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# DETERMINANTS OF TAX RATES IN LOCAL CAPITAL INCOME TAXATION: A THEORETICAL MODEL AND EVIDENCE FROM GERMANY

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## Abstract

In a theoretical model local jurisdictions provide a public input and a public consumption good financed by a tax on capital income. When deciding about tax rate and budget structure the jurisdictions will generally respond to each others fiscal choices irrespective of whether the policy is more oriented towards raising local income or raising public consumption. These policy differences along with differences in size will however give rise to local differences in tax rates. The theoretical implications for the distribution of tax rates are then confronted with the case of the business tax (Gewerbesteuer) in West Germany. Taking into account possible competition effects, tax rates are found to be positively related to the population size of the communities even when controlling for density. This conforms with the hyothesis that large jurisdictions are less concerned with a tax policy aimed at attracting mobile capital. In addition, federally mandated local welfare expenses are established as a determinant of local tax differences raising concerns about distortions induced by the German federal system.

Keywords: Capital income taxation, public inputs, local public finance, spatial econometrics, business tax (Gewerbesteuer)

JEL Classification: D78, H71, H72, H73

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# 1 Introduction

The nature and consequences of fiscal competition and especially of tax competition have been intensively discussed in the last decade. Whereas most theoretical contributions were dealing with normative issues such as the question whether competition between governments is efficient (see Wellisch, 1998, for an overview), the empirical literature has dealt with the question whether in fact competition can be identified in the actual taxation or expenditure decisions of public authorities (for an overview, see Devereux, 1995, and Schulze and Ursprung, 1999). Whereas, national tax systems show a huge degree of complexity, which makes it hard to study tax competition at an international level, most federations allow for some fiscal autonomy at the local level and thus offer a rich experience with provision of public goods and taxation in the presence of mobility. Furthermore, often local differences in taxation are restricted to differences in a few parameters. Consequently, many studies are concerned with fiscal policy in federal states and show that jurisdictions are involved in tax competition or mimicking of neighbors' tax burdens (e.g., Ladd, 1992, Seitz, 1994, Kirchgässner and Pommerehne, 1996). There is also evidence for spatial effects in expenditure decisions (e.g., Case et al., 1993, and Seitz, 1994). Furthermore, some studies show that voters and thus politicians compare policies at neighboring locations (see Besley and Case, 1995, and, Ashworth and Heyndels, 1997).

Despite evidence of tax competition observed local tax rates display marked differences between locations. In particular, large cities tend to set relatively high tax rates in the US (e.g., Hoyt, 1992). Besides more conventional explanations such as urban characteristics affecting demand or costs of public goods, Epple and Zelenitz (1981) and Hoyt (1992) argued that market power of larger jurisdictions might explain the urban tax premium. This hypothesis is of particular importance as it sheds doubts on the efficiency of mobile capital to constrain the taxing power of governments. Therefore, the analysis in this paper takes into account asymmetries between jurisdictions and presents empirical evidence on the long-run distribution of tax rates.

The theoretical model presented in this paper discusses how the local tax rates of a capital income tax are determined in presence of both public consumption goods and public inputs. This is of importance because especially local business taxation may contain elements of benefit taxation, which might have strong implications for location. Thus, the analysis deals with two fiscal choices rather than one by assuming that the local jurisdiction determines the tax rate as well as the expenditure structure, i.e. the share of public consumption in total expenditures. In order to provide explanations for tax rate differences we deal with asymmetric jurisdictions which differ in their endowment with immobile factors following Bucovetsky (1991) and Wilson (1991). The analysis also allows for different government objectives including income maximization of residents and revenue maximization, similar to Edwards and Keen (1996), since consequences of tax competition are dependent on the behavioral assumption of public authorities (Hange and Wellisch, 1998). The empirical implications concerning the differences in local tax rates are tested by an empirical analysis of the collection rates of the local business tax (Gewerbesteuer) in Germany. This case is of particular interest since it is the most important element of decentral taxing autonomy in Germany and the collection rates show considerable cross-sectional variation. Taking into account possible competition effects between neighboring jurisdiction and jurisdictions with the same position in the central place hierarchy tax rates are found to be positively related to the population size of the communities and the share of local welfare recipients.

The theoretical model laid out in the following section describes the determination of local tax rates in capital income taxation. Then, the empirical investigation is presented, which analyzes observed local differences of the rates of the business tax in Germany with respect to their determinants. Finally, the results are summarized.

## 2 A model of local fiscal choices

As is standard in simple models of tax competition two factors are distinguished with respect to their mobility: the one referred to as capital is assumed mobile, the other, termed labor, immobile. The local council decides upon the amount of public consumption C and of the supply of a public input G both financed by a tax rate t on local capital income $Y_K$. This yields the budget constraint

$$C + G = tY_K\left(G, t; r, L\right).$$

When deciding about the tax rate and the expenditure structure of the budget, the council thus faces the problem that it's tax base is affected by it's policy. It is increased by the supply of public inputs but decreased by the the local tax rate. In addition, the tax base is determined by further determinants, which cannot be set by the local council. For the purpose of the current study we will focus on the effects of the size of the considered locality in terms of the supply of the immobile factor $L$ as well as on the effects of the fiscal choices of competing governmental bodies affecting the rental rate of capital $r$. By making use of a Nash assumption, the analysis is separated and first the optimal choice of fiscal instruments of the considered community are derived conditional on the fiscal choices of others. Afterwards, the impact of variations in the given conditions is derived by means of comparative static analysis.

Given the constraint, the council is supposed to maximize an objective function having as arguments public consumption and the income of local labor. This reflects the assumption that the council realizes the impact it's policy has on labor income. Two channels of influence can be distinguished. First, the supply of public inputs has direct effects on labor productivity. And, secondly, there are indirect effects of public inputs and the local tax rate on the amount of capital invested locally. Formally, the decision problem of the local council is to maximize

$$V = V\,[\,C\,,\,Y_L\,(G, t; r, L)\,]$$

by choosing the tax rate and the composition of the budget into public consumption and public inputs. By subsuming the whole policy process behind an unanimous local council the preferences hide a possibly important decision process (cf. Inman, 1989). But, since the considered tax policy is only concerned with taxing business, this neglect is of possibly minor importance. The objective function is quite general in the sense that it encompasses a variety of different assumptions about the local council. By embedding the relationship between local capital income taxation and the public input provision into this general target function the analysis extends to cases where local councils use the distorting capital income tax to finance spending on general public expenditures. This is especially important in the case of Germany, where local taxing autonomy is mainly confined to the business tax. A specific normative interpretation would be to assume that the true social value of public consumption is zero, thus constituting “wasteful expenditures” (cf. Edwards and Keen, 1996). In fact, our setting is analogous: where Edwards and Keen contrast wasteful public expenditures with utility increasing public goods, our setting could be regarded as contrasting them with productivity increasing public inputs. However, as our concern is to derive a positive model of the choice of the business tax rate, the assessment of public consumption can be left open.

