A joint Initiative of Ludwig-Maximilians-Universität and Ifo Institute for Economic Research

# Working Papers

# LOCAL BUSINESS TAXATION AND COMPETITION FOR CAPITAL: THE CHOICE OF THE TAX RATE

Thiess Buettner*

CESifo Working Paper No. 440

March 2001

CESifo

Center for Economic Studies & Ifo Institute for Economic Research
Poschingerstr. 5, 81679 Munich, Germany

Tel.: +49 (89) 9224-1410
Fax: +49 (89) 9224-1409
e-mail: office@CESifo.de



* I would like to thank Roel Beetsma, Margit Kraus, two anonymous referees, and participants of conferences at the ZEW, Mannheim, and at the ZEI, Bonn, for helpful comments and criticism. I am grateful also to Jonathan Beck, who helped me in collecting and preparing the database.

CESifo *Working Paper No. 440*
*March 2001*

# LOCAL BUSINESS TAXATION AND COMPETITION FOR CAPITAL: THE CHOICE OF THE TAX RATE

## Abstract

A theoretical model describes the local choice of the tax rate on capital income. It establishes preferences and various fiscal conditions - including the tax rates of competing jurisdictions - as determinants of the tax rate. The empirical implications are tested using a large panel of jurisdictions in Germany, which have discretion in setting the local rate of the business tax. Tax competition is identified by means of instrumental variables techniques. Despite significant competition effects between local neighbors, where tax rates are strategic complements, jurisdictions are found to have some leeway in using the tax rate as an instrument of their policy. In particular, large jurisdictions set higher tax rates in interjurisdictional competition.

Keywords: Local public finance, tax competition, instrumental variables, spatial econometrics, business taxation

JEL Classification: H71, H72, H73, C23, D62.

*Thiess Buettner*
*ZEW*
*L 7-1*
*68161 Mannheim*
*Germany*
*Email: buettner@zew.de*

# 1 Introduction

Public economics has become increasingly concerned with the consequences of economic integration, especially of international factor mobility. The notion that established systems of taxation face serious difficulties in capital income taxation has brought about a large literature on international tax competition. However, as compared to the theoretical and political significance of this issue the empirical literature is still on a small scale. Possibly, this is related to the difficulties of tracing back observed actions of economic agents to the national tax systems and in a more general perspective to the shape of the public sector as a whole. Given this background several researchers have found it helpful to skip the broad international perspective and to take a look at local issues. Some federal states, highly integrated, have substantial local autonomy in the public sector and offer rich observable experience with the consequences of economic integration.

This article analyses local tax policy using a panel of more than 1000 jurisdictions in a major German state. The focus is on the local tax on business earnings and business property. An attractive feature of this case lies in its resemblance to the theoretical case of source based capital taxation, which is important in the literature on tax competition. As the business tax constitutes the main local competence in tax policy in Germany, the set of tax instruments is restricted in such a way that governments use the distorting tax on the mobile factor, which is essential for many of the results of the tax competition literature (eg., Wellisch, 2000). Therefore, this case allows to study the determinants of the local choice of the tax rate, and, in particular, to investigate to what extent local tax policy is involved in tax competition.

The empirical analysis is based on a theoretical model of a council's choice of the local tax rate. This model collects various important aspects from the literature in order to derive a testable set of predictions about the local tax policy. Taking into account the productivity effects of public spending as in Matsumoto (1998) tax rates of competing jurisdictions are shown to be interdependent. However, in view of large differences in terms of the population size of the local jurisdictions in Germany, the model takes account of asymmetries in tax competition following Bucovetsky (1991) and Wilson (1991). In addition, the objectives of the local councils are not assumed to be the same across jurisdictions, although, unlike Inman (1989) the focus is not on the impact of various interest groups on local policy, as an unanimous objective function of the local council is assumed. Moreover, predetermined and exogenous revenue components in the local budget, such as grants, are established as determinants of the choice of the tax rate.

In the empirical investigation observed tax rates are regressed on various local characteristics of potential influence according to the theoretical model. The tax policy of possibly competing jurisdictions is taken into account by employing observed tax rates in the nation as a whole as well as in the local neighborhood in the regression. Yet, in order to

take account of the simultaneity of the observed taxing decisions predetermined or exogenous determinants of tax rates are used as instruments of neighbors' tax policy by means of a spatial instrumental variables technique. Following Kelejian and Prucha (1998) the estimation also controls for additional spatial autocorrelation of residuals.

The results confirm the existence of local tax competition, and thus support evidence by Ladd (1992), Besley and Case (1995), and Brett and Pinske (1997) for the U.S, as well as Seitz (1995) for Germany, and Ashworth and Heyndels (1997) for Belgium. However, the findings indicate that tax competition by no means deprives jurisdictions of all leeway in using the tax rate as an instrument of their policy. Large jurisdictions, in particular, are found to set higher tax rates. In view of the theoretical model, and given the set of control variables, this size differential is interpreted as indicating the market power of large jurisdictions (cf. Epple and Zelenitz, 1981, and Hoyt, 1992). Furthermore, the endowment with fiscal revenues as well as spending mandates are reflected in the taxing decisions.

The following section lays out a theoretical model establishing testable predictions about the local tax policy. The empirical investigation in section 3 starts with some basic institutional facts, develops an estimation strategy and gives a description of the dataset before presenting the results. The appendix contains the derivation of the comparative static properties of the theoretical model, as well as a detailed description of the sources and definitions of the data.

# 2 A model of local tax setting

The model consists of three blocks. The first deals with the decision problem of the local council, which faces two constraints: the budget constraint and a condition requiring equal earnings opportunities of the mobile factor across jurisdictions. The second block is a description of the local economy, where two factors, a crowding externality, and a productivity effect of public expenditures, are combined. The third block, then, closes the model by considering the integration of the mobile factor market between jurisdictions.

## 2.1 Local policy decision problem

In an economy with a mobile and an immobile factor the local council is supposed to maximize a simple objective function including the income of the immobile factor $Y^L$ and the level of public expenditures $E$ as arguments. The local council is assumed to supply an all–purpose public good, which has an impact on local productivity.[1] Focusing on the immobile factor's income is justified by the strong interest of owners of local, immobile

[1] cf. Buettner (2000) for an analysis with both a public input and a public consumption good.

factors in influencing local policies (e.g., Wellisch, 2000, 55). To what extent the target function reflects the residents' utility or the preferences of a leviathan government aiming at increasing "wasteful" expenditures (cf. Edwards and Keen, 1996) is, however, left open. Assuming a log linear target function the council maximizes

$$V = E^{\nu} \left( Y^{L}(E,\tau) \right)^{1-\nu}, \qquad 0 \leq \nu \leq 1, \tag{1}$$

subject to the budget constaint. $\nu$ is the weight of public expenditures relative to local private income. Note that the income of the immobile factor is a function of both the level of expenditures and the local tax rate. A higher level of spending is assumed to increase the local factor's income, since public spending is productive and the mobile factor is attracted. The tax rate reduces local income, since the attempt to reduce the after tax rate of return on the mobile factor may lead to an outflow of that factor. When determining its policy the local council takes into account that expenditures are in turn determined by the taxes via its budget constraint. In an atemporal context spending equals income from taxation plus the level of grants $G$ received

$$E \;=\; \tau Y^{C}(E,\tau) + G, \tag{2}$$

$Y^{C}$ is the total return on capital invested locally, which also is affected by the policy variables.

Solving the budget constraint for the expenditures and inserting into the target function the following first order condition is obtained by logarithmic differentiation

$$\frac{V}{t}\left[ \nu \frac{d\log E}{d\log \tau} \;+\; (1-\nu)\frac{d\log Y^{L}}{d\log \tau} \right] = 0. \tag{3}$$

The first term in the brackets shows the gain from a percentage increase of the tax rate due to higher revenues and spending. The second term gives the marginal welfare loss from a percentage increase in the tax rate provided local income decreases with the tax rate. At the optimum the two terms just balance. In order to derive empirical predictions from this condition the elasticities need to be derived by inspection of the workings of the local economy and the consequences of capital market integration.

## 2.2 The local economy

Indexing the variables with the jurisdiction output at location $i$ is given by

$$Y_i \;=\; A(E_i,K_i)\,F(K_i,L_i),$$

where $F$ is a production function with labor $L_i$ and capital $K_i$ as inputs and the output price is set to unity. $A(E_i,K_i)$ is a shift–term capturing the location specific total

factor–productivity. It is formulated as a function of local public expenditures capturing productivity gains and of the amount of the mobile factor, capital, installed locally, which reflects a crowding externality. The positive impact of public expenditures is formulated analogous to the treatment of external scale economies as used for instance by Helpman (1984) and Henderson (1985). Following Matsumoto (1998) this specification may be referred to as a factor augmenting public input. For simplicity we will assume a loglinear technology, i.e. a production function of Cobb-Douglas type and a constant elasticity of productivity with respect to public expenditures, $\beta$. In addition, the crowding effect, namely the elasticity of productivity with respect to the stock of capital installed, $\gamma$, is also set constant. With labor earning a constant fraction of income local labor income is

$$Y_i^L = (1-\alpha)\, E_i^{\beta}\, (k_i L_i)^{-\gamma}\, k_i^{\alpha} L_i, \tag{4}$$

where $k_i$ denotes the capital intensity and $\alpha$ the share of capital. The income equation is affected by the tax rate, since the tax rate determines the level of expenditures via the budget constraint, and because it may affect the local capital intensity, formally

$$\frac{d \log Y_i^L}{d \log \tau_i} = \beta \epsilon_{E_i,\tau_i} - (\alpha - \gamma)\, \epsilon_{k_i,\tau_i}, \tag{5}$$

$$\text{where} \qquad \epsilon_{E_i,\tau_i} = \frac{d \log E_i}{d \log \tau_i}, \qquad \epsilon_{k_i,\tau_i} = -\frac{d \log k_i}{d \log \tau_i}.$$

The pre-tax return on capital is correspondingly

$$Y_i^C = \alpha E_i^{\beta}\, (k_i L_i)^{-\gamma}\, k_i^{\alpha} L_i. \tag{6}$$

Inserting this equation into the budget constraint allows to calculate the increase in spending resulting from a tax increase

$$\epsilon_{E_i,\tau_i} = \frac{1-g_i}{1-\tilde{\beta}_i} \left[1 - (\alpha - \gamma)\, \epsilon_{k_i,\tau_i}\right], \tag{7}$$

$$\text{where} \qquad \tilde{\beta}_i = (1-g_i)\, \beta,$$

and $g_i$ is the share of grants in the local budget. $\tilde{\beta}_i$ measures the elasticity of total productivity with respect to an increase in tax revenues. The term in squared brackets captures the direct revenue increase plus the indirect effect due to mobility. Multiplication by $1-g_i$ gives the budget rather than the revenue increase, and the division by $1-\tilde{\beta}_i$ reflects the self–financing effect of productive expenditures due to their direct impact on productivity.

