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Spatial Administrative Structure and Intra-Metropolitan Tax Competition

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Abstract

I investigate whether the spatial administrative structure of agglomerations is associated with local business tax rates in core cities of agglomerations. Using data for German municipalities, I define agglomerations based on distances and based on cumulative population densities. The results show that the population share of the core in its agglomeration is positively associated and the number of surrounding municipalities is negatively associated with the tax rate of the core. When municipalities consolidate, the core has the opportunity to increase the tax rate.

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Keywords: Spatial administrative structure, municipal borders, local business taxation, tax competition.

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1 Introduction

Borders influence the scope of local governments' policies such as setting tax rates and providing public goods. Borders may also influence the location of businesses. Firms that do not locate in the core of the city, but rather at the border, may choose between two or more municipalities with different administrative bodies. When customers' demand or public infrastructure is similar at both sides of the border, the firm will choose the municipality that provides a more attractive bundle of tax rates and public services. If the core of a city is more attractive to firms as compared to the outskirts, tax competition is likely to be stronger the closer the border of a city is drawn around its core. The surrounding municipalities may well participate in the core's benefits (such as the high density of consumers) and may offer low tax rates when the core's infrastructure can be co-used. With a wide border, by contrast, the city can tax its benefits of agglomeration away, which gives rise to less tax competition.

Using data for German municipalities, I investigate whether the spatial administrative structure of agglomerations is associated with local business tax rates in core cities of agglomerations. The local business tax ("Gewerbesteuer") is one of the most effective economic measures employed by local politicians. I define agglomerations based on distances and based on cumulative population densities. The results show that the population share of the core in its agglomeration is positively associated and the number of surrounding municipalities is negatively associated with the tax rate of the core. When municipalities consolidate, the core has the opportunity to increase the tax rate.

2 Tax Competition and the Role of Borders

Many studies investigate how jurisdictions engage in tax competition. The seminal paper by Zodrow and Mieszkowski (1986) shows that jurisdictions competing for a mobile factor (capital) set inefficiently low tax rates. When the number of competing jurisdictions increases, the mobility of capital increases. A race to the bottom in the levels of taxation and public good provision occurs; the positive externality of a tax increase on the neighboring jurisdictions is neglected (see also Hoyt, 1991;

Wildasin, 1989; and Wilson, 1986).[1] When demand for public goods is allowed to differ between jurisdictions, high-demand jurisdictions have been shown to have higher tax rates and lower capital stocks than low-demand jurisdictions; the demand for public goods thus mitigates the pressure to reduce tax rates (Brueckner, 2000 and 2004). Asymmetry in jurisdictions' size has been shown to influence tax competition. With two equal jurisdictions, the smaller jurisdiction has been shown to set a lower tax rate than the larger jurisdiction (Bucovetsky, 1991; and Wilson, 1991; see also Haufler and Wooton, 1999).

In reaction-function models, experts empirically explain tax rates by the spatial interaction in jurisdictions' tax-setting behavior. In alternative models, the spatial administrative structure describes the degree of competition. Decentralization as measured, for example, by the number of municipalities may well reduce the size of the public sector by taming the leviathan. In the United States, decentralization has been shown to reduce the size of the public sector (Sjoquist, 1982; Nelson, 1987; and Zax, 1989). The results by Oates (1985), however, do not show that decentralization influences the size of the public sector. In German counties, local business taxation has been higher when the number of municipalities has been small (Buettner, 1999). In the German state Baden-Wuerttemberg, local business taxation has increased in the population size. The tax rate of a municipality has been influenced by neighboring municipalities' tax rates (Buettner, 2001). The tax base has reacted negatively to the own tax rate; the results do, however, not show that the tax base has reacted to the tax rates of neighboring municipalities (Buettner, 2003). In the Canadian province British Columbia, tax rates have also been influenced by neighboring municipalities' tax rates (Brett and Pinkse, 2000). In Italy and the Boston metropolitan area, governments have interacted strategically in property taxation (Bordignon et al., 2003; and Brueckner and Saavedra, 2001).[2]

The role of borders has also been examined in contexts other than taxation. In the United States, for example, the number of public school districts in metropolitan areas has been shown to increase

[1] For a survey on theories of tax competition, see Wilson (1999). For positive and negative aspects of tax competition, see Wilson and Wildasin (2004).