In order to simplify the derivation of the central implications the analysis is making use of log-linear technology. For reasons of simplicity the target function is maximized with respect to the tax rate and explicitly to the share of public consumption in total expenditures, which leads to the unconstrained maximization problem[1]

$$\max_{t,s} V = \qquad s^{\nu}\, t^{\nu}\, Y\left(s\,,\, t\,;\, r, L\right) \tag{1}$$

where $s$ denotes the share of public consumption in total expenditure and $\nu$ is the relative weight of public consumption in the target function. The first order conditions are

$$V_t = \frac{\partial V}{\partial t} \quad = \quad \frac{V}{t}\left\{\nu + \epsilon_{Y,t}\right\} \stackrel{!}{=} 0, \tag{2}$$

$$V_s = \frac{\partial V}{\partial s} \quad = \quad \frac{V}{s}\left\{\nu + \epsilon_{Y,s}\right\} \stackrel{!}{=} 0, \tag{3}$$

where $\epsilon_{Y,t}, \epsilon_{Y,s}$ denote the elasticities of income with respect to the tax rate and to the share of public inputs. The preference parameter $\nu$ describes the policy of the local council: at $\nu = 0$ the council maximizes local income, and on the other extreme at $\nu = 1$ the council maximizes the tax revenues. To obtain more substantial results we need to explore the properties of the solution by deriving the two income elasticities from the underlying production technology and the regional allocation of capital.

## 2.1 Local production

The impact of public inputs on local production is specified by introducing a shift-term into the production funtion capturing the location specific total factor productivity. It is formulated as a function of local public inputs $G$ and their total usage captured by the amount of the mobile factor, capital, installed locally

$$Y = (\underbrace{(1-s)\; t\,\alpha Y}_{G})^{\beta}\; (kL)^{-\gamma}\; k^{\alpha} L, \qquad 0 \leq \gamma \leq \beta, \qquad \alpha > \gamma, \tag{4}$$

[1]In the objective function public consumption $C$ and public inputs $G$ are replaced by

$$C = stY_K\left(s\,,\, t\,;\, r, L\right) \quad , \quad G = (1-s)\, tY_K\left(s\,,\, t\,;\, r, L\right).$$

With constant weights the target function can thus be expressed as

$$\left(stY_K\left(s\,,\, t\,;\, r, L\right)\right)^{\nu}\left(Y_L\left(s\,,\, t\,;\, r, L\right)\right)^{1-\nu}$$

As production technology is assumed log linear, the factor incomes are equal up to a constant fraction, and it is equivalent to maximize the above expression.

where $\alpha$ is the share of capital in local income, $k$ denotes the capital intensity, $L$ denotes local labor supply, $\beta$ determines the productivity impact of public inputs and $\gamma$ determines the degree of rivalry in their use. The positive impact of public inputs 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. In order to allow for crowding effects in the usage of public inputs we assume that there is a nonpositive effect of the total stock of capital on total factor productivity (cf. Sinn, 1997). Only if public inputs are purely nonrivalrous the impact is zero $\gamma = 0$. The other extreme is the case where only the intensity of expenditures relative to the amount of installed capital has an effect on productivity $\gamma = \beta$. Then, the goods locally supplied are rivalrous such as private goods.[2] In order to exclude cases where the crowding externality more than offsets the productivity of capital it seems reasonable to require $\alpha > \gamma$. Otherwise, a higher capital intensity would translate into lower labor productivity and there would be no incentive for the local council to attract capital even when it cares only for the local labor income.

In order to close the model we need to derive the local capital supply. As is standard in the literature this is done by holding constant the total supply of capital but introducing an opportunity location for investment (cf. e.g. Bucovetsky, 1991, and Wilson, 1991). In equilibrium we can require that the after tax rate of return to capital $r$ is equalized across locations. Indexing the variables with the region, assuming gross returns equal the value of the marginal product of capital this yields

$$r_1 \overset{!}{=} r_2, \tag{5}$$

$$r_i = \alpha (1 - t_i) ((1 - s_i) t_i Y_i)^{\beta} L_i^{-\gamma} k_i^{\alpha-\gamma-1}, \quad i = 1, 2 \tag{6}$$

$$1 = k_1 L_1 + k_2 L_2, \tag{7}$$

where total labor supply and total capital supply are set equal to unity.

Indexing the variables in the income equation (4) with the region and taking into account the interregional equilibrium on the capital market (5,6,7) we can derive the elasticity of local income with respect to the tax rate and the

[2] Sinn (1997) emphasized that an ideal public sector will focus on the case of inputs with only some degree of rivalry.

share of public consumption

$$\epsilon^i_{Y,t} = \frac{\beta}{1-\beta} + \left(\frac{\beta}{1-\beta} - \frac{t_i}{1-t_i}\right) \xi^{-1} \left(1+\kappa_i\right)^{-1}, \tag{8}$$

$$\epsilon^i_{Y,s} = -\frac{\beta}{1-\beta}\frac{s_i}{1-s_i} \left(1 + \xi^{-1} \left(1+\kappa_i\right)^{-1}\right), \tag{9}$$

where:

$$\xi = \left(\frac{1-\beta}{\alpha-\gamma} - 1\right),$$

and $\kappa_i$ denotes region $i$'s capital stock relative to region $j$. This capital ratio is, of course, endogenous

$$\kappa_i = \frac{k_i L_i}{k_j L_j} = \left(\left(\frac{1-t_i}{1-t_j}\right)^{1-\beta} \left(\frac{1-s_i}{1-s_j}\right)^{\beta} \left(\frac{t_i}{t_j}\right)^{\beta} \lambda_i^{1-\alpha}\right)^{\frac{1}{1-\alpha-\beta+\gamma}}, \tag{10}$$

where $\lambda_i$ denotes the labor supply in region $i$ relative to region $j$. According to the first order conditions (2) and (3) the council in region $i$ sets the tax rate $t_i$ and the share of spending on public consumption $s_i$ such that both elasticities just equal $-\nu_i$. From equation (8) it can be seen that this condition might be fullfilled for $t_i > \beta$, if the productivity of public inputs is not too large[3]

$$1 - (\alpha - \gamma) > \beta \qquad \Rightarrow \xi > 1$$

The condition requires that the diminishing returns caused by holding the local factor constant outweigh the returns from public spending, where capital productivity is corrected for the crowding effects. The consequence is that the interregional allocation of the local factor predetermines the locational equilibrium in the sense that a higher share of the immobile factor is

[3] With this conditition also the second order condition is fulfilled irrespective of the value of $\kappa_i$. A higher tax rate has a direct effect on the elasticity and an indirect effect via the capital share. The direct effect is:

$$\frac{\partial \epsilon^i_{Y,t}}{\partial t_i} = -\left(1-t_i\right)^{-2} \xi^{-1} \left(1+\kappa_i\right)^{-1},$$

which is negative only under the above condition. The indirect effect is

$$\frac{\partial \epsilon^i_{Y,t}}{\partial k_i}\frac{\partial \kappa^i}{\partial t_i},$$

which is negative unambigously since the first term is positive whereas the second is negative as can be seen from equations (8) and (10).

related ceteris paribus with a higher share of the mobile factor, such that $\kappa_i$ increases with $\lambda_i$. In order to obtain a determinate locational equilibrium a similar condition needs to hold in the context of agglomeration economies, see Henderson (1985) and Büttner (1999a).