In order to close the model we need to determine the impact of the tax rate on the capital intensity. In the equilibrium of the interregional capital allocation the after–tax return to capital at jurisdiction $i$ is equal to the equilibrium rate of return $r$

$$r \stackrel{!}{=} r_i \equiv (1-\tau_i)\, \alpha E_i^{\beta} k_i^{\alpha-1-\gamma} L_i^{-\gamma}. \tag{8}$$

Using Eq. (7) the impact of a variation of jurisdiction $i$'s tax rate on the capital intensity is derived by logarithmic differentiation

$$\epsilon_{k_i,\tau_i} = \left[\frac{\tau_i}{1-\tau_i} - \frac{\tilde{\beta}_i}{1-\tilde{\beta}_i}\right] / \left[1 - \tilde{\varphi}_i + \epsilon_{r,k_i}\right], \tag{9}$$

$$\text{where} \qquad \tilde{\varphi}_i = \frac{\alpha-\gamma}{1-\tilde{\beta}_i}, \qquad \epsilon_{r,k_i} = \frac{d\log r}{d\log k_i}.$$

$\tilde{\varphi}_i$ denotes the elasticity of total output at jurisdiction $i$ with respect to capital and $\epsilon_{r,k_i}$ describes the elasticity of the capital supply. Because the latter is nonnegative, the denominator is positive, if the productivity of public expenditures is limited so that

$$1 - \tilde{\beta}_i > \alpha - \gamma \quad \Rightarrow \tilde{\varphi}_i < 1.$$

If this restriction did not hold, higher spending might always attract the mobile factor leading to a tax rate of unity. Moreover, the interregional equilibrium would be unstable in this case (cf. Richter, 1994). A similar requirement is necessary in the context of agglomeration economies (cf. Henderson, 1985). Thus, we assume that the diminishing returns from holding constant the immobile factor outweigh the returns from public spending.

At low tax rates the numerator of equation (9) is negative, indicating that an increase in the tax rate will reduce rather than increase the elasticity of the local capital intensity.[2] The reason is that the marginal productivity of public spending is large at low tax rates. But if the tax rate equals $\tilde{\beta}_i$ the numerator is zero, and for higher tax rates it is positive, so that an increase in the tax rate will increase the elasticity of the local capital intensity.

The consequences for the tax rate can be seen when inserting (9) into equations (3),(5), and (7), which yields an expression for the optimum tax rate

$$\frac{\tau_i}{1-\tau_i} = \frac{\tilde{\beta}_i}{1-\tilde{\beta}_i} + \varphi^{-1}\left(\frac{1-g_i}{1-\nu_i g_i}\right)\left(\nu_i + \frac{\beta}{1-\beta}\right)\left[1 - \tilde{\varphi}_i + \epsilon_{r,k_i}\right], \tag{10}$$

$$\text{where} \quad \varphi = \frac{\alpha-\gamma}{1-\beta} < 1.$$

This expression seems to indicate that the tax rate will be higher, the larger the elasticity of the equilibrium interest rate with respect to region $i$'s capital intensity, the higher the productivity of public expenditures $\beta$, the higher the preference for public spending $\nu_i$, and the lower the share of grants in the local budget (smaller $g_i$ implies a larger $\tilde{\beta}_i$). However, proving these presumptions is difficult, since the expression employs the budget shares of

[2]Note that $\epsilon_{k_i,\tau_i}$ has been defined as the negative of the logarithmic derivative of the capital intensity with respect to the tax rate.

grants on the right hand side, which are endogenous to local taxation.[3] Nevertheless, we can already deduce that the tax rate is set higher than the output elasticity of public expenditures ($\tilde{\beta}_i$) irrespective of whether the council has a direct preference for public expenditures, or is maximizing local income. This simply reflects the fact that even if the local council is conducting a purely income maximizing policy $\nu_i = 0$, it is not maximizing the supply of the immobile factor. The intuition behind this is that public expenditures exert a positive externality on productivity, and thus it is reasonable for the council to set the tax rate above $\tilde{\beta}_i$, which would ensure that $\epsilon_{k_i,\tau_i} = 0$. In other words, the rational policy will not simply maximize capital since this would not maximize the social value of output due to the presence of increasing returns to scale (cf. Helpman, 1984).

## 2.3 Integration of the capital market

The elasticity of the equilibrium rate of return in the denominator of equation (9) captures the role of the integration of capital markets. In case of fully segmented capital markets of the jurisdictions the capital supply is inelastic and this term approaches infinity. Consequently, the impact of the tax rate on the local capital intensity is zero, and the optimum tax rate approaches unity if public expenditures are productive ($\beta > 0$), or if the local council attaches a positive weight to local expenditures in its target function ($\nu_i > 0$). In the other extreme with a fully integrated and large, say worldwide, factor market the supply of the mobile factor is infinitely elastic and the elasticity of the equilibrium rate of return approaches zero.

The cases without mobility and with complete mobility are extreme. In order to discuss different degrees of integration it suffices to distinguish two jurisdictions. The degree of capital market integration is then reflected in the size of the other region constituting the opportunity location. Without any capital market integration, the opportunity location is negligibly small. With regional capital market integration each jurisdiction has a significant share in the regional factor market. With world–wide market integration the opportunity location is the whole world and the local share in the factor market is negligible. The impact of a variation in the capital intensity on the equilibrium rate of return is explicitly derived by assuming a fixed supply of capital to the integrated economy. The full employment condition in the market for capital is

$$k_i L_i + k_j L_j = 1, \qquad L_i + L_j = 1, \tag{11}$$

where for reasons of simplicity the total supply of capital as well as the total supply of labor is set equal to unity. From equation (11) follows

$$\frac{d \log k_j}{d \log k_i} = -\frac{k_i L_i}{k_j L_j} = -\frac{K_i}{K_j}. \tag{12}$$

[3]Note that the second order condition is fulfilled as is shown in the appendix.

Accordingly, a change in region $i$'s capital intensity implies a change in the region $j$'s capital intensity as well.

Since condition (8) holds also for region $j$, the impact of a variation in region $i$'s capital intensity on the equilibrium rate of return is equivalent to its impact on region $j$'s rate of return. In order to derive a formal expression we need to introduce an assumption about region $j$'s policy. It is tempting to assume that its policy is taken as given, i.e. that tax rate $\tau_j$ as well as expenditures $E_j$ remain constant. However, this would introduce an inconsistency, since the budget constraint would be neglected. Thus, we employ a Nash–assumption about the tax rate, but take into account the implied, or passive, change in expenditures (cf. Conrad and Seitz, 1997). This amounts to assume that tax rates rather than expenditures are strategic variables. The impact of $k_j$ on region $j$'s after tax rate of return on capital is

$$\frac{d\log r_j}{d\log k_j} \;=\; (\alpha - 1 - \gamma) + \beta\frac{d\log E_j}{d\log k_j}, \tag{13}$$

where the term in brackets shows the direct impact on the rate of return, and the last term shows the impact via an increase in public expenditures. At a given tax rate $\tau_j$ the relative increase in public expenditures is

$$\frac{d\log E_j}{d\log k_j} \;=\; \tilde{\varphi}_j\,(1 - g_j)\,. \tag{14}$$

Using (12), (13), and (14) the impact of $k_i$ on the equilibrium rate of return is

$$\epsilon_{r,k_i} \;=\; (1 - \tilde{\varphi}_j)\,\frac{K_i}{K_j}. \tag{15}$$

The effect of an increase in region $i$'s capital intensity on the equilibrium rate of return depends on the relative size of region $i$, reflecting the result of Bucovetsky (1991) and Wilson (1991) that the "perceived" elasticity of the capital supply decreases with the size of the region.

Inserting the expression for the equilibrium rate of return into equation (10) we see that the ratio of the local stocks of capital at the two locations has an effect on the local tax rate. By increasing this ratio a higher tax rate at the opportunity location $j$ has an impact on the tax rate chosen at jurisdiction $i$. Yet, this impact depends on the share of jurisdiction $i$ in the capital market and vanishes if this share approaches zero. So, without grants the tax policy of a jurisdiction with a negligible share of the relevant factor market solely depends on the parameters of preferences and the underlying technology, but not on the other jurisdiction's policy. But, if both locations have a significant share in the relevant factor market we expect a direct interdependence between the jurisdictions' choice of the tax rate.