[2] For surveys on the strategic interaction in spatial (tax) competition with a focus on empirical tests of theoretical models, see Brueckner (2003) and Revelli (2005). On how expected local property tax liabilities are capitalized into property values, see, for example, Oates (1969 and 1973), Quang Do and Sirmans (1994), Palmon and Smith (1998), and Borge and Rattsø (forthcoming).

the quality of schooling (Hoxby, 2000). Income growth has been higher in metropolitan areas that host many county governments (Hatfield and Kosec, 2013). How the spatial administrative structure is associated with local business tax rates remains as an empirical question.[3]

3 German Municipalities and Taxation

The tax system in Germany allows both the federal government and the municipalities to tax business income. While the federal government taxes corporations with the *corporate tax* and sole proprietors and partnerships with the *income tax*, the municipalities decide upon the rate of the *local business tax* (which applies to corporations, sole proprietors, and partnerships). Sole proprietors and partnerships can credit the local business tax partly against the income tax. The local business tax is the most important autonomously determined source of revenue for German municipalities. In the average city the local business tax generated about 52 percent of tax revenues in 2007.[4] The local business tax has a lower bound of 10 percent for corporations, but no upper bound.[5] The federal government introduced the lower bound in 2004 to avoid zero-tax strategies in individual municipalities. The tax rates in the cities varied in 2007 between 15 percent in Coburg and 24.5 percent in Munich, Bottrop, and Hoyerswerda. The tax base follows the same definition in all municipalities: profit plus additions (e.g., shares of interest payments and rents) minus deductions (e.g., dividends and share of property).

There were 12,263 municipalities in Germany in 2007. After the German reunification in 1990 the number of municipalities in East Germany declined, while the number of municipalities remained fairly constant in other parts of the country. The municipal structure differs a great deal among

[3]Borders may well influence tax competition in an international context: in the French-German border region, local business tax competition has been present between municipalities within a country, but not across the country border (Cassette et al., 2012). In Germany, local politicians have perceived competition independent of state or country borders (Geys and Osterloh, 2013).

[4]The ratio of local business tax revenues to total tax revenues was highest in the city of Salzgitter at 71 percent. The city of Wolfsburg had negative revenues due to high tax refunds.

[5]I report the tax rates for corporations in my analysis. In fact, the municipality chooses a uniform "rate of assessment" for corporations, sole proprietors, and partnerships, which was multiplied in 2007 in the case of corporations by 5 percent and in the case of sole proprietors and partnerships by up to 5 percent to obtain the percentage being taxed away.

the German states ("Bundesländer"). Figure 1 shows the number of municipalities per 100 square kilometers. The state of Rhineland-Palatinate, for example, has 2,306 municipalities but the state of North Rhine-Westphalia has only 396, though North Rhine-Westphalia has a larger area.

4 Agglomerations and Empirical Strategy

I define agglomerations around all cities that are independent of counties ("Kreisfreie Städte"). In 2007 there were 118 county-independent cities.[6] I focus on county-independent cities as core cities of agglomerations, because they represent Germany's largest cities being regional centers. A clear-cut definition of agglomerations does not exist. I use two different approaches to define agglomerations: my first approach is based on the proximity of municipalities to a core city, my second approach focuses on population densities.

In the first approach, I define an agglomeration as consisting of the core city and all surrounding municipalities within a certain distance (of 15, 25, or 50 km) to the core city (see Figure 3). To measure the (linear) distance between municipalities, I rely on the geographical coordinates of municipalities' official central points. The central points are well-defined in Germany and are typically very central places in the municipalities' centers. To define an agglomeration in the second approach, I sort the surrounding municipalities according to their distance to the core. Starting from the core, I add municipalities – with increasing distances – until the *cumulative* population density from the core to the respective municipality no longer changes significantly (see Figure 4; a more detailed explanation follows in Section 5). Agglomerations' area differs from city to city in the second approach, while agglomerations' area is (almost) the same for all cities in the first approach. In both approaches agglomerations can overlap.[7]

[6] County-independent cities are not associated with a county, but are directly subordinate to their state. A county-*dependent* city, by contrast, is part of a county, which is at an intermediate stage between city and state. I also consider the cities of Hanover and Saarbrücken as county-independent cities, although their legal status deviates slightly ("Kommunalverband besonderer Art"). One may exclude the city states (Berlin, Hamburg, and Bremen), which form a city and a state at the same time, because city states have more responsibilities than other cities. While Berlin and Hamburg (that consist of only one city) are dropped because of collinearity, the results are not sensitive to excluding Bremen (that consists of two cities).

