smaller in absolute terms. This refers, in particular, to virtual grants, and indicates that the main impact of virtual grants results from the variation across regimes. In order to test whether the results

Table 5: Results for First Differences (Dep. Variable: Change in Tax Rate)

Variable \ Specification	(1)	(2)	(3)	(4)
Virtual grants	-.139 ⋆	-.141 ⋆	-.136 ⋆	-.138 ⋆
	(.057)	(.057)	(.056)	(.056)
Marginal contribution rate	.152 ⋆	.154 ⋆	.153 ⋆	.155 ⋆
	(.090)	(.092)	(.090)	(.091)
Other grants			.161	.156
			(.241)	(.243)
Debt service			.388	.395 ⋆
			(.176)	(.175)
Relative fiscal capacity	linear spline	quadratic spline	linear spline	quadratic spline
Sample size	3228			
Mean of dep. var.	.070			
R^2 (adjusted)	.0341	.0339	.0351	.0350

Observations where the status as having "low," "medium," or "high" fiscal capacity has changed relative to the previous period are omitted. All specifications include time-specific fixed effects as well as current values of relative fiscal capacity as indicated. Robust standard errors in parentheses. Significance at 10% level is marked with a star.

are robust against the inclusion of further control variables, specifications (3) and (4) provide results where changes in debt service and grants are included. While the debt service variable shows a significantly positive effect, compared to specifications (1) and (2) the differences in the coefficients obtained for virtual grants and the marginal contribution rate are negligible.

Even though the marginal contribution rate shows a differing impact across specifications the pure incentive effect of a higher contribution rate might be more similar due to the differences in the income effect. In order to compute the implied compensated effect of an increase in the marginal contribution rate we use the observed effect of a change in virtual grants in order to get an estimate of the response to the revenue loss implied by a higher contribution rate.[16] Considering the specification which gives the best fit among all estimations in first

[16]The compensated effect of the marginal contribution rate is obtained from the estimated effects of the contribution rate $\partial\tau/\partial\vartheta_i$ and of virtual grants on tax policy $\partial\tau/\partial y_i$ (time index suppressed) using

$$\frac{\partial\tau^c}{\partial\vartheta_i} = \widehat{\frac{\partial\tau}{\partial\vartheta_i}} + \widehat{\frac{\partial\tau}{\partial y_i}}\left(k_i - \frac{\partial y_i}{\partial\vartheta_i}\right),$$

where $k_i - \frac{\partial y_i}{\partial\vartheta_i}$ denotes the amount of additional funds needed to compensate for the revenue loss at a unit increase in the contribution rate. In the simple theoretical framework above the term in brackets would simplify

differences (specification 3 in Table 5) the compensated effect of an increase in the marginal contribution rate by 1 percentage point on the tax rate amounts to .142 percentage points. The corresponding figure for the level estimates is somewhat smaller. Considering the best-fitting specification (2) in Table 4 the compensated effect is .121 percentage points.

6 Summary and Conclusion

Theoretical considerations suggest that fiscal equalization transfers exert an incentive effect on the tax effort of local jurisdictions. In particular, a higher marginal contribution rate is predicted to be associated with a higher tax rate and the level of a local government's virtual grant is predicted to exert a negative impact on tax effort.

These theoretical predictions about the incentive effect of fiscal equalization are tested using a large panel of German municipalities. The data allow us to analyze directly the impact of the fiscal transfer system on the tax rate chosen by a municipal government. A special advantage of the dataset is that the system of fiscal equalization treats jurisdictions differently and differs across regions (counties) as well as over time; these differences allow us to pursue alternative identification strategies and to compare their results. The first approach taken in the paper exploits the fact that incentives are discontinuous functions of relative fiscal capacity by means of regression discontinuity estimation techniques. More specifically, we can distinguish three regimes of fiscal equalization which introduce discontinuous changes in the marginal contribution rate and virtual grants as relative taxing capacity is gradually increasing. Thus, at the threshold levels of taxing capacity even a tiny difference in relative fiscal capacity results in very different incentives. The second approach exploits the variation of incentives due to changes in the system over time.