It is instructive to consider the case of a small region ($\lambda_i = 0$) which always has a neglibile share of the capital market ($\kappa_i = 0$). It's optimum tax rate and public consumption share can be derived as

$$t_i^*|_{\lambda_i=0} = \frac{\nu_i\xi + \frac{\beta}{1-\beta}(\xi+1)}{1+\nu_i\xi + \frac{\beta}{1-\beta}(\xi+1)}, \tag{11}$$

$$s_i^*|_{\lambda_i=0} = \frac{(1-\beta)\,\nu_i\xi}{\beta+(1-\beta)\,\xi}. \tag{12}$$

The tax rate chosen depends on the productivity effects and on the preference parameter $\nu_i$. The more the council aims to use revenues to finance public consumption expenditures, i.e. the higher $\nu_i$, the higher it sets the tax rate. Obviously the absence of market power on the capital market does not prevent the council from using the capital income tax revenues partly for general public purposes or even for wasteful expenditures. But, even if policy only aims at increasing local income, the tax rate is nonzero if public inputs are productive $\beta > 0$. Equation (12) shows that irrespective of the preferences the council would not use all revenues for public consumption as long as public inputs are productive ($\beta > 0$). But, without any preference for public consumption $\nu_i = 0$ the consumption share would be zero.

Yet, in the general case the capital ratio $\kappa_i$ is contained in the elasticity equations, indicating that the responsiveness of both local labor and local capital income, to the fiscal choice parameters is lower at large jurisdiction. This implies that large jurisdictions experience market power on the mobile factor's market.

## 2.2 Comparative static effects

It is convenient to inspect further the optimal fiscal choices by exploring their comparative static behaviour. Given the formalization of local production, of special interest is the impact in the variation of the size of the locality in terms of the immobile factor, the impact of stronger orientation towards public consumption, and the impact of the fiscal choices of the opportunity location.

Formally, we explore the impact of a vector of local income determinants of region $i$

$$(\lambda_i, \nu_i, t_j, s_j)'$$

indicating the relative size of $i$'s labor supply $\lambda_i$, the local council's policy parameter $\nu_i$, and the two opportunity location's fiscal choices: the tax rate $t_j$ and the share of public consumption $s_j$. Now we can express the relationship between the variables by total differentiation of the two first order conditions which yields the system of equations

$$\mathsf{H}\begin{pmatrix} dt_i \\ ds_i \end{pmatrix} = \begin{pmatrix} -V_{t_i,\lambda_i} & -V_{t_i,\nu_i} & -V_{t_i,t_j} & -V_{t_i,s_j} \\ -V_{s_i,\lambda_i} & -V_{s_i,\nu_i} & -V_{s_i,t_j} & -V_{s_i,s_j} \end{pmatrix} \begin{pmatrix} d\lambda_i \\ d\nu_i \\ dt_j \\ ds_j \end{pmatrix}, \qquad (13)$$

where $\mathsf{H}$ is the Hessian of the maximization problem and the $V$ terms denote mixed second order partial derivatives of region $i$'s target function. For instance, the term $V_{t_i,t_j}$ denotes the second order derivative to it's own and region $j$'s tax rate. Leaving the derivations to the appendix we can state the following comparative static results:

(i) $\frac{dt_i}{d\lambda_i} > 0$, (ii) $\frac{dt_i}{d\nu_i}\ (>)\ 0$, (iii) $\frac{dt_i}{dt_j} > 0$, (iv) $\frac{dt_i}{ds_j} > 0$,

(v) $\frac{ds_i}{d\lambda_i} > 0$, (vi) $\frac{ds_i}{d\nu_i} > 0$, (vii) $\frac{ds_i}{dt_j} > 0$, (viii) $\frac{ds_i}{ds_j} > 0$.

(i) and (v) are size effects: a higher share of the total labor supply causes the council to set a higher tax rate (i) and to increase the level of public consumption (v). This stems from the fact that the elasticity of capital supply depends on the size of the local community relative to the country (cf. Bucovetsky, 1991, and Wilson, 1991). Thus, the larger the share of capital installed locally, the weaker are adverse income effects.

(ii) and (vi) are preference effects. (vi) is indicating that a higher preference for public consumption relative to the local factor's income is reflected in a higher share of public consumption within the budget. But, under the given assumptions a higher preference for consumption expenditures is not necessarily related to a higher tax rate. Since, with strong productivity effects of public spending it can be the case that the detrimental effect of increased consumption share on the local supply of capital requires a reduction in the tax rate in order to fulfill the equilibrium condition. Yet, this is a peculiar result arising if the productivity of public inputs is so strong that doubling the supply of inputs would more than double the supply of capital. Thus, we place an additional restrictions on the productivity of public inputs and argue that the effect is positive (see appendix).

(iii) and (iv) describe the impact of the fiscal choices at the opportunity location on the choice of the local tax rate. Both a higher tax rate as well as a higher budget share of public consumption induces tax increases as a response. Thus, the model states that tax rates are strategic complements.

(vii) and (viii) finally show the impact of fiscal choices at the opportunity location on the share of public consumption expenditures. (viii) indicates also positive relationships between the shares of public consumption in the budgets.

It has already been pointed out that the specification of total factor productivity bears some resemblance to the case of agglomeration economies. In fact, by assuming constant returns to scale in the factor inputs the productivity effect of public inputs introduces a non-convexity which strongly alters the properties of the interregional factor allocation (cf. Richter, 1994). The consequence is that, as long as public inputs display some degree of nonrivalry ($\beta - \gamma > 0$), the value of output at the aggregate level is not maximized. Yet, for an inefficiency due to market-size effects on the capital markets or to differences in preferences the non-convexity issue does not matter: even with complete rivalry ($\beta = \gamma$) or no productivity effects at all ($\beta = \gamma = 0$) deviations from strong symmetry in size and preferences cause a situation where reallocation of the mobile factor would increase total output.