[7] As an alternative approach, I also considered the so-called "BIK regions". The concept of BIK regions (provided by *BIK ASCHPURWIS+BEHRENS*) is based on Boustedt (1953), who in turn took the US concept of "Standard

To describe how agglomerations differ, I use two kinds of indicators: the position of the core city relative to the surrounding municipalities, and the structure of the surrounding municipalities. I measure the position of the core city relative to the surrounding municipalities by the population of the core city relative to the total population in the agglomeration. This "share of core" aims at measuring the "power" of the core in the agglomeration. To measure the structure of the surrounding municipalities, I consider two alternative variables: the number of surrounding municipalities and the population per surrounding municipality. The structure of the surrounding municipalities is included with a view to measuring competition from the surrounding municipalities. Table 1 shows the ten largest German cities and their agglomerations defined with a radius of 50 km around the city.

As a robustness test, I also consider the Herfindahl index of the agglomerations' fragmentation in population figures. The Herfindahl index assumes large values (up to 1) when a city has a large population share in its agglomeration, and when the number of surrounding municipalities is small.

It is conceivable that tax rates are higher in agglomerations because of "agglomeration rents", as formulated in the New-Economic-Geography literature (see Krugman, 1993). Firms may exploit economies of scale by producing in a small number of locations. Firms may locate in agglomerations to reduce transport costs, both to customers and from input suppliers. These positive externalities give rise to higher profits in agglomerations, with agglomeration forces being "strongest for intermediate trade cost, i.e., when trade costs are low enough to make agglomeration possible yet high enough to make it worthwhile" (Baldwin and Krugman, 2004: 22). The agglomeration rents that cities can tax away follow the "bell-shaped link between trade costs and agglomeration".[8]

Public expenditure (per capita) may be higher in large cities because the inhabitants of large cities have a higher demand for public goods (Popitz, 1932). Population density and public expenditure may be positively related because of the size disadvantages of large cities (Brecht, 1932). Experts

Metropolitan Areas" (SMA) as a model. According to the BIK-regions concept agglomerations are formed by those surrounding municipalities in which a certain share of the population is commuting to the core city. The empirical results with the BIK-regions concept are similar to the empirical results in the two other approaches.

[8]In German municipalities, tax rates have been shown to be higher when agglomerations are present (Koh et al., 2013). For an overview of the empirical results of the New-Economic-Geography literature, see Redding (2010).

elaborate on a U-shaped relationship with decreasing per-capita expenditure up to an optimal municipality size or density (economies of scale) and increasing per-capita expenditure afterwards (congestion externalities).[9] Per-capita expenditure and tax rates should thus be higher the larger the population or the population density of the core or the whole agglomeration becomes. Since congestion externalities in the city are not only caused by inhabitants of the city, but also by inhabitants of the surrounding area, I focus on the whole agglomeration (which includes the core) when controlling for the population.[10] Because the data in both approaches to defining agglomerations indicate a positive correlation between population and population density (the correlation coefficient is between 0.38 and 0.99), I only include population as control variable.

To capture the intensity of tax competition between cities, I include the distance to the next county-independent city as control variable.[11] To describe expenditure needs, I include unemployment per 1000 capita and the level of public debt per 1000 capita.[12] To describe budget conditions, I include revenues from other taxes per 1000 capita (including property taxes, municipal share of income tax, and municipal share of value added tax). To describe preferences, I include the share of the population aged 18 and younger and the share of the population aged 65 and older. To account for ideology-induced policy making, I include a variable describing the party affiliation of the mayor, which assumes the value one for a left-wing mayor (from the Social Democrats or the Greens), the value zero for a right-wing mayor (from the Christian Democrats or the Free Democrats), and the value 0.5 for a mayor without party affiliation.[13]

Local business tax rates depend on the state a municipality belongs to (see Figure 2). One reason for the different levels of taxation may be the different fiscal equalization schemes in the states,

[9]For empirical evidence of a U-shaped relationship regarding population densities see Ladd (1992) for the United States and Seitz (2002) for Germany. All of my observations are above the optimal size of jurisdictions because I only include core cities of agglomerations.

[10]The surrounding municipalities co-use the infrastructure and hence may also cause taxes in the city to be higher.

[11]Janeba and Osterloh (2013) examine competition on two levels: cities compete with smaller neighboring municipalities and more distant cities; small municipalities only compete with other municipalities in their neighborhood.

[12]In the United States, redistributive politics have been shown to influence the tax policies of large cities (Inman, 1989).