Regardless of the identification approach taken, the empirical results support the predictions

to the tax base k_i. However, the empirical revenue impact of an increase in ϑ_i is somewhat more complex, since a change in ϑ_{it} will also have a negative effect on virtual grants. In our data, the combined revenue impact of a change in the marginal contribution rate by 1 percentage point is € 82 per capita on average. With variables specified in € 1,000, the income effect of an increase in the marginal contribution by one percentage point on the tax rate is calculated with 0.082 times the estimated coefficient of virtual grants.

of the theoretical analysis. The marginal contribution rate is found to exert a significantly positive impact on the local tax rate whereas the volume of grants received reduces tax effort. However, the size of coefficients in the basic fixed effects regression is sensitive to the inclusion of nonlinear terms in fiscal capacity. Despite some sensitivity with regard to the inclusion of nonlinear terms, the results are robust with regard to the inclusion of other conditioning variables such as other grants and debt service, as well as to the use of lags in time and spatial lags. Considering the specifications with the best fit, an increase in the marginal contribution rate by one percentage point is found to induce municipalities to raise their tax rate by up to 0.23 percentage points. The impact of virtual grants is weaker, indicating that an increase in the amount of virtual grants by as much as € 1000 per capita tends to reduce the tax rate by 0.9 to 1.5 percentage points. The alternative approach which neglects regime shifts and focuses on the impact of a variation in the incentives due to changes in the rules over time yields a somewhat smaller coefficient of around 0.15 for the marginal contribution rate. But, also the corresponding estimates of the effect of virtual grants are smaller than in the level regression, suggesting that an increase of virtual grants by € 1000 causes a reduction in tax rates only by about 0.13 or 0.14 percentage points.

As compared with the observed effects, the implied compensated effects of an increase in the marginal contribution rate vary less with the identification approach. Evaluated at the mean, the incentive effect, *i.e.* the compensated impact of an increase in the marginal contribution rate by 1 percentage point on the tax rate, amounts at an increase of the tax rate by .12 to .14 percentage points. An impression of the magnitude of this effect is obtained from its evaluation at the sample average of the marginal contribution rate (12.8%): accordingly, a plausible range for the point estimate of the overall compensated impact of the marginal contribution rate would be around 1.5 to 1.8 percentage points of the business tax rate.

While the results point to a significant incentive effect of fiscal equalization transfers, the welfare implications are not obvious. If the tax base elasticity with regard to the tax rate mainly reflects reallocation of capital within the state, it is possible that the incentives created by the system of fiscal equalization actually restore a first-best optimum, but if local externalities from tax competition are weak, and if there are important inefficiencies within the public sector, the fiscal equalization system is likely to induce municipalities to set tax rates too high. One

possible way to tackle this difficult question in future research may be to ask whether state governments have the right incentives to optimally structure their system of fiscal equalization or whether they pursue alternative objectives.

Appendix A: Derivation of the Parameters of the Fiscal Transfer System

This section gives a formal derivation of equations (9) and (10) for the fiscal transfer system in the state of Baden-Wuerttemberg. Note that we abstract from the use of lagged data in the calculation of transfers and treat all elements as contemporaneous. Let g_i be the total revenue from intergovernmental transfers determined by the local share of the state's income tax revenue, fiscal equalization grants, and three separate contributions:

$$\begin{aligned} g_i &= x_i && \text{income tax revenue share} \\ &+ g_i^{equal} && \text{fiscal equalization grants} \\ &- \tau^{rs} k_i && \text{revenue sharing contribution} \\ &- \theta_i^{local} \left((\tau_0 - \tau^{rs})\, k_i + g_i^{equal} + x_i \right) && \text{county contribution} \\ &- \theta_i^{state} \left((\tau_0 - \tau^{rs})\, k_i + \zeta g_i^{equal} + x_i \right) && \text{state contribution} \end{aligned}$$

Most of the parameters have already been introduced in Section 3.1: τ^{rs} is the revenue sharing tax rate, τ_0 is the standardizing tax rate used to determine the taxing capacity. θ_i^{local}, θ_i^{state}, and θ_i^{equal} are contribution rates out of fiscal capacity. Note that fiscal equalization transfers tend to raise the contributions to the state and the county – albeit only partially if $\zeta < 1$. As is depicted by the following equation, fiscal equalization grants are determined by the difference between fiscal need (n_i) and fiscal capacity ($(\tau_0 - \tau^{rs})\, k_i + x_i$), where the latter is determined not only by the business tax base but also by other revenues

$$g_i^{equal} = \xi_i n_i - \theta_i^{equal} \left((\tau_0 - \tau^{rs})\, k_i + x_i \right), \tag{13}$$

where the parameters depend on the ratio between fiscal capacity and fiscal need:[17]

[17] In some years, also the state contribution parameter θ_i^{state} depends on relative fiscal capacity. To keep the exposition simple, this effect is, however, neglected in this description.

$$\theta_i^{equal} = 1.00 \quad \xi_i = 0.88 \quad \text{if} \quad 0 \quad < \quad \frac{(\tau_0 - \tau^{rs})k_i + x_i}{n_i} \quad < \quad 0.6 \qquad (\textit{low capacity})$$

$$\theta_i^{equal} = 0.70 \quad \xi_i = 0.70 \quad \text{if} \quad 0.6 \quad < \quad \frac{(\tau_0 - \tau^{rs})k_i + x_i}{n_i} \quad < \quad 1 \quad (\textit{medium capacity})$$

$$\theta_i^{equal} = 0.00 \quad \xi_i = 0.00 \quad \text{if} \quad 1 \quad < \quad \frac{(\tau_0 - \tau^{rs})k_i + x_i}{n_i} \qquad (\textit{high capacity}).$$