## 2.4 Policy predictions

Using the theoretical model we can derive predictions about the local tax policy. Of special interest is the impact of local characteristics such as the share of the labor supply, the weight of the policy targets, and the level of grants received, as well as the impact of the competing jurisdiction's tax policy. Leaving the detailed derivation of the model's comparative static properties to the appendix we obtain the following set of policy predictions:

| | (i) $dL_i$ | (ii) $d\nu_i$ | (iii) $d\tau_j$ | (iv) $dG_i$ |
|---|---|---|---|---|
| $d\tau_i$ | $> 0$ | $> 0$ | $\gtrless 0$ | $\gtrless 0$ |
| $d\tau_i$ at $\beta = 0$ | $> 0$ | $> 0$ | $> 0$ | $< 0$ |

For each of the four determinants two predictions are stated, one for the general case and one for the specific case without productive public expenditures. The first prediction (i) concerns the size effect, namely that a jurisdiction with a larger share of the labor supply sets a higher tax rate. As the greater than sign applies in both rows, this holds irrespective of whether or not public expenditures are productive. The explanation for the size effect is that a larger share of the labor market also implies a higher share of the capital market, so that the elasticity of the factor supply is reduced. This result is known from the literature about asymmetric tax competition (cf. Bucovetsky, 1991, and Wilson, 1991) but applied here in a setting with productive public expenditures and grants.

According to the second prediction (ii) a higher preference for public spending relative to the immobile factor's income in the target function of the council is reflected in a higher tax rate. Again this prediction applies irrespective of the productivity of public expenditures.

The comparative static effect of the competing jurisdiction's tax rate (iii) is ambiguous in the case of productive expenditures. Although jurisdiction $i$ experiences an increase of its capital share with a tax increase at jurisdiction $j$, it is not clear, whether it will respond with a tax increase. For the tax increase at $j$ also tends to reduce the share of grants in the budget of that jurisdiction, which in turn increases the overall output elasticity of capital at jurisdiction $j$. Therefore, the elasticity of the equilibrium rate of return may decline. This would increase the response of mobile capital to local tax increases at jurisdiction $i$ and higher taxes would become less favorable. The countervailing effect, however, is absent if public expenditures are not productive ($\beta = 0$). Moreover, even with productive expenditures, the countervailing effect is conditional upon a private–income oriented tax policy at location $j$, since if the council at jurisdiction $j$ maximized the budget a tax increase would have no effect on expenditures and would leave the share of grants constant at the margin.

The productivity of public expenditures is also a precondition for an ambiguity of the comparative static effect of the level of grants on the tax rate, cf. prediction (iv). If public expenditures are not productive, an increase in the level of grants would cause a tax rate reduction, because the lower weight of tax revenues in the budget reduces the gains from raising the tax revenues. But, with productivity effects an increase in the level of grants does not necessarily increase the share of grants in the budget. The reason is that due to the external productivity effects each additional dollar spent on public goods will increase revenues. If the share of revenues in the budget is small, the revenue gain resulting from an increase in grants may outweigh the direct effect of the grants, and the share of grants might decline. Then, additional grants may actually lead to increases in the tax rate as the gain from additional revenues is higher. This reaction, however, is conditional upon a private–income oriented policy at jurisdiction $i$. Since, if expenditures were maximized, tax increases would not affect the budget at the margin, and the effect from an increased supply of capital would dominate.

# 3 Empirical investigation

When deriving the set of predictions about the tax setting behavior of local jurisdictions the theoretical model employs a specific assumption, which is prominent in the literature about tax competition: local jurisdictions are assumed to be constrained in the set of tax instruments available, and use a tax rate on the mobile factor in order to raise funds for public spending. Due to its institutional setting the local government level in Germany fits well into this setting. Although their autonomy is stipulated in the German constitution (article 28, Grundgesetz), the *communities* (Gemeinden) have only few tax instruments at their disposal, since the German system of fiscal federalism relies heavily on tax sharing and centralization on the revenue side.

Until 1997, and thus in the period of our investigation, the local business tax consisted of two components, a tax on business earnings and a tax on business property. Communities have local discretion in taxation, since they decide about the *collection rate* $c_i$, which is a factor applied to base tax rates on business' earnings and their property. The revenues $\mathrm{T}_i$ at location $i$ are determined according to

$$\mathrm{T}_i = c_i \left( 0.05 \, \tilde{Y}_i^C \; + \; 0.002 \tilde{K}_i \right) ,$$

where $\tilde{Y}_i^C$ denote taxable earnings and $\tilde{K}_i$ the property value.[4] A collection rate of 320 % which is the median in our sample of communities (cf. Table 2) thus amounts to a tax of about 16 % on taxable earnings plus a tax of about 0.64 % on property. The overall variation of collection rates is quite substantial, in the given sample the rates vary between

[4]The tax base of multi–plant firms is divided among jurisdictions using their employment share.

280 and 445 %. Yet, the variation in effective tax rates is much lower, since tax payments are deductible: first, from the taxable earnings of the business tax itself, and, second, from the tax base of corporate and personal income taxes. Under the rules of 1997 the effective tax rates on business earnings vary between jurisdictions by at least 2.8 % for individuals with highest personal income tax rate, and 4.1 % for corporations receiving revenues from a subsidiary.[5] It has also to be emphasized that due to tax exemptions of earnings below a certain threshold, small firms are often not taxed.

Table 1 gives an overview of revenues and spending of the consolidated local budget in Germany.

[Table 1 about here.]

Accordingly, the revenues from the business tax amount to a share of 15 % in the local budget in the western part of Germany. The local tax revenues are somewhat higher since about 19 % (1997, source: Federal Ministry of Finance) of the revenues are transferred to the state and the federal level because of revenue sharing. The transfer obligation is based on standardized revenues, calculated at a uniform collection rate across communities.[6] The revenues from the income tax are also substantial. But, the communities do not have discretion in tax rates, and, moreover, the local share of the income tax revenues is an instrument of redistribution among communities. Apart from the business tax only the land taxes allow for local discretion in tax setting. However, the land taxes are of minor importance, as the revenues amount only to a third of the revenues from the business tax.[7]

## 3.1 Estimation approach

Using the conditions for the optimum tax rate the theoretical discussion has explained the local choice of the tax rate by a set of four local conditions

$$\tau_i = \tau \left( \tau_j \, , \, L_i \, , \, \nu_i \, , \, G_i \right) .$$

Accordingly, we regress the tax rate on a set of fiscal variables describing the predetermined or exogenous budgetary components reflecting the availability of alternative funds as indicated by $G_i$, on a set of mainly demographic variables capturing differences in local

[5] If the tax payments were only deductible from the business tax itself one could obtain an effective tax rate on earnings when dividing the collection rate by $1 + 0.05c_i$. But, since terms and conditions of deductibility depend on the specific conditions of each case, and because of the interaction with the tax on property it is more appropriate to use the collection rate as the dependent variable in the investigation.

[6] From 1984 to 1990 the transfer obligation was calculated using a standard collection rate of 52 %, until 1996 the rate was increased to 78 %.

[7] The fiscal assessment of land according to the land tax is rather special as it is based on a combination of market values in the sixties and the characteristics of its use (cf. Junkernheinrich, 1991).

preferences indicated by $\nu_i$, and on some variables capturing the relative size of the community as indicated by $L_i$. In addition, to take account of the interdependence in local taxing decisions further variables are used to capture the competing jurisdictions' tax policy as indicated by $\tau_j$.

For the empirical testing of interjurisdictional competition effects, it is helpful to make some a priori assumptions about which communities might engage in an interjurisdictional tax competition. There are several justifications to expect geographical proximity to matter for capital income tax competition. Consider the Weberian location problem, where the location of production is determined by a minimization of transport costs with respect to input and output markets (e.g., Beckmann, 1968). If a certain region has been found to be an optimal location, there might still be some degrees of freedom in choosing the specific community. This will put local communities into competition for the location of investment. A related case is the location decision of an expanding firm establishing an additional plant or workplace. If the firm plans to place the new plant in the vicinity in order to minimize spatial transaction costs, there may be several communities fulfilling this qualification. A further reason to expect tax competition between geographic neighbors especially is the existence of spatial information costs. This kind of costs has been used to in order to motivate the yardstick competition in local elections as found by Besley and Case (1995) and Ashworth and Heyndels (1997).

Although there is good reason to expect competition between local neighbors, interjurisdictional competition may also take place at the national level. Therefore, we explicitly include the national collection rate, and allow the data to assess whether the neighbor's or the national collection rate is significant. In a similar spirit, we take account of the possibility that there may be other dimensions of neighborhood which give rise to interjurisdictional competition. In a system of cities of different size as suggested by Henderson (1985), there might be some hierarchical competition between urban areas and separately between peripheral areas, if some industries require an urban location, whereas others exploit lower real estate prices in peripheral areas. This is also suggested by the finding of intercity competition in Germany by Seitz (1995). A competition between areas with the same population density is tested for by employing national tax rates for communities belonging to the same type of district according to a classification of districts with respect to their population density.

Including the tax rate of a small set of competing jurisdictions in the local neighborhood introduces a specific simultaneity problem, which is well established in the spatial econometrics literature (cf. Cliff and Ord, 1973). Different approaches to tackle spatial simultaneity have been suggested. Whereas the earlier literature emphasized the use of maximum likelihood (ML) estimation, recent contributions suggest instrumental variable techniques (cf. Kelejian and Robinson, 1993, Kelejian and Prucha, 1998). Aside from the computational costs due to the presence of large spatial weighting matrices in the likelihood function, ML estimation hides the spatial interaction process by a priori imposing a spatial structure

upon the data, which brings about difficulties in interpretation (cf. Case et al., 1993). Furthermore, in order to understand interjurisdictional competition it would be interesting to make the identification strategy explicit by means of instrumental variable techniques. The panel data available to this study are quite promising in this respect, as they allow the use of lagged fiscal and as well as demographic variables as instruments.