[13]Using the ideology of the majority in the city council instead of the ideology of the mayor does not change the inferences. On ideology-induced policy making in Germany see, for example, Potrafke (2011, 2012, and 2013).

which redistribute between the municipalities to different degrees. The state of Hesse, for example, balances only 50 percent of the difference between "fiscal need" and "fiscal capacity" of a municipality (if positive), the state of North Rhine-Westphalia balances 90 percent of this difference. There are thus significant differences in the share of an additional Euro of revenue that a municipality can keep. I include state fixed effects (based on the state of the core city) because of the resulting different incentives in setting tax rates.[14]

The regression equation is:
$Local\ business\ tax\ rate_i = \alpha + \beta_1\ Share\ of\ core_i + \beta_2\ Surrounding\ municipalities_i + \boldsymbol{\gamma}\ \boldsymbol{X}_i + u_i.$

$Share\ of\ core_i$ describes the population share of the core city, $Surrounding\ municipalities_i$ describes the number of surrounding municipalities or the population per surrounding municipality, $\boldsymbol{X}_i$ describes a vector of control variables (including population of the agglomeration, distance to the next county-independent city, unemployment per 1000 capita, level of public debt per 1000 capita, revenues from other taxes per 1000 capita, shares of the young and the old population, mayor ideology, and state dummies), and u_i is the error term. I estimate an OLS model with standard errors robust to heteroskedasticity (Huber/White/sandwich standard errors – see Huber, 1967; and White, 1980).[15] I use data from the German Federal Statistical Office. The sample includes 115 observations for the year 2007. Tables 2 to 4 show descriptive statistics.

5 Empirical Results

First Approach (Based on Distances)

The left part of Table 5 shows the results for agglomerations with a radius of 15 km. Column (1) shows that the effect of the share of the core city lacks statistical significance. When the number of municipalities and hence the number of competitors increases by 100 percent, the tax rate decreases

[14]It is worth noting that the share of an additional Euro of revenue that a municipality can keep is also influenced by other factors, such as the rate that is applied to normalize revenues. For how fiscal equalization transfers influence tax policy, see Bucovetsky and Smart (2006), Buettner (2006), Egger et al. (2010), and Köthenbürger (2002).

[15]I do not use clustered standard errors due to the scarcity of available clusters.

by 0.60 percentage points. The effect is statistically significant at the 10 percent level. Column (2) shows that when the share of the core city increases from 0 to 100 percent, the tax rate increases by 2.43 percentage points. The effect is statistically significant at the 5 percent level. When the population per surrounding municipality increases by 100 percent, the tax rate increases by 0.67 percentage points. The effect is statistically significant at the 10 percent level. The effect results from the declining number of competitors because of the larger surrounding municipalities. Column (3) shows that the effect of the Herfindahl index does not turn out to be statistically significant. When the population of the agglomeration increases by 100 percent, the tax rate significantly increases by 1.19 to 1.34 percentage points (columns 1 and 3). When the level of public debt per 1000 capita increases by 100 percent, the tax rate significantly increases by 0.20 to 0.22 percentage points. When the share of the young population increases from 0 to 100 percent, the tax rate significantly decreases by 16.43 to 21.35 percentage points. The effects of the distance to the next county-independent city, unemployment per 1000 capita, revenues from other taxes per 1000 capita, share of the old population, and mayor ideology lack statistical significance.

The right part of Table 5 shows the results for agglomerations with a radius of 25 km. Column (4) shows that when the share of the core city increases from 0 to 100 percent, the tax rate increases by 2.56 percentage points. The effect is statistically significant at the 10 percent level. When the number of municipalities increases by 100 percent, the tax rate decreases by 1.00 percentage points. The effect is statistically significant at the 5 percent level. Column (5) shows that when the share of the core city increases from 0 to 100 percent, the tax rate increases by 4.15 percentage points. The effect is statistically significant at the 1 percent level. When the population per surrounding municipality increases by 100 percent, the tax rate increases by 1.05 percentage points. The effect is statistically significant at the 5 percent level. Column (6) shows that the effect of the Herfindahl index does not turn out to be statistically significant. When the population of the agglomeration increases by 100 percent, the tax rate significantly increases by 1.24 to 1.53 percentage points (columns 4 and 6). When the level of public debt per 1000 capita increases by 100 percent, the tax rate significantly increases by 0.26 percentage points (columns 4 and 5). When the share of the young population increases from 0 to 100 percent, the tax rate significantly decreases by 18.54 to 26.87 percentage points. The effects of the distance to the next county-independent city, unemployment per 1000 capita, revenues from other taxes per 1000 capita, share of the old

population, and mayor ideology lack statistical significance.