Inserting the grant formula into the budget equation we obtain

$$\begin{aligned} g_i &= x_i + \xi_i n_i \left(1 - \theta_i^{local} - \theta_i^{state}\zeta_i\right) \\ &- \left(\tau^{rs} + \theta_i^{local}\left(\tau_0 - \tau^{rs}\right) + \theta_i^{state}\left(\tau_0 - \tau^{rs}\right)\right) k_i \\ &- \theta_i^{equal}\left(\tau_0 - \tau^{rs}\right)\left(1 - \theta_i^{local} - \theta_i^{state}\zeta_i\right) k_i \\ &- \left(\theta_i^{local} + \theta_i^{state} + \theta_i^{equal}\left(1 - \theta_i^{local} - \theta_i^{state}\zeta_i\right)\right) x_i. \end{aligned}$$

Reformulation yields the above linear relationship

$$g_i = y_i - \vartheta_i k_i,$$

where marginal contribution rate ϑ_i and virtual grants y_i are determined by equations (9) and (10), respectively (see above). Note that the the marginal contribution rate does not directly enter into the determination of virtual grants. Instead, the last term in equation (10) employs the marginal contribution out of other revenues, where the contribution rate

$$\frac{\vartheta - \tau^{rs}}{\tau_0 - \tau^{rs}} = \theta_i^{local} + \theta_i^{state} + \theta_i^{equal}\left(1 - \theta_i^{local} - \theta_i^{state}\zeta_i\right),$$

is independent of τ_0 and τ^{rs}.

Appendix B: Data Sources and Definitions

The basic dataset consists of all 1,111 municipalities (*Gemeinden*) of the state of Baden-Wuerttemberg. The municipalities comprise the lowest of the fiscal tiers, forming 44 districts, *i.e.* 35 counties (*Kreise*) and 9 independent cities (*Kreisfreie Städte*). The municipalities show marked differences in size, with average population ranging from 100 to more than 500,000 residents.

Table 6: Size Distribution of Municipalities

Population size in 1,000		<1	1-2	2-5	5-10	10-20	20-50	50-100	>100
No. of municipalities	N=1,111	94	136	416	245	135	63	13	9

Based on average population figures 1980-2000.

With the exception of the price index, all data are obtained from the state's statistical office (*Statistisches Landesamt*).

The **statutory tax rate** of the business tax (*Gewerbesteuer*) is determined as follows. The tax law sets a base rate of 5% and requires each local jurisdictions to set its *collection rate* ("Hebesatz"). For instance, the *collection rate* might be a figure of 380%, which means that the statutory tax rate applied to the firm is $3.8 \times 0.05 = 19\%$.

Marginal contribution rates are obtained from a full implementation of the fiscal equalization law and further relevant statutory definitions for each year in the period 1980-2000. State specific rules are obtained from the "Gesetzblatt fuer Baden-Wuerttemberg" issued by the Ministry of State (*Staatsministerium fuer Baden-Wuerttemberg*). Data for taxing capacity and fiscal capacity (*Steuerkraft*) are obtained from the state's statistical office. Fiscal need is explicitly calculated from the official population figures according to the equalization law. Further specific additions with regard to the number of students and military personnel etc. are neglected. The base allowance of fiscal need per (modified) resident (*Grundkopfbetrag*) is obtained from the state's Ministry of Finance.

Virtual grants give the amount of grants including equalization grants and revenue sharing grants net of contributions the considered municipality would receive if it would have a zero tax base under its current equalization regime. The revenue sharing grants relate to the distribution of statewide income tax revenues (*Gemeindeanteil an der Einkommensteuer*).

Other grants include specific non-matching grants independent of the tax base (*Zuschuesse fuer laufende Zwecke*) but conditional on specific uses as reported in the annual budgetary statistics (*Jahresrechnungsstatistik*).

The **tax base** is calculated from the total revenues of the business tax (*Gewerbesteueraufkom-*

men, brutto) as reported in the annual budgetary statistics. It is obtained via dividing tax revenues by the statutory tax rate.

Debt service is defined as annual interest expenses net of interest income according to the annual budgetary statistic.

The **price index** used is the price index for public consumption for West Germany (source: Council of Economic Experts).

Annual population is the average of quarterly figures based on census data and official projections using resident registration information.

Spatial weighting matrix: Euclidian distances are computed from a digital map of the geographical position of the administrative center of each municipality. The matrix employed in the estimations presented defines neighbors as municipalities located within a distance of 30 kilometers (18.65 miles). A simple binary weighting scheme is used. The matrix is row standardized.

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