Summing up the theoretical exercise, we can state that in a setting with institutional restriction on tax instruments the council is forced to use tax revenues not only to supply public inputs but also to finance public consumption expenditures. The analysis suggests that we should oberve a situation of tax competition, where local tax rates as well as the share of public consumption expenditures are strategic complements. Tax rates and budget structures are not necessarily equal, since large communities will set higher tax rates because of their market power on the market for mobile capital. The theory also suggests that communities with strong preferences for public consumption expenditures set higher tax rates.

# 3 Empirical investigation of Germany's business tax

The taxing autonomy of communities (Gemeinden) in Germany mainly consists of their choice of the local collection rate of the business tax (Gewerbesteuer). Yet, terms and conditions of the business tax are the same for all communities. Since German communities are quite different in terms of size and composition, Germany provides an interesting application of the theoretical model, and this sections aims to test the conclusions especially with respect to the impact of differences in size and preferences on the cross-sectional distribution.

The collection rates define the factor by which the base tax rates of about 5 % on profits and 0.2% on the value of capital are increased for the purpose of computing the local tax rate.[4] In 1996 the range of collection rates at the level of the communities was between 250 % and more than 500 %, indicating a variation in tax rates of about 12.7 % and 20.5 %.[5] But, the business tax payments are deducted when calculating personal and corporate income taxes. Thus, depending on the individual tax rates the local variation in effective tax rates will be reduced up to a figure of 3.9 %.

The investigation uses the complete set of collection rates in the 327 districts (Kreise- und kreisfreie Städte) in West Germany in the years 1980–1996. The majority of districts consists of several local communities. But because of difficulties of obtaining data at community level, the analysis focuses on the local business tax rates at district level, where the reported collection rates are weighted averages of the communities' collection rates.[6]

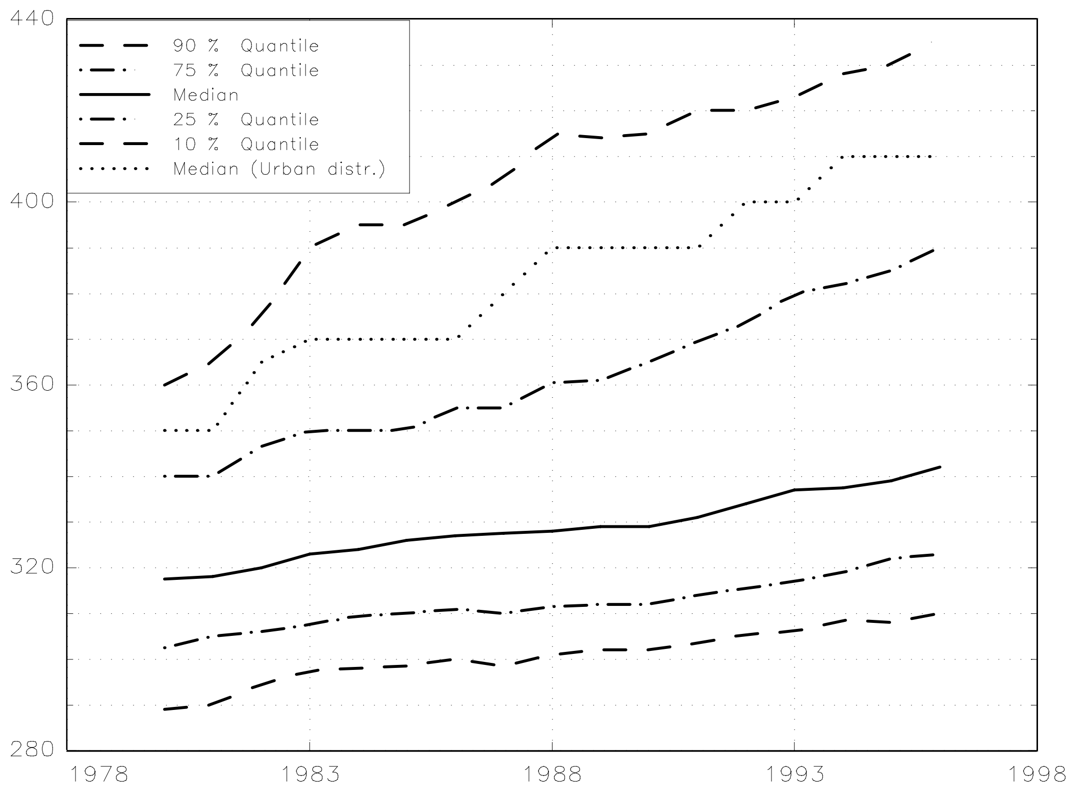
Figure 1 plots some location measures of the distribution across districts. The lines in the figure show various quantiles of the distribution. The solid line depicts the median of the collection rates across West Germany's districts. The quantiles indicate a relatively stable distribution of collection rates. It is evident that there is a significant wedge between the median of tax rates at urban and rural districts. This already seems to indicate that larger jurisdictions in fact use their market power to raise taxes as was argued in the theoretical section. But it is difficult to relate the observed cross-sectional distribution with local characteristics, since from the theoretical

[4] The tax on the value of capital was abolished in 1997.

[5] Note, that tax payments are deductible from the tax base.

[6] The weights are the communities' shares of the tax bases. For the details see series 10.1 ("Finanzen und Steuern – Realsteuervergleich") of the German federal statistical office (Statistisches Bundesamt).

Figure 1: Collection Rates Across German Districts




analysis we should expect tax rates at different districts to be interdependent. Therefore, we cannot say a-priori whether a collection rate is high because of the district's characteristics or because of it's neighbors' characteristics.

## 3.1 Design of the investigation

In order to take into account the interdependence of collection rates the theoretical model suggests to search for competing jurisdictions. In the above case of two communities, this would suggest to determine simply the correlation between the two district's collection rate. But with multiple regions we need to impose a structure on the districts determining which are more likely to engage in an interdistrict tax competition. Assuming spatial trans-

Table 1: Expenditure Shares of Communities

| | 1980 | 1985 | 1990 | 1995$^{a)}$ | 1996$^{a)}$ |
|---|---|---|---|---|---|
| Public Investment | 30.4 | 21.2 | 21.7 | 16.9 | 16.1 |
| Social Assistance (Net) | 5.7 | 8.1 | 9.3 | 11.0 | n.a. |

Share in total expenditures (Bereinigte Ausgaben) in percentage. Source: Finanzbericht, own calculations. $a$) except New Länder.

action costs in a broad sense fiscal competition will be particularly strong with communities in the neighborhood, whereas more distant locations constitute a less relevant location option for residents and investors. Additionally, the perceived political costs or benefits are higher for tax differentials with the local neighborhood if voters compare the policy with the policy in the neighborhood (see Ashworth and Heyndels, 1997, and Besley and Case, 1995). Therefore, we consider local competition between geographic neighbors. This suggests, to use the collection rate in the local neighborhood as a determinant of the collection rates. Of course, other characteristics may also determine the degree of intercommunity competition. Especially, we need to take account of the central place hierachy. For instance an urban district with it's high population density might not only compete with it's neighborhood but also with other more distant urban districts.