Table 6 shows the results for agglomerations with a radius of 50 km. As compared to agglomerations of 25 km, the effect of the share of the core has increased. A large share in a widely defined agglomeration thus gives rise to a stronger position of the core than a large share in a narrowly defined agglomeration. Also the effect of the number of surrounding municipalities or the population per surrounding municipality has increased. Considering also municipalities located far away does thus not reduce the effect of the surrounding municipalities' structure on the tax rate of the core.[16] The positive and statistically significant effect of the Herfindahl index confirms that a city with a large population share in its agglomeration and few (and thus large) competitors charge higher tax rates. The effect of the population of the agglomeration has become smaller, because the broader definition of agglomerations also covers population from far away. The effect of the level of public debt per 1000 capita is statistically significant (columns 1 and 2). The share of the young population is also statistically significant. When the share of the old population increases from 0 to 100 percent, the tax rate significantly decreases by 16.17 percentage points (column 3). Inferences do not change when all control variables unrelated to the administrative structure are excluded (unemployment per 1000 capita, the level of public debt per 1000 capita, revenues from other taxes per 1000 capita, the shares of the young and the old population, and mayor ideology; see columns 4-6).

Second Approach (Based on Population Densities)

I now focus on population densities to define agglomerations. I rank surrounding municipalities according to their distance to the core. I add municipalities from this list to the core until the cumulative population density of the resulting agglomeration remains roughly constant. I stop adding municipalities when the cumulative population density from the core to some surrounding municipality n exceeds the cumulative population density from the core to the surrounding municipality $n + 20$ by no more than q percent (with $q = 1, 10$).[17] This approach captures the "agglomeration

[16] Ohsawa (1999) examines how the location of administrative bodies influences commodity tax competition.

[17] I also used a different span ($n + 10$) and different values for q $(2, 5)$. The larger the span and the smaller q, the larger the agglomerations. The empirical results confirm the results in this section.

mountain" that rises from the flat country (see again Figure 4).[18]

The left part of Table 7 shows the results for $q = 10$. When the share of the core city increases from 0 to 100 percent, the tax rate increases by 2.79 to 4.64 percentage points. The effects are statistically significant at the 5 percent and 1 percent level. When the number of surrounding municipalities (the population per surrounding municipality) increases by 100 percent, the tax rate decreases by 0.83 (increases by 0.92) percentage points. The effects are statistically significant at the 1 percent level. The Herfindahl index confirms these results. When the population of the agglomeration increases by 100 percent, the tax rate significantly increases by 0.92 to 1.75 percentage points. The effect of the level of public debt per 1000 capita is statistically significant (columns 1 and 2). The share of the young population is also statistically significant.

The right part of Table 7 shows the results for $q = 1$. The agglomerations are now larger, because a smaller decline in the cumulative population density is required. The effect of the core city's share is thus slightly larger than before. When the share of the core city increases from 0 to 100 percent, the tax rate increases by 2.98 to 4.98 percentage points. The effects are statistically significant at the 5 percent and 1 percent level. When the number of surrounding municipalities (the population per surrounding municipality) increases by 100 percent, the tax rate decreases by 0.88 (increases by 0.95) percentage points. The effects are statistically significant at the 1 percent level. The Herfindahl index confirms the results. When the population of the agglomeration increases by 100 percent, the tax rate significantly increases by 0.91 to 1.82 percentage points. The effects of the level of public debt per 1000 capita (columns 4 and 5) and of the share of the young population are statistically significant. The effect of the share of the old population is also statistically significant (column 6).

Variables including population figures may suffer from reverse causality bias. I replaced variables that include population figures (population share of the core city, population per surrounding municipality, the Herfindahl index, population of the agglomeration, and the level of public debt per 1000 capita) by the respective variables in terms of the area (in square kilometers). Variables

[18]Since in few cases cities are part of a plateau of population density, a surrounding area of zero municipalities can result. I drop these observations, so that I am left with 109 and 113 out of 115 observations.

based on the area may not suffer from reverse causality bias, because in West German cities, which account for about 80 percent of the observations, borders have not been notably adjusted since 1978. I excluded all remaining variables that may suffer from reverse causality bias (unemployment per 1000 capita, revenues from other taxes per 1000 capita, the shares of the young and the old population, and mayor ideology). Replicating Tables 5-7, the effects of the share of the core city and the Herfindahl index are statistically significant in all specifications. The effect of the number of surrounding municipalities or the area per surrounding municipality is statistically significant only in agglomerations of 50 km.

Based on column (1) of Table 6, I predict the tax rates of individual German cities that would result if these cities had the average administrative structure of the ten largest German cities (compare Table 1). Stuttgart and Frankfurt, for example, are currently exposed to strong tax competition. With the average administrative structure of the ten largest German cities, Stuttgart and Frankfurt were able to increase their tax rates by about 1.7 and 1.3 percentage points as compared to the predicted tax rates with the current administrative structure. Munich, a city less exposed to tax competition, would have to reduce its tax rate by about 1.0 percentage points. The population share of the core city influences the effects more than the number of surrounding municipalities.