As a starting point, assume the following equation characterizes the observed tax rate

$$\tau_t = \rho W \tau_t + X_{t-1}\delta + u_t, \tag{16}$$

where $\tau_t$ denotes the vector of local tax rates in period $t$, $X_{t-1}$ denotes the matrix of fiscal and demographic variables, and $u_t$ is the vector of residuals. $W$ is a spatial weighting matrix, transforming the vector of observed tax rates into the vector of weighted tax rates of the competing jurisdictions. By employing lagged local characteristics $X_{t-1}$ we assume that the local community sets the tax rate ex–ante, i.e. it is using current values of the fiscal variables when deciding about next year's tax rate. Because the local policy is decided upon publicly in the local council, the actual tax choice of local neighbors is assumed to be observable, and the contemporaneous tax rates of the competing jurisdictions are employed.

Equation (16) cannot be consistently estimated using OLS since $W\tau_t$ is correlated with the residuals (e.g, Cliff and Ord, 1973, and Anselin, 1988). But as suggested by Kelejian and Robinson (1993) as well as Kelejian and Prucha (1998) we might use a subset $(X^*_{t-1})$ of the set of local characteristics in order to form a matrix of what can be considered natural instruments in this context

$$H_t = \left(X_{t-1}, W X^*_{t-1}\right), \tag{17}$$

using spatial lags of the local characteristics. Using $Z_t = (W\tau_t, X_{t-1})$ the corresponding 2SLS estimator for the vector of parameters is

$$\begin{aligned} (\hat{\rho}, \hat{\delta}')' &= \left(Z_t' P_t Z_t\right)^{-1} \left(Z_t' P_t \tau_t\right), \\ P_t &= H_t \left(H_t' H_t\right)^{-1} H_t'. \end{aligned} \tag{18}$$

Because the coefficients are assumed to be time invariant, estimation is carried out for pooled cross–sections rather than for a single period.

Besides the simultaneity of the tax rate of competing jurisdictions, there is a further estimation problem. Particularly when using spatial lags as instruments we need to make sure that no spatial residual autocorrelation is present, i.e. that $\lambda = 0$ with

$$u_t = \lambda W u_t + \epsilon_t, \tag{19}$$

where $\epsilon_t$ is a vector of independent disturbances. Yet, in the current investigation, standard tests have documented significant residual spatial autocorrelation. Kelejian and Prucha

(1998) recommend adding a further step to the estimation and applying a Cochrane–Orcutt type of transformation to equation (18). Provided a consistent estimator of the coefficient of spatial autocorrelation of the residuals $\overline{\lambda}$ is available this amounts to estimate

$$(\tilde{\rho}, \tilde{\delta}')' = \left(\overline{Z}_t' P_t \overline{Z}_t\right)^{-1} \left(\overline{Z}_t' P_t \overline{\tau}_t\right), \tag{20}$$

$$\overline{Z}_t = Z_t - \overline{\lambda} W Z_t, \overline{\tau}_t = \tau_t - \overline{\lambda} W \tau_t.$$

As was noted by Anselin (1988, 59) the parameter of autocorrelation cannot be obtained by applying OLS to equation (19). Instead we compute $\overline{\lambda}$ by means of a nonlinear least squares estimator based on the residuals of the basic instrumental variables estimator as suggested by Kelejian and Prucha (1998, 1999).

## 3.2 Data and variables

The empirical analysis employs a large panel of fiscal and demographic variables for the complete set of local jurisdictions in a major German state (Baden–Württemberg). The dataset provides annual observations of local collection rates in 1111 communities (Gemeinden) from 1980 until 1996.

[Table 2 about here.]

Table 2 provides some descriptive statistics on the collection rates. The first line shows the variation of the collection rates for the pooled data, the second shows the variation of the long–run average between communities. Obviously, most of the variation is cross–sectional.

The underlying communities are very different especially in population size, which according Table 2 ranges from nearly 100 residents to almost 600 thousands of residents. Table 2 also shows descriptive statistics of the budgetary variables capturing exogenous and predetermined components of the revenue side: namely unconditional grants, income tax revenues, and standardized revenues from the land tax, calculated as if the collection rate was 100 % everywhere.[8] Since less than the entire budget of the community is available for financing the provision of public goods, we also control for fixed spending categories in the local budget, such as the debt service of the community and transfers paid. The debt service variable is especially important, since communities which have accumulated excessive debts are controlled by the state's ministry of the interior, which will force these communities to raise collection rates in order to repay their debt. In addition to debt service, the available

[8] A negative minimum of the pooled observations of standardized revenues for land and business taxes is reported, which is resulting from remissions. Therefore, negative values are only transitory and the minimum of the average is positive.

funds of communities are further reduced by mandated transfers to other governments as well as to individuals. Most of the communities pay contributions to the county (Kreis) they belong to, as it is the county which runs the welfare aid. Some of the communities constitute independent cities (Kreisfreie Städte) which have to finance welfare aid on their own. This explains the strong variation of welfare expenditures and county contributions. When interpreting these variables we have, however, to take into account that they may pick up local preferences, since they indicate the presence of poverty in the respective city or county.

The theoretical model has endogenized the tax base, and has explained it by the supply of the immobile factor and fiscal conditions. For purposes of the empirical investigation we have however to take account of the possibility that this is not sufficient to explain the location of economic activities. For instance, there might be agglomeration economies apart from the public sector and path dependence might be important for location. As a consequence some communities will have a larger tax base than others, despite a similar factor endowment and similar fiscal conditions, including the tax rates of competing jurisdictions. This is also indicated by the huge cross–sectional variation of standardized tax revenues as documented especially by the figures for the average cross–section in Table 2. Therefore, in addition to the other budgetary variables, a standardized measure of the base of the business tax is included among the regressors. Since we use lagged values of this variable as well as lagged values of the own tax rate (see below) a possible simultaneity bias is avoided. However, the tax base might also pick up local preferences, since the policy of a community with a large tax base might be under pressure from the tax payers, especially since smaller firms are exempted from the business tax, and the tax is paid by the large local employers.

In order to capture the preferences driving local policy a set of demographic characteristics is employed, see the lower part of Table 2. Four variables take up the age structure of the population. This is of importance because the demand for public expenditures varies over a citizen's lifecycle. Children will demand public child care, all the more so since communities in Germany are obliged to provide this type of service.[9] Young citizens will demand opportunities for vocational training. In general, citizens of working age will be more eager to get well paid jobs and will favor an income or employment oriented policy more strongly than elder citizens, who are possibly retired and more interested in the provision of public goods. In addition to the age structure we employ three variables capturing the religious affiliation of residents. The hypothesis behind this is that communities with a strong christian influence might show preferences diverted against ordinary public spending but favoring spending of the parish, at least since part of social and welfare aid is taken on by the christian community's charity. Note that the descriptive statistics show strong segregation in terms of the church affiliation, as the share of protestant and catholic

[9]However, note that in Germany schooling is not financed out of the budget of community but out of the budget of the state.

population varies from almost zero to unity.[10]

Another preference variable refers to the share of foreign nationals in the local population, capturing resident population without voting power. Since the majority of foreigners belong to the lower part of earnings distribution this might also indicate higher demand for public spending, if a large share of foreigners indicates stronger social problems. Also, the number of jobs registered in the social security accounts is included, since a private–income oriented policy will be of special importance where employment is rather weak. However, because of data limitations both the employment and the foreign nationals per population are entered at the county and city level, aggregating the whole set of communities into 44 districts.

Concerning the size of communities the log of the population is entered as a lagged value. In order to control for differences in the regional conditions which are possibly affecting local productivity through urbanization and agglomeration economies also a set of district type dummies is employed, based on a classification capturing centrality and population density at the county and city level. Furthermore, the estimation employs a set of border dummies for the communities directly situated at the border to France and Switzerland. This shall pick up regions particularly exposed to international competition.

The regression conditions not only on past standardized revenues but also on the past collection rate, as it includes the lagged local collection rate among the regressors. This captures sluggish adjustment of tax rates. More profoundly, one can argue that the past level is an important determinant of today's collection rate, since the local public compares current policy with last year's policy. In other words, it will be easier to raise the collection rate to a certain level, if that level is not very much different from last year's.

Finally, the spatial weighting matrix is specified from a digital map of the geographical position of the administrative center of each set of community. The matrix employed defines local neighbors as communities located within a certain distance. The threshold is set at 30 kilometers, as this distance gives a reasonable description of the commuting range in Germany (see appendix). Each neighboring community is weighted according to its relative distance, since previous experiments with alternative weighting schemes have revealed the best fit for the distance weights.

## 3.3 Results

The results are presented in Table 3. The estimated regression contains no fixed effects despite a panel of communities beeing used. Instead, a set of characteristics is employed capturing the cross–sectional determinants of the tax rate. Moreover, the estimation tech-

[10]One community even reports a share of catholics above unity. As this community is very small (187 people at the 1987 census) this can be ascribed to a minor lack of coincidence in the questionnaires.

nique takes account of spatial correlation in both the dependent variable and the residuals and thus can be considered as controlling for regional effects in a constrained way (cf. Case, 1991). Note also that the regression conditions on the local collection rate in the previous year, and thus controls for various inherited conditions. Even without fixed effects the coefficient of determination shows a value of .9145. According to the F-Statistic (F-Stat.: 1.968) this is significantly lower than the value of .9243 for the corresponding fixed effects regression.[11] Yet, since the F-Statistic is invalid with heteroskedasticity, and the underlying coefficient of determination would favor any reduction in degrees of freedom, this should not be overemphasized (cf. Amemiya, 1985).

[Table 3 about here.]