It is apparent in Figure 1 that all location measures show positive trends. Within the confines of the above theoretical model a positive trend could be explained by a continuous shift in council's preferences towards public consumption expenditures. And, in fact during the considered period 1980-1996 the share of public investment in total expenditures has seen a significant decline whereas welfare transfers such as social assistance payments have increased steadily (cf. Table 1). The trends in the tax rates are, however, more significant in densely populated districts. Using the classification of the BBR, the federal office for regional planning, Table 2 documents that especially cities have increased their tax rates during the sixteen years considered. Since social assistance payments have increased especially in cities (cf. Karrenberg and Münstermann, 1998) the differentials in the trends are conforming with the preference-shift hypothesis.

However, given those trends, a correlation between tax rates in different jurisdictions may not only be observed because of interjurisdictional competition but also because of similarities in the underlying trends. Due to data limitations potential determinants of differences in the evolution of tax rates

Table 2: Tax Trends among District Types

| District Class | Median Level 1980 | Median Level 1996 | Median Change abs. | Median Change rel. |
|---|---|---|---|---|
| City | 360.0 | 440.0 | 65.0 | 17.0 % |
| Highly Dense | 310.0 | 372.5 | 42.0 | 13.5 % |
| Dense | 317.0 | 339.0 | 20.0 | 5.7 % |
| Rural | 310.0 | 323.5 | 10.5 | 3.3 % |

Median collection rates among the 327 districts in 1996 and 1980 as well as median absolute and relative changes between 1980 and 1996. District class according to the classification of the BBR. Source: own computations.

are not available and it seems difficult to distinguish empirically trends from competition effects. Therefore, we employ district-class specific time effects in the analysis of collection rates, which remove both effects entirely.

Controlling for the evolution of collection rates in the neighhborhood and in districts of the same density class, we will obtain some estimate of the cross-sectional distribution of tax rates. This can be used to obtain tests of the theoretically maintained explanation for local tax rate differentials. In view of the theory we should first of all expect that collection rates are higher in larger jurisdictions. The size effect should therefore lead to higher collection rates at more populous districts and at districts with a lower number of communities. Yet, the theoretical model considers districts as simple points in space and the implied differences in population density are neglected. But, the considered districts show large differences in density, which affect local governments' tax policy in a variety of ways. Though not included in the theoretical model, higher density reflects advantages from agglomeration such as urbanization economies which translate into a higher taxing power analogous to the simple size effect. Yet, higher density also induces crowding externalities which increase the local cost of production but may also lead to a higher demand for public goods. Although it will be difficult to distinguish these implications for tax policy, it is important to take density into account in order to check whether the pure size effect is relevant. We therefore use not only density but also the price for developed vacant land, the travel time to the next agglomeration and to the next international airport in order to control for density effects.

Besides differences in density the identification of population size is hindered by several other determinants of location. Some of them can explicitly be considered in the analysis: as regional policy in Germany is aimed at increasing the after tax rate of return in selected areas, a dummy is included indicating whether a specific district contains a specific development area (Schwerpunktort). Furthermore, local differences in the supply price of electric power are controlled for by employing average power prices at district level.

In addition, the theoretical model suggests that differences in councils' preferences will also cause tax differentials. The model has dealt with a broad and simple characterization of preferences by the weight given to public consumption expenditures as compared to the local income. When it comes to the empirical question the latter target should not be taken too literally. The model has assumed full employment of all factors, but if there are some factor market imperfections, this target could be regarded as a policy of raising local employment. Moreover, referring to the weights of public consumption as compared to local income or employment in the target function as public preferences seems to indicate a free choice of government objectives at the local level. As a part of local expenditures is related to federal spending mandates, this neglects frictions arising from differences in the incompatibility of local targets and federal mandates. Yet, as the current focus is on the horizontal dimension between local jurisdictions those frictions are neglected. Without going into the details of public preference determination, the following determinants should be taken into account:

1. age structure of resident population
2. poverty
3. unemployment

ad 1: The age structure is of importance because the demand for public consumption will vary over the citizen's lifecycle. For instance, as younger citizens are more eager to get good paid jobs they would favor an income or employment oriented policy more strongly than elder citizens which are possibly retired and more interested in the provision of consumable public goods. Also a higher share of children will shift preferences towards public consumption as it indicates a higher demand for child care institutions, all the more so since communities in Germany are obliged to provide those type of services. However, note that in Germany schooling is not financed out of the budget of council, but out of the budget of the state (Land).
ad 2: Given the German institutional setting, especially the local share of

welfare recipients among the population should be important, as communities are federally mandated to provide social assistance to the poor.
ad 3: In the German case where regional unemployment differentials show a high degree of persistence, the local unemployment rate might have considerable impact on local preferences. Because it reflects the strength of problems in the labor market, it can be expected to shift council preferences towards income and employment increasing policies. However, if higher unemployment shifts preferences towards higher public employment, it may also be related with an increase of public consumption.

## 3.2 Estimation and results

In order to test whether the cross-sectional distribution can be explained empirically in accordance with our theoretical suggestions, the local collection rates at different points in time are regressed on the collection rates of the local neighbors and a set of time invariant local characteristics. In addition, common trends as well as intercommunity competition between districts of the same density class according to the BBR classification are taken into account by introducing district-class specific time effects. This yields the following regression equation:

$$t_{i,\tau} \quad = \quad \rho\bar{t}_{i,\tau} + a_i + b_{1,\tau} + b_{2,\tau} + b_{3,\tau} + b_{4,\tau} + u_{i,\tau}, \tag{14}$$

where $i$ is the index of the region and $\tau$ is the index of the period. $\bar{t}_{i,\tau}$ denotes the average tax rate in the local neighborhood, $a_i$ captures district $i$'s position in the cross-sectional distribution of tax rates, the $b_{j,\tau}(j = 1...4)$ terms denote the district class specific time effects, and $u_{i,\tau}$ is the error term. Note, that the inclusion of the four district-class time effects is equivalent to removing the district-class average from each variable. Thus, common shocks to each set of districts are removed.