6 Conclusion

I investigate whether the spatial administrative structure of agglomerations is associated with local business tax rates in core cities of agglomerations. Using data for German municipalities, I define agglomerations based on distances and based on cumulative population densities. The results show that the population share of the core in its agglomeration is positively associated and the number of surrounding municipalities is negatively associated with the tax rate of the core.[19]

The administrative structure of an agglomeration is thus an important determinant of tax policy

[19]When the analysis is restricted to the West German states the effect of the share is stronger, while the effect of the surrounding area is weaker. When I only consider the East German states, the effect of the share is weaker, while the effect of the surrounding area is stronger.

in the core. When municipalities consolidate, the core has the opportunity to increase the tax rate. Cities with "narrow" borders may suffer from tax competition because of the positive externalities of their public goods.[20] Surrounding municipalities co-use the core city's infrastructure without paying for it and may thus attract firms with low tax rates. Being exposed to this "externality-based" tax competition, the core city also sets a lower tax rate. The results support a consolidation policy because the consolidation internalizes the positive externality from the core city to the surrounding municipality. With less externality-based tax competition the core city may then set a higher tax rate.[21] This core city's higher tax rate does not describe a leviathan municipality (with a tax rate increasing above the optimal level), but rather a tax rate that approaches the optimal tax rate from below. Predicting the effects of reforming administrative structures shows that this would have significant effects on the local business tax rate.

Future research may well investigate what determines the tax policy in the areas surrounding core cities. Experts may also investigate whether local business tax rates exert effects on the administrative structure. Examining whether the design of borders influences where firms locate within an agglomeration, and whether redesigning municipalities' borders attracts new investors are also worthwhile endeavors.

[20]Cities with "wide" borders, by contrast, suffer less from tax competition because distant surrounding municipalities can hardly benefit from the cities' positive externalities. On competition between core city and surrounding municipalities, see, for example, Hollar (2011).

[21]When the consolidation policy makes the region a high-tax region, the core city may not only benefit from improving its *intra*regional position, but may also suffer from reduced *inter*regional competitiveness. By splitting up municipalities, by contrast, regional competitiveness may increase when the region becomes a low-tax region. On the effects of consolidations, see, for example, Hanes and Wikström (2008) and Kauder (forthcoming).

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Figure 1: Number of Municipalities per 100 km^2