The discussion of results starts with the impact of the predetermined or exogenous variables. The lagged own tax rate is significantly positive as well as lower than unity, indicating a slow adjustment of tax policy to changes in the communities' conditions. Unconditional grants allocated to the local community exhibit significant negative effects on the tax rate. A similar effect is found for the income tax revenues. Predetermined expenditure components which reduce available funds all show positive effects, in particular the service of the local debt shows a strong effect. Also the county contributions as well as mandated welfare spending show significant positive effects, indicating that communities transmit adverse social conditions into higher local business taxation. Generally, the predetermined budget components affect tax policy in a way that a larger amount of alternative revenues and a lower amount of fixed expenditures not available for the funding of public goods lead to lower tax rates. In this context we should also note that the level of the standardized tax revenues has a negative effect, indicating that "rich" communities set a lower tax rate. The theory offers the explanation that a larger amount of available funds makes a policy of increasing revenues by raising the tax rate less attractive.

Turning to preferences, the demographic characteristics show the expected sign. All age groups exert a negative effect as compared to the reference group of people above 65 years. However, the effects show no monotonous effect along the lifecycle, even when standardizing the coefficients with the means of the corresponding regressors. However, this may reflect the specific responsibilities of the local public sector in Germany. Foreign nationals show a strong positive effect, indicating their lack of voting power or indicating social problems forcing governments to increase spending. The job variable did not show significant effects. However, since this variable is reported at the county level it may simply fail to pick up the local conditions. The three variables capturing religious affiliation show the hypothesized negative influence, which is possibly pointing towards charity related crowding out of governmental policy. Taken together, although it is not possible to ensure that all underlying preferences are taken into account, the obtained results are in line with the theoretical predictions.

[11] Results available from the author.

The size of communities in terms of population rather than in terms of capital invested shows strong significant effects on the local collection rate. As dummies for density are included (especially district types 1 and 5 picking up larger cities) this result is obviously not due to price effects in urban communities related to crowding. Given the discussion about the social burden of cities it is also important to note that the size differential is not driven by welfare expenditures, as they are included among the set of regressors. However, the significant size effect might still be related to different preferences of larger jurisdictions. But, insofar as these preferences stem from different administrative obligations of larger communities, they should already be captured in the grant variable. Because, the system of fiscal federalism in Germany aims to provide jurisdictions with sufficient fiscal resources in order to meet their mandates, and systematic violations can be alleged at a state court. Although it is difficult to ensure that the size effect is not at all driven by preferences, it at least conforms to prediction (ii). The view that large cities use their market power to require a tax premium (cf. Hoyt, 1992) is supported in particular, since the interjurisdictional competition effects indicate that the relevant market of the mobile factor is regional.

Concerning intercommunity competition in tax rates, the results show a significant positive impact of the local neighbors' tax rate. It should be stressed that this result has been obtained by instrumental variable techniques, which take account of the simultaneity of taxing decisions of competing jurisdictions. The set of instruments consists of all regressors - except for the neighbor's tax rate - plus spatial lags of all those predetermined or exogenous regressors which are reported at community level, except for the border variables and the age structure variables.[12] Note that the orthogonality of the set of instruments with respect to the residuals cannot be rejected, since the test of overidentifying restrictions shows no significance at the 10 % level (13 overidentifying restrictions). The national collection rate also shows a significant impact on the local collection rate, which is, however, negative. Note, that this result is not driven by the trend, since it was also obtained when removing the trend from the regression. The joint impact of national ($\tau_t^N$) and local collection rates as found in the regression is

$$\tau_t = .917\tau_{t-1} - .011\tau_t^N + .052W\tau_t$$

The difference in the signs of national and local neighbors' tax rates indicates that the local jurisdiction follows the taxing decisions of its competing local neighbors, but responds inversely to tax increases outside of its region. This might be explained by differences in the degree of capital mobility at the local and the national level. A nationwide tax increase might simply serve as a beneficial fiscal externality to the local tax base without changing the elasticity of the local tax base with respect to local tax rates. Thus, the local jurisdiction might react with a tax reduction. Actually, the neighboring jurisdictions will lower their tax rates as well and the estimated simultaneous relationship suggests that the joint effect

[12]The border variables are not used as instruments since the spatial lag is included explicitly among the regressors. Spatial lags of the age structure variables are not used as instruments since they have been found to be significantly correlated with the residuals.

is slightly larger. The observed direct interdependence between tax rates of local neighbors, however, indicates a much stronger mobility of capital at the local level, where – in the light of the theory – a tax increase of competing jurisdictions reduces the elasticity of the capital supply with respect to the local tax rate. The local jurisdiction, therefore, responds with a tax increase. This response of the tax rate to a fiscal externality is consistent with the theoretical discussion on the underprovision of public infrastructure (eg., Matsumoto, 1998).

The border variables show no direct significance, but for their spatial lags, i.e. a weighted average of the neighbors of border communities, we find significant negative effects. This could point to the inherited peripheral status of the communities situated very close to the border, whereas communities located within a distance of 30 km to the border face significant cross–border competition.

# 4 Summary

In order to provide explanations for the choice of the tax rate in a setting with local taxation of mobile capital, the paper has developed a theoretical model combining several aspects of possible importance for the local policy. The model considers an economy consisting of two jurisdictions, which may differ in the endowment with the immobile factor, in the level of grants received, and in the preferences of the local council. A special feature of the model is that it takes account of productivity effects of public expenditures. In accordance with the literature it is shown that with differences in the supply of the immobile factor, the larger jurisdiction sets a higher tax rate. The model also shows that a shift of public preferences from a private–income oriented policy towards higher public spending results in a higher tax rate. If capital markets of the jurisdictions are integrated, tax policies of the two jurisdictions are shown to influence each other, but tax rates are not necessarily strategic complements in the presence of productivity effects of public expenditures. The reason is that due to the productivity effects public expenditures are partly self–financing, and, thus, changes in the composition of the revenue side of the budget may alter the impact of capital movements on local productivity. For similar reasons the model is ambiguous with respect to the impact of grants, if public inputs are productive. Without the productivity effects of public expenditures, however, tax rates are strategic complements and a higher level of grants leads to a reduction in the tax rate.

In the second part of the paper the theoretical implications are empirically tested using a large panel of local jurisdictions in Germany. The case of Germany is of special interest, since the local jurisdictions are restricted in the set of tax instruments available, and use a source based tax on business earnings and property. As suggested by the theory, the investigation employs various local characteristics capturing population size, preferences, competing communities' tax rates, as well as grants and other predetermined budget com-

ponents in a regression model. In order to reflect the local decision process the regression uses lagged values of local conditions, except for the competing communities' tax rates, since the latter are assumed to be set simultaneously. The simultaneous relationship in the tax rates is taken into account by means of a spatial instrumental variables approach, which allows for spatial residual autocorrelation as suggested in the recent econometric literature. The list of instruments includes predetermined components of the revenue side of the budget of the local jurisdictions as well as specific predetermined expenditure components such as debt service and mandated transfers. In addition, in order to capture preferences of the local population the religious affiliation of the residents is employed.

The regression is quite successful in explaining the local choice of the tax rate as about 91 % of the total variation of tax rates is explained. The budgetary variables, including grants, other predetermined revenue components, as well as mandated transfers, and the debt service all show significant effects indicating that a reduction of funds available to finance the supply of public goods is causing an increase in the tax rate. Also various indicators of preferences show significant effects conforming to the hypothesized influence. A higher share of old aged residents is related to a higher tax rate, indicating a stronger preference towards public expenditures rather than towards a private–income oriented policy. A stronger christian affiliation of residents is related to lower tax rates, possibly reflecting the substitution of public expenditures by spending from the parish.

The empirical identification strategy of tax competition employs spatial lags of the local determinants of the tax rate as instrumental variables. As the orthogonality conditions of the set of instruments cannot be rejected, the regression gives clear evidence for local tax competition, where tax rates are found to be strategic complements. Yet, tax competition by no means deprives jurisdictions of all leeway in using the tax rate as an instrument of their policy. Rather, communities use the tax rate in order to reduce the impact of variations in predetermined budget components on expenditures. The regression also establishes a strong effect of population size on the tax rate, which in the light of the theoretical model should be interpreted as a market size effect, especially since the estimation conditions on the burden of welfare expenses as well as on the level of grants received.

## References


Ashworth, J. and B. Heyndels, 1997, Politicians' preferences on local tax rates: an empirical analysis, European Journal of Political Economy 13, 479–502.

Amemiya, T., 1985, Advanced econometrics (Oxford: Basil Blackwell).

Anselin, L., 1988, Spatial econometrics: methods and models (Dordrecht et al.: Kluwer Academic Publishers).

Beckmann, M., 1968, Location theory (Random House, New York).

Besley, T. and A. Case, 1995, Incumbent behavior: vote–seeking, tax–setting, and yardstick competition, American Economic Review 85, 25–45.

Brett, C. and J. Pinske, 1997, Those taxes are all over the map! A test for spatial independence of municipial tax rates in British Columbia, International Regional Science Review 20, 131–151.

Bucovetsky, S., 1991, Asymmetric tax competition, Regional Science and Urban Economics 30, 167–181.

Buettner, T., 2000, Determinants of tax rates in local capital income taxation: a theoretical model and evidence from Germany, Finanzarchiv 57, 1–26.

Case, A. C., 1991, Spatial patterns in household demand, Econometrica 59, 4, 953–965.

Case, A. C., H. S. Rosen, and J. R. Hines, 1993, Budget spillovers and fiscal policy interdependence: Evidence from the states, Journal of Public Economics 52, 285–307.

Cliff, A. D. and J. K. Ord, 1973, Spatial processes: models and applications (London: Pion Ltd.).