The specification (14) would imply that the local tax rate is always at it's optimum value. But, prior checks have revealed a sluggish adjustment of collection rates. Therefore, rather an autoregressive distributed lag model is applied. For the case of two lags it is probably best respresented in an error-correction fashion:

$$\begin{aligned} \Delta t_{i,\tau} \quad &= \quad c_1 \Delta t_{i,\tau-1} + c_2 \Delta \bar{t}_{i,\tau} + c_3 \Delta \bar{t}_{i,\tau-1} \qquad (15) \\ &- \quad d_1 \left( t_{i,\tau-1} - \rho\bar{t}_{i,\tau-1} - a_i - b_{1,\tau} - b_{2,\tau} - b_{3,\tau} - b_{4,\tau} \right) + u_{i,t}. \end{aligned}$$

This equation contains equation (14) as the long-run relationship. In both equations, however, the time invariant $a_i$ is considered to be a function of the local characteristics:

$$a_i = \sum_{k=1}^{K} c_k x_i^k. \tag{16}$$

Thus, the empirical specification consists of two steps. The first is a panel regression which delivers an estimate of the cross-sectional distribution. The seconds step consists of relating the districts' positions in the cross-sectional distribution to their local characteristics. Depending on whether we take this second step into account implicitly or explicitly when estimating (15) we can estimate the two equations jointly or in a two step procedure. If the level relationship (16) is correctly specified and gives a sufficient description of the cross-sectional distribution it will be most efficient to proceed by joint estimation. But, to test, whether this relationship can be considered as a reasonable description of the $a_i$ we should first estimate equation (15) by means of fixed effects panel regressions, and then in a second step regress the fixed effects on the local characteristics, as this allows explicite testing of the imposed restriction (16). In order to check the estimation, therefore, it seems to be reasonable to proceed by employing both approaches.

Nevertherless, irrespective of whether estimation is carried out jointly or separately it is helpful to separate the estimation results and to consider first the estimation of the error-correction regression (15). This regression contains lagged values of the dependent variable on the right hand side. As 15 consecutive time periods are considered the Nickell (1981) bias will be rather small and is therefore neglected. However, the equation also contains a spatially lagged variable, i.e. the change in the average tax rate in the local neighborhood. It it well known that the introduction of a spatial lag introduces a simultaneity bias and in order to estimate the simultaneous spatial model maximum-likelihood (ML) estimation is appropriate under standard assumptions (cf. Cliff and Ord, 1973, Anselin, 1988).[7] Yet, the maximum-likelihood estimation may suffer from heteroscedasticity, but for the given dimension of the spatial model, incorporation of heteroscedasticity into the ML estimation is simply not computationally feasible. In order to at least robustify

[7]The present panel data setting is, however, nonstandard due to the incidental parameter problem (cf. Chamberlin, 1980). But, it can be shown that in the spatial model ML estimation is consistent as OLS in the standard panel setting, if the coefficient of spatial correlation is close to zero and the degrees of freedom are corrected for the fixed effects, cf. Büttner (1999b).

Table 3: Regression Results, Part I

| observations | 4905 | | | |
|---|---|---|---|---|
| dep.variable | Collection Rate Change, 1982-1996 | | | |
| | (1) | | (2) | |
| Regressors | | | | |
| $\Delta t_{i,\tau-1}$ | $-.118^{***}$ | (.014, .031) | $-.201^{***}$ | (.014, .048) |
| $\Delta \bar{t}_{i,\tau}$ | .054 | (.019, .036) | $.140^{***}$ | (.018, .048) |
| $\Delta \bar{t}_{i,\tau-1}$ | .069 | (.028, .043) | $.287^{***}$ | (.029, .045) |
| $t_{i,\tau-1}$ | $-.347^{***}$ | (.013, .038) | $-.064^{***}$ | (.006, .009) |
| $\bar{t}_{i,\tau-1}$ | $.071^{**}$ | (.017, .031) | $.014^{**}$ | (.006, .008) |
| Unification | $-.577$ | (.899, 1.20) | $-.776$ | (.832, .710) |
| Wald statistics | | | | |
| spec.time eff. (P-val.) | $.000^{***}$ | | $.000^{***}$ | |
| bias (P-val.) | 1.00 | | 1.00 | |

Notes: ML estimates of the simultaneous spatial model. Both estimations include district-class specific time effect. Column (1) additionally uses district specific effects, whereas column (2) employs a set of local characteristics. Figures in parentheses are standard errors: the first from Maximum Likelihood estimation and the second from a spatial block bootstrap estimator based on 5.000 resamples. Significant coefficients are marked with one, two, or three stars for levels of 10%, 5%, and 1%. .) Wald statistics based on bootstrap estimate of the variance-covariance matrix.

inference, therefore, a heuristic block bootstrap approach is applied to the regression. Instead of drawing single observations for the purpose of obtaining resamples this approach consists of drawing presumably dependent blocks of observation jointly which retains the dependency between observations.[8]

Column (1) in Table 3 reports Maximum Likelihood estimates from an estimation employing fixed district effects and a set of district-class specific time effects.[9] According to the Wald statistic the district-class specific time effects are highly significant. Note that for each estimated coefficient two standard errors are reported. The first is the ML estimate, and the second

[8] See Fitzenberger, 1997, for a treatment of the time-series case. As in Büttner (1999b) the blocks consist of the considered districts and it's neighbors in all years.

[9] As some of the districts in the aftermath of unification were exposed to the neighborhood of East German districts, a dummy variable for districts close to the intra-German border in the post-unification period (1992-1996) is added. Various other specifications including a similar border dummy for 1991 and for the period (1991-1996) did not show better fit.

is the bootstrap estimate. Since ML estimation is no longer consistent in the presence of heteroscedasticity at the bottom of column (2) in Table 3 a Wald statistic is displayed testing for joint differences between the bootstrap estimator and the ML estimator. However, no significance is found.

The dynamic specification employed uses two lags of the current collection rates, since further lags did not prove significant. It is important to note that the lagged level of the own collection rate shows a significant negative sign, indicating that in fact, collection rates tend to approach the level relationship and, thus, converge towards a stable cross-sectional distribution. Although the current as well as the lagged change in the neighbors' tax rate shows significant effects according to the ML standard error the larger bootstrap standard errors rejects their significance. But, the lagged level of the neighbors' collection rates is significant even according to the bootstrap standard error, indicating a correlation between neighboring communities. The implied level relation between the local tax rates can be obtained from dividing the coefficient of the lagged level of neighbors' tax rates by the adjustment coefficient, yielding

$$t_{i,\tau} = 0.205\ \bar{t}_{i,\tau}.$$

Turning to the second-step regressions, column (1) of Table 4 presents the results from regressing the fixed effects according to the estimation presented in column (1) of Table 3 on local chacteristics. Since the fixed effects are not observed directly but estimated one may increase the efficiency of the estimation by applying a minimum-distance estimator (MDE) (see Greene, 1993) which makes use of the (estimated) variance-covariance matrix.[10] The size of population as well as the number of communities are highly significant indicating that the long-run tax rate is high where population per single community is large. As several density related variables are employed this significance is not simply due to density. From the preference variables especially the share of welfare recipients is significant, indicating that higher federally mandated social assistance payments lead to higher tax rates. In addition, there is also a significantly higher tax rate at regional development areas indicating that regional development policy tends to be offset by higher tax rates.