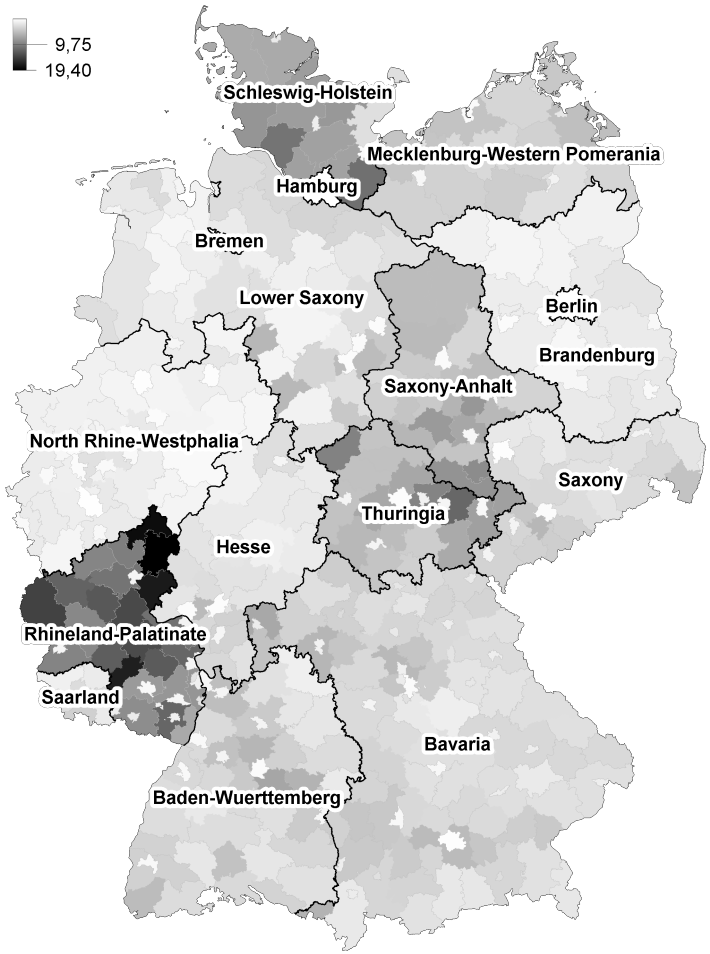


Figure 2: Local Business Taxation in Germany

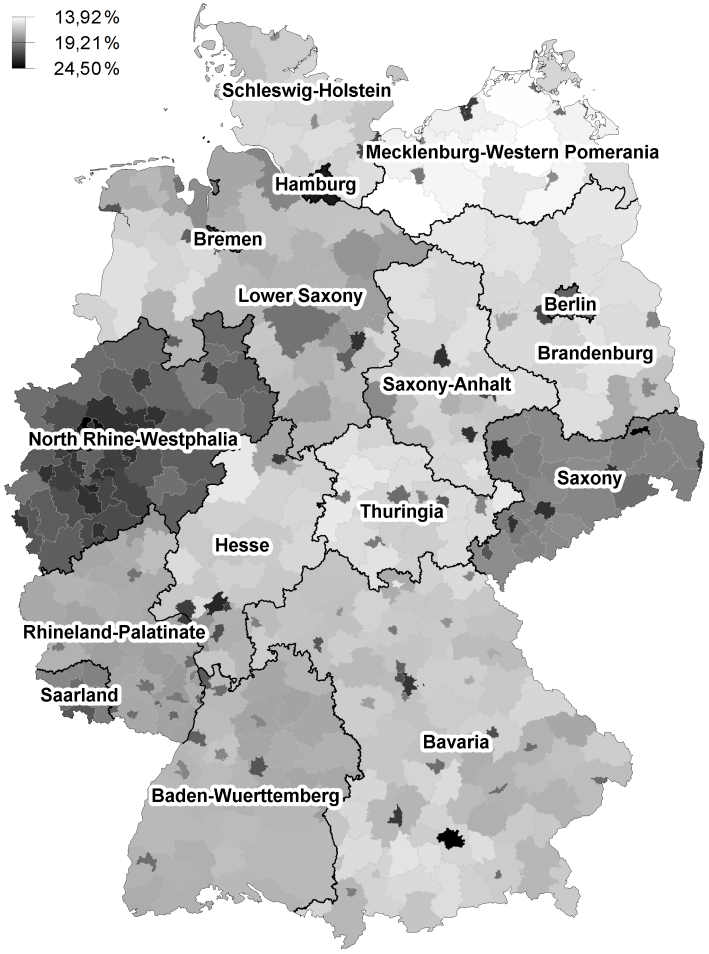
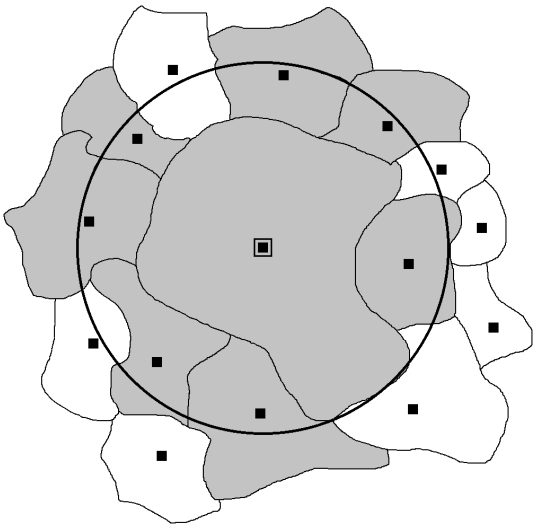
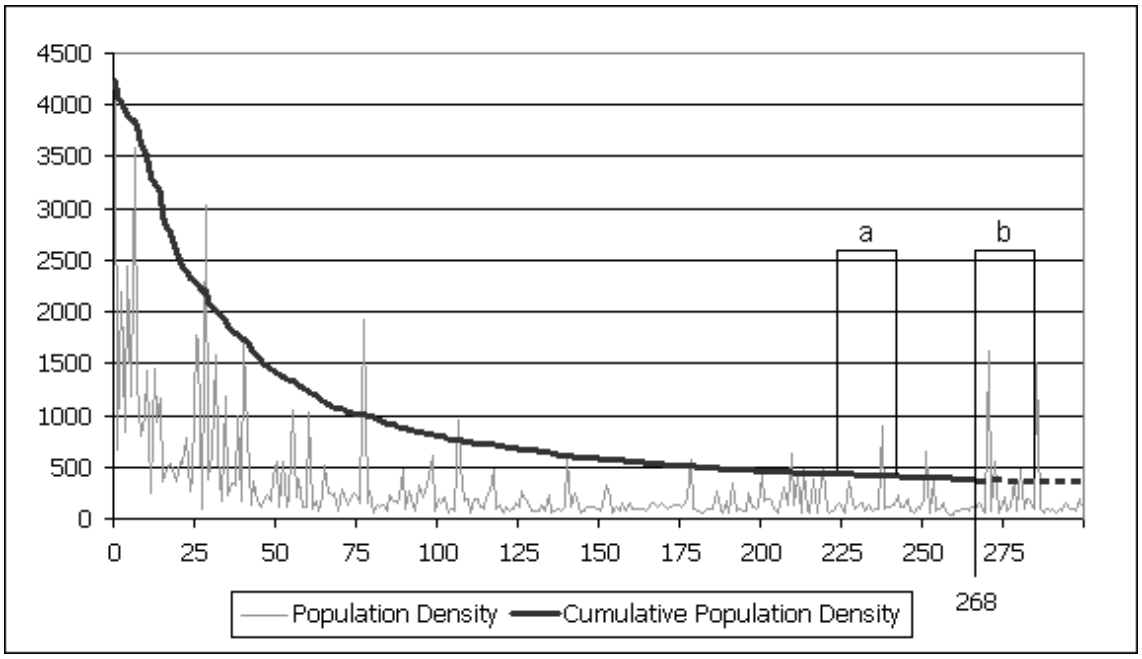