Conrad, K. and H. Seitz, 1997, Infrastructure provision and international market share rivalry, Regional Science And Urban Economics 27, 6, 715–734.

Edwards, J. and M. Keen, 1996, Tax competition and Leviathan, European Economic Review 40, 113–134.

Epple, D. and A. Zelenitz, 1981, The implications of competition among jurisdiction: does Tiebout need politics? Journal of Political Economy 89, 1197–1217.

Heidenreich, H.–J., 1988, Berufs– und Ausbildungspendler, Wirtschaft und Statistik 2, 86–100.

Helpman, E., 1984, Increasing returns, imperfect markets, and trade theory, in: R. Jones and P. Kenen, eds., Handbook of international economics, Vol. I (Amsterdam et al.: North Holland), 325–365.

Henderson, J. V., 1985, Economic theory and the cities (San Diego: Academic Press).

Hoyt, W. H., 1992, Market power of large cities and policy differences in metropolitan areas, Regional Science and Urban Economics 22, 539–558.

Inman, R. P., 1989, The local decision to tax – evidence from large U.S. cities, Regional Science and Urban Economics 19, 455–491.

Junkernheinrich, M., 1991, Gemeindefinanzen. Theoretische und methodische Grundlagen ihrer Analyse (Berlin: Analytica).

Kelejian, H. H. and I. R. Prucha, 1998, A generalized spatial two–stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances, Journal of Real Estate Finance and Economics 17, 1, 99–121.

Kelejian, H. H. and I. R. Prucha, 1999, A generalized moments estimator for the autoregressive parameter in a spatial model, International Economic Review 40, 509-533.

Kelejian, H. H. and D. H. Robinson, 1993, A suggested estimation for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model, Papers in Regional Science 72, 297–312.

Ladd, H. F., 1992, Mimicking of local tax burdens among neighboring counties, Public Finance Quarterly 20, 450–467.

Matsumoto, M., 1998, A note on tax competition and public input provision, Regional Science and Urban Economics 28, 465–473.

Richter, W. F., 1994, The efficient allocation of local public factors in Tiebout's tradition, Regional Science and Urban Economics 24, 323–240.

Seitz, H., 1995, The productivity and supply of urban infrastructure, Annals of Regional Science 29, 121–141.

Wellisch, D., 2000, Theory of public finance in a federal state (Cambridge: Cambridge University Press).

Wilson, J. D., 1991, Tax competition with interregional differences in factor endowments, Regional Science and Urban Economics 21, 423–451.

# A Derivation of policy predictions

The above policy predictions can be derived as comparative static exercises from differentiation of the first order condition. They are indicated by the following differentials:

$$\begin{aligned}
\frac{d\tau_i}{dL_i} &= \frac{\partial V^2}{\partial \tau_i \partial L_i}\left(-\frac{\partial V^2}{\partial \tau_i^2}\right)^{-1}, \\
\frac{d\tau_i}{d\nu_i} &= \frac{\partial V^2}{\partial \tau_i \partial \nu_i}\left(-\frac{\partial V^2}{\partial \tau_i^2}\right)^{-1}, \\
\frac{d\tau_i}{d\tau_j} &= \frac{\partial V^2}{\partial \tau_i \partial \tau_j}\left(-\frac{\partial V^2}{\partial \tau_i^2}\right)^{-1}, \\
\frac{d\tau_i}{dG_i} &= \frac{\partial V^2}{\partial \tau_i \partial G_i}\left(-\frac{\partial V^2}{\partial \tau_i^2}\right)^{-1}.
\end{aligned}$$

The sign of the differentials is determined by the sign of the partial derivative of the first order condition with respect to the considered variable or parameter, if the second order condition is fulfilled. Therefore, we start to show that the second order condition is fulfilled.

Inserting the expenditure and income elasticities into the first order condition we obtain

$$\begin{aligned}
\frac{\partial V}{\partial \tau_i} &= -\left(1-\nu_i\right)\left(\alpha-\gamma\right)\epsilon_{k_i,\tau_i} \\
&+ \left(\nu_i+\left(1-\nu_i\right)\beta\right)\underbrace{\frac{1-g_i}{1-\tilde{\beta}_i}\left[1-\left(\alpha-\gamma\right)\epsilon_{k_i,\tau_i}\right]}_{\epsilon_{E_i,\tau_i}}.
\end{aligned} \tag{21}$$

A variation of the tax rate has two effects. First, the elasticity of the capital intensity with respect to the tax rate may be affected. Second, as the share of grants in the budget varies, $\tilde{\beta}_i$ might change. Formally, total differentiation and re–substitution of the first order condition yields

$$\begin{aligned}
\frac{\partial^2 V}{\partial \tau_i^2} &= -\left(\nu_i+\left(1-\nu_i\right)\beta\right)\frac{1-g_i}{1-\tilde{\beta}_i}\frac{1}{\epsilon_{k_i,\tau_i}}\frac{d\epsilon_{k_i,\tau_i}}{d\tau_i} \\
&- \epsilon_{k_i,\tau_i}\left(1-\nu_i\right)\left(\alpha-\gamma\right)\frac{1}{1-g_i}\frac{1}{1-\tilde{\beta}_i}\frac{dg_i}{d\tau_i}.
\end{aligned} \tag{22}$$

Starting with the first term, differentiation of equation (9) yields

$$\frac{d\epsilon_{k_i,\tau_i}}{d\tau_i} = \frac{1}{1-\tilde{\varphi}_i+\epsilon_{r,k_i}}\left[\frac{1}{\left(1-\tau_i\right)^2}+\frac{\epsilon_{E_i,\tau_i}}{1-g_i}\frac{\beta}{1-\tilde{\beta}_i}\frac{dg_i}{d\tau_i}-\epsilon_{k_i,\tau_i}\frac{d\epsilon_{r,k_i}}{d\tau_i}\right], \tag{23}$$

where the first term inside of the brackets reflects the direct impact of an increase in the tax rate, the second reflects the variation of the share of grants, and the third term captures a change in the equilibrium rate of return $\epsilon_{r,k_i}$. To evaluate the latter is somewhat tedious, since we need to determine the impact on the capital allocation.

From the equalization of the after tax returns on capital

$$\frac{K_i}{K_j} = \left( \left( \frac{1-g_i}{1-g_j} \right)^{-\beta} \left( \frac{L_i}{L_j} \right)^{1-\alpha} \left( \frac{1-\tau_i}{1-\tau_j} \right)^{1-\beta} \left( \frac{\tau_i}{\tau_j} \right)^{\beta} \right)^{\frac{1}{1-(\alpha-\gamma)-\beta}}. \tag{24}$$

When using this expression to derive the impact of the own tax rate on the capital allocation, we have to take account of the fact that the shares of grants $g_i, g_j$ are dependent in turn on the capital allocation. Formally, total differentiation of the share of grants yields

$$\hat{g}_i = \left[ 1 - \frac{g_i}{1-\tilde{\beta}_i} \right] \hat{G}_i - \frac{1-g_i}{1-\tilde{\beta}_i} \left[ \hat{t}_i + (\alpha-\gamma)\,\hat{K}_i + (1-\alpha)\,\hat{L}_i \right], \tag{25}$$

where the hat denotes relative changes. If we further note that

$$\hat{K}_j = -\frac{K_i}{K_j}\hat{K}_i, \quad \hat{L}_j = -\frac{L_i}{L_j}\hat{L}_i,$$

since $K_i + K_j = 1$ and $L_i + L_j = 1$ we can obtain the following differential of the local stock of capital by total differentiation of equation (24)

$$\begin{aligned} [1 - \tilde{\varphi}_i + \epsilon_{r,k_i}]\,\hat{K}_i &= \frac{\beta g_i}{1-\tilde{\beta}_i}\hat{G}_i + \left[ \frac{1-\alpha}{1-\tilde{\beta}_i} + \frac{1-\alpha}{1-\tilde{\beta}_j}\frac{L_i}{L_j} \right] \hat{L}_i \\ &- \left[ \frac{\tau_i}{1-\tau_i} - \frac{\tilde{\beta}_i}{1-\tilde{\beta}_i} \right] \hat{t}_i + \left[ \frac{\tau_j}{1-\tau_j} - \frac{\tilde{\beta}_j}{1-\tilde{\beta}_j} \right] \hat{t}_j. \end{aligned} \tag{26}$$

Since in the neighborhood of the optimum the tax rate is set above $\tilde{\beta}_i$ the share of capital decreases as the local tax rate rises. Now we can derive the impact on the elasticity of the equilibrium rate of return by logarithmic differentiation of equation (15)

$$\frac{d\log \epsilon_{r,k_i}}{d\tau_i} = \left[ \frac{\tilde{\varphi}_j}{1-\tilde{\varphi}_j}\frac{\tilde{\beta}_j}{1-\tilde{\beta}_j} g_j \tilde{\varphi}_j + \left( 1 + \frac{K_i}{K_j} \right) \right] \frac{d\log K_i}{d\tau_i}, \tag{27}$$

Because the term in squared brackets is positive the elasticity is increasing with the share of capital installed locally and, therefore, is decreasing with the tax rate.