[10]The MDE minimizes:

$$\left(\hat{f} - S\gamma\right)' \left(V\hat{C}M(f)\right)^{-1} \left(\hat{f} - S\gamma\right),$$

where $\hat{f}$ denotes the vector of fixed effects, $V\hat{C}M(f)$ their variance-covariance estimator, $S$ a matrix of local characteristics, and $\gamma$ a vector of parameters.

Table 4: Regression Results, Part II

| | | | | |
|---|---|---|---|---|
| observations | 327 | | | |
| dep.variable | Fixed Effects | | cf. Table 3 | |
| method | Min. Dist. | | | |
| | (1) | | (2) | |
| constant | 123. *** | (29.4) | | |
| log av. Population | 10.3 ** | (4.08) | 1.96 *** | (.281, .411) |
| log no. of Communities | −9.12 *** | (3.03) | −1.24 *** | (.193, .272) |
| log av. Density | 7.16 | (5.16) | .645 | (.331, .398) |
| Price Vacant Dev. Land | .004 | (.008) | −.000 | (.001, .002) |
| Time to Agglomeration | −.017 | (.042) | .006 | (.007, .006) |
| Time to Airport | −.016 | (.038) | −.002 | (.006, .007) |
| share of Recreation Area | .050 | (.048) | .012 | (.008, .009) |
| share of Welfare Recipients | .210 ** | (.092) | .037 * | (.015, .020) |
| share of Children | −.557 | (.881) | .269 | (.146, .188) |
| share of Citizens Age > 65 | −.282 | (.661) | .126 | (.107, .120) |
| Unemployment Rate | −.212 | (.541) | −.102 | (.090, .097) |
| dummy Development Area | 3.47 * | (1.98) | .736 ** | (.295, .306) |
| Power Price | −1.55 | (1.01) | −.086 | (.140, .177) |
| MSD | 107 | | | |

Notes: Standard errors in parentheses. Column (1) gives results from minimum-distance estimation based on the bootstrap estimate of the variance-covariance matrix of the fixed effects. Column (2) reports coefficients from joint estimation. Significant coefficients are marked with one, two or three stars for levels of 10%, 5%, and 1%.

According to the mean squared distance (MSD) displayed at the bottom of the table the restrictions imposed on the fixed effects by the estimated linear relationship cannot be rejected. This indicates that we might also estimate the panel regression as well as the regression of the time-invariant cross-sectional distribution on local characteristics $a_i$ jointly. The results are presented partly in Table 3 and partly in Table 4. Column (2) in Table 3 contains results with respect to the dynamic part. They show the same signs, but the magnitude of the coefficients are different. Especially the lagged tax rate shows a coefficient smaller by a factor of 5 as compared to the fixed-effects panel regression. This indicates a much smaller convergence towards the cross-sectional distribution. This difference can be explained by the fact that two step estimation implicitly describes the cross-sectional distribution as the average in the sample period, whereas the joint estimation characterizes the cross-sectional distribution by the charcteristics. Consequently the implied level relation between local tax rates is almost the same as above

$$t_{i,\tau} = 0.219\ \bar{t}_{i,\tau}.$$

Also the coefficients in Table 4 show coefficients smaller by a similar factor. But, again the qualitative picture remains and the population size effect as well as the positive impact of the share of welfare recipients and of the development area are confirmed.

Therefore, we can conclude that, indeed, the size of communities in terms of population is an important determinant behind the local tax rate differences, even when taking into account several characteristics of location including density. Given the German institutional setting it is also important to note that the population size effect is not driven by the social assistance payments. The significance of these payments, however, raises concernes that the joint presence of federally mandated spending and local taxing autonomy may cause distortions of the spatial allocation of productive activities. Finally, it is important to note that the results about the determinants of local differences in tax rates hold only with the qualification that causality runs in the suggested way. But, given the relatively strong segmentation of regional labor markets in Germany (e.g., Buettner, 1999a) it seems difficult to argue that local tax rate differences are the cause rather than the consequence of districts' population size, their number of welfare recipients, and their eligibility for regional development aid. Therefore, it is left for future research to tackle possible simultaneity problems.

## 4 Summary

The theoretical discussion has presented a positive model of the choice of a local tax rate on capital income used to finance both public inputs and public consumption expenditures. This enables to discuss cases where jurisdictions or forced to use finance public spending by a distorting tax rate as well as cases where jurisdictions tax the mobile factor in order to finance wasteful expenditures. From this general model, basic implications for local differences in tax rates were derived in accordance with the literature. Namely, tax rates set by local communities will rise with the population size as well as with the council's preference in favor of public consumption expenditures. Moreover, tax rates will be positively related to the neighbors' tax rates.

In the empirical part these implications were then confronted with the distribution of collection rates of the business tax across West Germany's districts. The results are at least consistent with the existence of tax competition, since collection rates were found to be positively related to the tax rates in the neighborhood. Yet the interdependencs of taxing decisions does not eliminate all differences in the local tax rates. The analysis of the long-run distribution of tax rates has revealed a robust positive relationship between tax rates and population size but not with density in the German case. This conforms with the theoretical hypothesis that larger communities experience a market power in the market for mobile capital, such that they face a lower response to variations in their tax rate. A further interesting result is the significant positive relationship between the share of welfare recipients and the local tax rates, indicating that the federally mandated local expenditures affect local tax policy. This raises concerns about the distribution of responsibilities in the German federal system.

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# A Derivation of comparative static results

The above comparative static results are obtained by solving the system of equations (13). Using Cramer's rule the differentials can be obtained from the ratio of specific determinants to the determinant of the Hessian. The determinant of the Hessian is computed as

$$
\begin{aligned}
|\mathsf{H}| &= V_{t_i,t_i}V_{s_i,s_i} - V_{t_i,s_i}V_{s_i,t_i} \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[\frac{\partial\epsilon^i_{Y,t}}{\partial t_i}\frac{\partial\epsilon^i_{Y,s}}{\partial s_i} + \frac{\partial\epsilon^i_{Y,t}}{\partial t_i}\frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial t_i} + \frac{\partial\epsilon^i_{Y,s}}{\partial s_i}\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}.\right]
\end{aligned}
$$

This determinant is positive as is required by the second order conditions since from equation (8) the direct partial derivatives of the elasticity are negative

$$\frac{\partial\epsilon^i_{Y,t}}{\partial t_i} < 0, \frac{\partial\epsilon^i_{Y,t}}{\partial s_i} < 0,$$

whereas the derivative with respect to the capital ratio is positive. Moreover, $\kappa_i$ is decreasing in $s_i$ and in the neighborhood of the optimum, where $t_i > \beta$, it is also decreasing in $t_i$

$$\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i} > 0, \frac{\partial\kappa^i}{\partial t_i} < 0, \frac{\partial\kappa^i}{\partial s_i} < 0.$$

Since the Hessian is positive, it suffices to inspect the determinants of the Hessian with columns replaced according to Cramer's rule in order to derive the sign of derivatives. Thus, the derivatives (i), (iii), and (iv) are positive, if the following determinants are positive:

$$
\begin{aligned}
\left|\mathsf{H}_{(i)}\right| &= -V_{t_i,\lambda_i}V_{s_i,s_i} + V_{s_i,\lambda_i}V_{t_i,s_i} \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial\lambda_i}\left(\frac{\partial\epsilon^i_{Y,s}}{\partial s_i} + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right) + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial\lambda_i}\left(\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right)\right] \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial\lambda_i}\frac{\partial\epsilon^i_{Y,s}}{\partial s_i}\right],
\end{aligned}
$$

$$\begin{aligned}
\left|\mathsf{H}_{(iii)}\right| &= -V_{t_i,t_j}V_{s_i,s_i} + V_{s_i,t_j}V_{t_i,s_i} \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial t_j}\left(\frac{\partial\epsilon^i_{Y,s}}{\partial s_i} + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right) + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial t_j}\left(\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right)\right] \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial t_j}\frac{\partial\epsilon^i_{Y,s}}{\partial s_i}\right], \\
\left|\mathsf{H}_{(iv)}\right| &= -V_{t_i,t_j}V_{s_i,s_i} + V_{s_i,t_j}V_{t_i,s_i} \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_j}\left(\frac{\partial\epsilon^i_{Y,s}}{\partial s_i} + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right) + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_j}\left(\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right)\right] \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_j}\frac{\partial\epsilon^i_{Y,s}}{\partial s_i}\right].
\end{aligned}$$

Inspecting the signs of the partial derivatives the positive sign of the determinants can be easily proofed. The determinants for the effectes (v),(vii), and (viii) can be proofed in the same way.

The determinants in the case of the comparative static preference effects are positive if the following derivatives are positive:

$$\begin{aligned}
\left|\mathsf{H}_{(ii)}\right| &= -V_{t_i,\nu_i}V_{s_i,s_i} + V_{s_i,\nu_i}V_{t_i,s_i} \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\left(\frac{\partial\epsilon^i_{Y,s}}{\partial s_i} + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right) + \frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial s_i}\right] \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,s}}{\partial s_i} - \frac{\partial\kappa_i}{\partial s_i}\left(\frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i} - \frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\right)\right], \\
\left|\mathsf{H}_{(vi)}\right| &= -V_{s_i,\nu_i}V_{t_i,t_i} + V_{t_i,\nu_i}V_{s_i,t_i} \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\left(\frac{\partial\epsilon^i_{Y,t}}{\partial t_i} + \frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial t_i}\right) + \frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i}\frac{\partial\kappa_i}{\partial t_i}\right] \\
&= \frac{V}{t_i}\frac{V}{s_i}\left[-\frac{\partial\epsilon^i_{Y,t}}{\partial t_i} + \frac{\partial\kappa_i}{\partial s_i}\left(\frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i} - \frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i}\right)\right].
\end{aligned}$$

Both determinants contain the difference between the effect of the capital ratio on the two elasticities, which is unambigously negative:

$$\frac{\partial\epsilon^i_{Y,s}}{\partial\kappa_i} - \frac{\partial\epsilon^i_{Y,t}}{\partial\kappa_i} = -\frac{\beta}{1-\beta}\left(1 + \frac{s_i}{1-s_i}\right)(1+k_i)^{-1}.$$

It follows that $\left|\mathsf{H}_{(vi)}\right|$ is positive. But whether $\left|\mathsf{H}_{(ii)}\right|$ is positive depends on the magnitude of the effects. After some calculations the following expression for this determinant can be found:

$$\left|\mathsf{H}_{(ii)}\right| = \frac{V}{t_i}\frac{V}{s_i}\frac{\nu_i}{s_i\left(1-s_i\right)}\left[1-\frac{\beta}{\frac{1-\beta}{\kappa_i}+1-(\alpha-\gamma)-\beta}\right].$$

This condition is fulfilled for any $k_i$ if

$$\beta \leq (1-(\alpha-\gamma)-\beta)\,,$$
$$\text{or: } \beta \leq \frac{1}{2}\left(1-\alpha+\gamma\right).$$

This condition seems not overly restrictive. Since it can be seen from equation (10) that a violation of this condition would imply that an increase of the spending share of public inputs by one percent causes an increase in the local capital share by more than one percent.

# B Sources and definitions of data:

**Local Collection Rates**: Collection of rates of the business tax among 327 districts from 1980 until 1996 are published in 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.

**No. of Communities**: Taken from the official registry of communities in Germany (Amtliches Gemeindeverzeichnis).

**District area**: Total area in squared kilometers taken from Eurostat database Regio referring to the district definitions in 1980.

**Share of Recreation Area**: Referring to 1988 taken from the INKAR CD-ROM of the BBR (federal office for regional planning).

**Travel Time Agglomeration**: Travel time to the next density point (Verdichtungsraumkern) in minutes, source: BBR (federal office for regional planning).

**Travel Time Airport**: Travel time (by car) to the next international aiport in minutes, source: BBR (federal office for regional planning).

**Share of Welfare Recipients**: Number of welfare recipients relative to total population. Average of 1982, 1985, 1988/1989, 1992, and 1995, source: Laufende Raumbeobachtung of the BBR (federal office for regional planning), own computations.

**Share of Citizens with Age > 65**: Number of citizens with age > 65 relative to total population. Average of 1983, 1989, and 1995, source: Laufende Raumbeobachtung of the BBR (federal office for regional planning), own computations.

**Share of Children**: Number of children (age < 15) relative to total population in 1989, source: Laufende Raumbeobachtung of the BBR (federal office for regional planning).

**Unemployment Rate**: Average rate of unemployment in the 327 districts in the years 1986 until 1995, source: Institut of Employment Research (IAB) of the federal ministry of labor (BMA), own computations.

**Price of Vacant Developed Land**: Turnover per area sold. Average of 1980-1982, 1987-1989, 1990-1992, 1994-1995 adjusted for price changes by the GDP price-index for former West Germany, missing values encountered, source: Council of Experts on Economic Development (SVR), Laufende Raumbeobachtung of the BBR (federal office for regional planning), own computations.

**Power Price**: Average price of electricity in DM per 100 kWh calculated at standardized demand values of four hypothetical firms. Average of 1982, 1985, 1991, and 1994 adjusted for price changes by the energy price index for former West Germany, source: Council of Experts on Economic Development (SVR), Laufende Raumbeobachtung of the BBR (federal office for regional planning), own computations.

**Development Area**: Dummy variable determining whether one of the communities is a development area (Schwerpunktort) according to the regional development act (Schwerpunktaufgabe Verbesserung der Regionalen Wirtschaftsstruktur). Average of 1983 and 1990, source: Laufende Raumbeobachtung of the BBR (federal office for regional planning), own computations.