Turning back to the question of whether the second order condition is fulfilled, we can deduce from equation (25) that the elasticity of the share of grants at given levels of grants

and labor supply ($\hat{G}_i = 0, \hat{L}_i = 0$) is equal to minus the expenditure elasticity $\epsilon_{E_i,\tau_i}$. Using equation (7) we can solve the first order condition for the expenditure elasticity and obtain

$$\epsilon_{E_i,\tau_i} = (1-\nu_i)\left(\frac{1-g_i}{1-\nu_i g_i}\right), \tag{28}$$

which is non–negative. Therefore, an increase in the tax rate reduces the share of grants. This is equivalent to the statement that the rational government in our analysis will always be at the rising portion of its revenue hill. Because the share of grants is reduced, the second term of the second order partial derivative (22) is positive. The first term is negative, if the elasticity of the local capital intensity with respect to the tax rate is positive. It suffices to consider the case where the elasticity of the equilibrium rate of return is constant, since we already know from equation (27) that, in the general case, it will decrease and contribute to an increase of $\epsilon_{k_i,\tau_i}$. Inserting expression (23) with $d\epsilon_{r,\tau_i} = 0$ and equation (25) into the second order partial derivative (22) and after some reformulations we arrive at

$$\left.\frac{\partial^2 V}{\partial \tau_i^2}\right|_{\epsilon_{r,\tau_i}=0} = -\frac{1-\nu_i}{(1-\tau_i)^2}\frac{\varphi_i}{1-\tilde{\varphi}_i+\epsilon_{r,k_i}}\left[\frac{1-g_i}{\epsilon_{E_i,\tau_i}} - g_i(1-\tau_i)\frac{\epsilon_{E_i,\tau_i}}{1-g_i}\right]. \tag{29}$$

This expression is always negative since we know from equation (28) that

$$\frac{1-g_i}{\epsilon_{E_i,\tau_i}} > 1.$$

Having shown the fulfillment of the second order condition, the comparative static properties are derived from the other second order partial derivatives of the target function.

ad (i):
After re–substitution of the first order condition (21) the second order partial derivative with respect to the labor supply is

$$\begin{aligned}\frac{\partial V^2}{\partial \tau_i \partial L_i} &= -\epsilon_{k_i,\tau_i}(1-\nu_i)(\alpha-\gamma)\frac{1}{1-g_i}\frac{1}{1-\tilde{\beta}_i}\frac{dg_i}{dL_i} \\ &- (\nu_i + (1-\nu_i)\beta)\frac{1-g_i}{1-\tilde{\beta}_i}\frac{1}{\epsilon_{k_i,\tau_i}}\frac{d\epsilon_{k_i,\tau_i}}{dL_i}.\end{aligned} \tag{30}$$

With a higher share of labor at location $i$ the share of capital installed at location $i$ increases as is shown by equation (26). Because of the resulting reduction in the share of grants, the first term is positive. The second term is positive, if the elasticity of the local capital intensity decreases. Logarithmic differentiation of equation (9) yields

$$\frac{d\epsilon_{k_i,\tau_i}}{dL_i} = \frac{1}{1-\tilde{\varphi}_i+\epsilon_{r,k_i}}\left[\frac{\beta}{1-\tilde{\beta}_i}\frac{\epsilon_{E_i,t_i}}{1-g_i}\frac{dg_i}{dL_i} - \epsilon_{k_i,\tau_i}\frac{d\epsilon_{r,k_i}}{dL_i}\right]. \tag{31}$$

Due to the reduction in the share of grants the first term is negative. Moreover, the elasticity of the equilibrium rate of return is increased, since logarithmic differentiation of equation (15) leads to

$$\frac{d\log\epsilon_{r,k_i}}{dL_i} = \left[\frac{\tilde{\varphi}_j}{1-\tilde{\varphi}_j}\frac{\tilde{\beta}_j}{1-\tilde{\beta}_j}g_j\tilde{\varphi}_j + \left(1+\frac{K_i}{K_j}\right)\right]\frac{d\log K_i}{dL_i}. \tag{32}$$

As a consequence, we know that

$$\frac{d\epsilon_{k_i,\tau_i}}{dL_i} < 0,$$

and the second term of (30) is positive. Therefore, the sign of the second order partial derivative is positive.

ad (ii):
It is obvious from the first order condition (21) that a higher preference for public expenditures raises the positive term and lowers the negative term. It follows immediately that the second order partial derivative with respect to the preference parameter $\nu_i$ is positive.

ad (iii):
The second order partial derivative with respect to the neighbor's tax rate is

$$\begin{aligned}\frac{\partial V^2}{\partial\tau_i\partial\tau_j} &= -\epsilon_{k_i,\tau_i}(1-\nu_i)(\alpha-\gamma)\frac{1}{1-g_i}\frac{1}{1-\tilde{\beta}_i}\frac{dg_i}{d\tau_j} \\ &- (\nu_i+(1-\nu_i)\beta)\frac{1-g_i}{1-\tilde{\beta}_i}\frac{1}{\epsilon_{k_i,\tau_i}}\frac{d\epsilon_{k_i,\tau_i}}{d\tau_j}.\end{aligned} \tag{33}$$

At a given supply of labor $\hat{L}_i = 0$ and a given level of grants $\hat{G}_i = 0$ it can be seen from equation (26) that the share of capital installed at location $i$ increases with the tax rate of jurisdiction $j$. According to equation (25) this implies a reduction in the share of grants. Consequently, the first term in the partial derivative (33) is positive. The second term is positive if the elasticity of the local capital intensity declines. To check this, we differentiate equation (9) and obtain

$$\frac{d\epsilon_{k_i,\tau_i}}{d\tau_j} = \frac{1}{1-\tilde{\varphi}_i+\epsilon_{r,k_i}}\left[\frac{\epsilon_{E_i,t_i}}{1-g_i}\frac{\beta}{1-\tilde{\beta}_i}\frac{dg_i}{d\tau_j} - \epsilon_{k_i,\tau_i}\frac{d\epsilon_{r,k_i}}{d\tau_j}\right]. \tag{34}$$

We see that the decline in the share of grants tends to reduce $\epsilon_{k_i,\tau_i}$. But, in the general case, we need to ensure that the elasticity of the equilibrium rate of return is not decreasing. After some reformulations, re–substitution of the first order condition of jurisdiction $j$ by differentiation of equation (15), and using equation (7) we obtain

$$\frac{d\epsilon_{r,k_i}}{d\tau_j} = \frac{1}{\tau_j}\left[(1-\tilde{\varphi}_j)\left(1+\frac{K_i}{K_j}\right)\epsilon_{k_j,\tau_j} - \frac{\beta\tilde{\varphi}_j g_j}{1-\tilde{\beta}_j}\frac{K_i}{K_j}\epsilon_{E_j,\tau_j}\right]. \tag{35}$$

Due to the second term inside of the brackets without additional restrictions this differential need not be positive. This term describes the effect that a tax increase at $j$ tends to reduce the share of grants in the budget of that jurisdiction, which in turn increases the overall output elasticity of capital at jurisdiction $j$. Therefore, $(1-\tilde{\varphi}_j)$ is reduced, and the elasticity of the equilibrium rate of return may decline. This would increase the response of mobile capital to local tax increases at jurisdiction $i$ and higher taxes become less favorable. Yet, in the absence of productivity effects of local expenditures ($\beta = 0$), the differential would be positive. Even with productive expenditures conditions can be found where the differential is positive. If public expenditures are maximized at location $j$ it is positive, since $\epsilon_{E_j,\tau_j} = 0$. Also, if location $i$ is small the differential is positive, irrespective of public preferences. But, in the general case, the elasticity of the equilibrium rate of return may rise or decline with a tax increase at $j$. Thus we cannot determine the sign of the second order partial derivative for the general case, and

$$\frac{\partial V^2}{\partial \tau_i \partial \tau_j} \gtrless 0, \quad \left.\frac{\partial V^2}{\partial \tau_i \partial \tau_j}\right|_{\beta=0} > 0.$$

As a consequence tax rates may be strategic complements as well as strategic substitutes.

ad (iv):
After re–substitution of the first order condition the second order partial derivative with respect to the level of grants is

$$\begin{aligned} \frac{\partial V^2}{\partial \tau_i \partial G_i} &= -\epsilon_{k_i,\tau_i}\left(1-\nu_i\right)\left(\alpha-\gamma\right)\frac{1}{1-g_i}\frac{1}{1-\tilde{\beta}_i}\frac{dg_i}{dG_i} \\ &- \left(\nu_i+\left(1-\nu_i\right)\beta\right)\frac{1-g_i}{1-\tilde{\beta}_i}\frac{1}{\epsilon_{k_i,\tau_i}}\frac{d\epsilon_{k_i,\tau_i}}{dG_i}. \end{aligned} \tag{36}$$

Using equation (25) we can find the following expression for the change in the share of grants

$$\frac{d\log g_i}{dG_i} = \left[1-\frac{g_i}{1-\tilde{\beta}_i}\right]\frac{1}{G_i} - \left(1-g_i\right)\tilde{\varphi}_i\frac{d\log K_i}{dG_i}. \tag{37}$$

If we allow the share of grants in the budget to vary between zero and unity an increase in the level of grants may increase or decrease the share of grants. So, in the general case, the sign of the first term in the partial second order derivative (36) is unknown. However, if public expenditures are not productive, the share of capital would be constant and the share of grants would increase. As a consequence, the first term in (36) would be negative. Without productivity effects of public expenditures ($\beta = 0$) and with a given share of capital the second term would be zero. So, without productive public expenditures, the second order partial derivative (36) would be negative. But with productivity of public expenditures we cannot determine whether grants would reduce or increase the tax rate

chosen by the local council

$$\frac{\partial V^2}{\partial \tau_i \partial G_i} \gtreqless 0, \quad \left.\frac{\partial V^2}{\partial \tau_i \partial G_i}\right|_{\beta=0} < 0.$$

# B Datasources and definitions

**Communities:** The dataset consists of the 1111 communities of the state of Baden–Württemberg. In the German system of fiscal federalism the communities build the lowest of the fiscal tiers. The 1111 communities form 44 districts, i.e. 35 counties and 9 independent cities.

**Spatial weighting matrix:** Euclidian distances are computed from a digital map of the geographical position of the administrative center of each community. The employed matrix defines local neighbors as communities located within a distance of 30 kilometers (km). This results from using commuting of the working population as an indicator of the geographic proximity, as 90 % of the male commuters – as a proxy for full–time employed commuters – have a commuting distance up to 30 km. This figure was obtained by means of linear interpolation based on relative frequencies of commuting distances published by Heidenreich (1988). Each neighboring community is weighted according to the inverse of its relative distance. The resulting matrix has a dimension of 1111, shows an average weight of .0236, contains 47028 nonzero links and an average of 42.3 links. The two most connected communities show 83 links, the least connected community display 5 links.

**Local collection rates** of the local business tax (Gewerbesteuer) for the years 1980–1996 are obtained from the database "Struktur- und Regionaldatenbank" (SRDB) of the state's statistical office (Statistisches Landesamt Baden–Württemberg).

**National collection rates:** the median of the overall national collection rate as well as the medians of the district type specific collection rates for the years 1980–1996 are calculated for the 283 districts (counties and cities) outside of the state of Baden–Württemberg using series 10.1 of the Statistisches Bundesamt (German federal statistical office). In districts with several communities the collection rate is an average weighted by the communities' share of the tax base.

**Annual population** refers to the first of January, official projections using resident registration information and census data (source: SDRB).

**Budgetary variables** are obtained from the annual budgetary statistics (Jahresrechnungsstatistik) in the SDRB, employed in terms of DM per capita. The data are transformed in constant prices of 1996 using the producer price index for West Germany (source: Annual Report 1999 of the German Council of Economic Experts):

**Unconditional grants**: (Schlüsselzuweisungen) received annually.

**Debt service**: annual interest payments (Zinsausgaben).

**County contributions**: payments to the county (Kreisumlage).

**Welfare expenses**: direct welfare expenses (Sozialausgaben) of the considered community.

**Income tax revenues:** community share of income tax revenues (Gemeindeanteil an der Einkommensteuer).

**Standardized revenues** of the business tax (Gewerbesteueraufkom-men, brutto) as well as the land tax (Grundsteueraufkommen Typ B) obtained by dividing the tax revenues by the local collection rate.

**Age structure**: annual population figures for different age groups referring to the first of January, official projections using residential registration information and census data (source: SDRB).

**Religious affiliation**: data from the 1987 census taken from SRDB. Number of residents belonging to the Protestant State Church (Landeskirche), or, alternatively, to the Protestant Free Church (Freikirche), or to the Roman Catholic Church.

**Foreign nationals**: foreign nationals among the residential population. Official projections using residential registration information and census data. The data refer to the district level, i.e. to the 35 counties and 9 independent cities.

**Employment:** employment according to the social security register. The data refer to the district level, i.e. to the 35 counties and 9 independent cities.

**District types:** dummies according to a classification provided by the federal office of regional planning (Bundesamt für Bauwesen und Raumordnung). The characteristics and the number of communities in the respective groups are:

**Type 1:** region with major agglomerations, core city, 4 communities.

**Type 2:** region with major agglomerations, very densely populated district, 265 communities.

**Type 3:** region with major agglomerations, densely populated district, 23 communities.

**Type 4:** region with major agglomerations, rurally structured district, 27 communities.

**Type 5:** region with conurbational features, core city, 4 communities.

**Type 6:** region with conurbational features, densely populated district, 413 communities.

**Type 7:** region with conurbational features, rurally structured district, 158 communities.

**Type 8:** rurally structured region, densely populated district, 192 communities.

**Type 9:** rurally structured region, rurally structured district, 25 communities (reference group in the estimation).

Table 1: Local Revenues and Expenditures in Western Germany, 1997

| Revenues | | | Expenditures | | |
|---|---|---|---|---|---|
| | bn. DM | % | | bn. DM | % |
| Business tax[a] | 33.6 | 15.1 | Wages & salaries | 60.8 | 26.9 |
| Unconditional grants | 35.4 | 15.9 | Administrative exp. | 41.8 | 18.5 |
| Matching grants[b] | 26.3 | 11.8 | Interest | 9.4 | 4.2 |
| Land tax [a,c] | 12.1 | 5.4 | Social assistance | 45.5 | 20.1 |
| Income tax[a] | 33.8 | 15.2 | Investment[d] | 37.3 | 16.5 |
| Charges | 35.6 | 16.0 | Other | 31.6 | 14.0 |
| Other | 45.3 | 20.4 | | | |
| Total | 222.1 | | Total | 226.4 | |

Source: Federal Ministry of Finance (Finanzbericht 1999) and own computations. *a*: after revenue sharing, *b*: including investment grants, *c*: type A and type B, *d*: financial investments included.

Table 2: Descriptive Statistics

| | Min. | Med. | Max. | Mean | CV.[a] |
|---|---|---|---|---|---|
| Collection rate in %[b] | 280.0 | 320.0 | 445.0 | 318.1 | .048 |
| Collection rate in %, *average*[b] | 290.0 | 317.1 | 407.5 | 318.1 | .040 |
| Population in 1,000 | .090 | 3.984 | 599.3 | 8.616 | 2.852 |
| *1,000 DM per capita values in prices of 1996* | | | | | |
| Unconditional grants | .000 | .358 | 2.068 | .353 | .493 |
| Income tax revenues | .000 | .495 | 1.594 | .503 | .282 |
| Std. revenues land tax | -.096 | .036 | .263 | .037 | .366 |
| Std. revenues land tax, *average* | .007 | .036 | .102 | .037 | .314 |
| Debt service | -.007 | .068 | .901 | .077 | .716 |
| County contributions | .000 | .213 | 1.352 | .230 | .349 |
| Welfare expenses | -.001 | .005 | .711 | .009 | 4.039 |
| Std. revenues bus. tax | -.172 | .096 | 2.396 | .129 | 1.058 |
| Std. revenues bus. tax, *average* | .001 | .102 | 1.364 | .129 | .910 |
| *per capita values* | | | | | |
| Population, age $< 15$ | .050 | .176 | .325 | .174 | .175 |
| Population, age $< 25$ | .068 | .157 | .413 | .154 | .189 |
| Population, age $< 40$ | .038 | .232 | .509 | .252 | .271 |
| Population, age $< 65$ | .122 | .298 | .500 | .289 | .134 |
| Protestant State–Church population[c] | .005 | .379 | .943 | .390 | .628 |
| Protestant Free–Church population[c] | .000 | .004 | .102 | .006 | 1.349 |
| Catholic population[c] | .025 | .521 | 1.016 | .519 | .531 |
| Foreign nationals at county level | .032 | .089 | .259 | .090 | .334 |
| Employment at county level | .211 | .329 | .752 | .323 | .164 |

Statistics based on pooled cross sections for the 1111 communities in the period 1980-1995 if not otherwise specified. *average* denotes statistics for the all–period averages (between groups). *a*: coefficient of variation. *b*: period 1981-1996. *c*: single cross–section for 1987.

Table 3: Estimation Results

| Dependent variable: collection rate, N=1111, 1981-1996 | | | |
|---|---|---|---|
| Neighbors' collection rate | .052 | * | Total population (log) $_{t-1}$ | .241 | * |
| | ( .011) | | | ( .047) | |
| National collection rate | -.011 | * | *Population shares* | | |
| | (.004) | | | | |
| District type's collection rate | -.008 | | Population age $< 15_{t-1}$ | -5.07 | * |
| | (.007) | | | (2.01 ) | |
| Own collection rate$_{t-1}$ | .917 | * | Population age $< 25_{t-1}$ | -8.91 | * |
| | (.004) | | | (2.03 ) | |
| *Budgetary variables* | | | Population age $< 40_{t-1}$ | -.646 | |
| | | | | (1.74 ) | |
| Income tax revenues$_{t-1}$ | -1.30 | * | Population age $< 65_{t-1}$ | -7.84 | * |
| | ( .570) | | | (2.39 ) | |
| Unconditional grants$_{t-1}$ | -.876 | * | Prot. State–Church pop. | -3.71 | * |
| | ( .354) | | | (1.35) | |
| Debt service$_{t-1}$ | 7.69 | * | Prot. Free–Church pop. | -11.6 | * |
| | ( .794) | | | (5.54) | |
| Std. revenues bus. tax$_{t-1}$ | -2.35 | * | Catholic population | -3.60 | * |
| | ( .409) | | | (1.29) | |
| Std. revenues land tax$_{t-1}$ | -1.23 | | Foreign nationals$_{t-1}$ | 9.62 | * |
| | (3.48 ) | | | (2.92 ) | |
| County contributions$_{t-1}$ | 3.19 | * | Registered employment $_{t-1}$ | .117 | |
| | (1.05 ) | | | (1.07 ) | |
| Welfare expenditures$_{t-1}$ | 6.91 | * | *Border variables* | | |
| | (2.21 ) | | | | |
| *Other* | | | Swiss border | .216 | |
| | | | | (.257) | |
| Linear trend | .142 | * | ditto in neighborhood | -1.61 | * |
| | (.028) | | | (.564) | |
| Constant | 22.8 | * | French border | .392 | |
| | (4.52) | | | (.265) | |
| Sargan statistic, p–val.: .238 | | | ditto in neighborhood | -1.82 | * |
| $\overline{\lambda}$: .432, $R^2$: .914 | | | | (.921) | |

Generalized instrumental variable estimates. The set of regressors includes also dummies for 8 district types. Heteroskedasticity robust standard errors in parentheses. A star (*) denotes significance at 5% level. The set of instruments includes all regressors excluding the neighbors' collection rate plus spatial lags of the following variables: all budgetary variables at $t-1$, population size at $t-1$, own collection rate at $t-1$, variables of religious affiliation, and district types 1 and 5.