Figure 3: The Definition of Agglomerations (First Approach)



In the first approach all municipalities that have their central point within a certain distance to the core are part of the agglomeration and are here illustrated by shadowed areas and a circle. The agglomeration includes seven municipalities plus the core.

Figure 4: The Definition of Agglomerations (Second Approach)



In the second approach I add municipalities (displayed at the abscissa with increasing distance to the core) to the agglomeration until the cumulative population density (from the core to the respective municipality) remains "roughly" constant (dashed line; technical details in Section 5). While the decline in cumulative population density at a is still too large, the decline is sufficiently small at b. The agglomeration (Munich) includes 268 municipalities.

Table 1: The Largest German Cities and their Agglomerations (of 50 km)

City	Pop. of City	Pop. of Agglom.	Pop. Share of City	No. of Munic.	Pop. per Munic.	Herfind. Index	Tax Rate of City
Berlin	3,416,255	4,575,679	74.66%	100	11,594	0.56	20.50%
Hamburg	1,770,629	3,358,761	52.72%	451	3,521	0.28	23.50%
Munich	1,311,573	3,084,994	42.51%	255	6,955	0.18	24.50%
Cologne	995,397	6,264,709	15.89%	141	37,371	0.05	22.50%
Frankfurt	659,021	4,283,820	15.38%	268	13,525	0.04	23.00%
Stuttgart	597,176	4,213,761	14.17%	321	11,267	0.03	21.00%
Dortmund	586,909	6,801,063	8.63%	91	68,287	0.04	22.50%
Essen	582,140	8,545,506	6.81%	104	76,571	0.03	23.50%
Düsseldorf	581,122	8,775,278	6.62%	103	79,555	0.04	22.25%
Bremen	547,769	1,601,718	34.20%	147	7,170	0.13	22.00%
Avg. of this List	1,104,799	5,150,529	27.16%	198	31,582	0.14	22.53%

The first column shows the population of the respective city, the second column the population of the municipalities within a circle of 50 km (including the core), the third column the population share of the core in its agglomeration, the fourth column the number of municipalities within a circle of 50 km (excluding the core), the fifth column the population per surrounding municipality, the sixth column the Herfindahl index of the agglomeration, and the seventh column the local business tax rate of the core.

Table 2: Descriptive Statistics (Agglomerations of 15 km)

Variable	Obs.	Mean	Standard Dev.	Min	Max
Tax Rate Core	115	20.73	1.87	15.00	24.50
Pop. Core	115	188.73	198.32	34.72	1311.57
Pop. Agglomeration	115	498.31	482.03	72.13	1994.25
Pop. Share of Core City	115	0.46	0.21	0.06	0.85
Pop. per Surr. Munic.	115	28.39	52.51	0.95	267.95
No. of Surr. Munic.	115	22.33	15.26	3	80
Herfindahl Index	115	0.31	0.16	0.05	0.72
Distance to next City	115	30.26	18.21	2.36	89.94
Unemployment/Pop.	115	0.06	0.02	0.03	0.11
Public Debt/Pop.	115	1585654.00	2750239.00	0	21600000.00
Other Revenues/Pop.	115	484699.10	133214.70	232471.30	895548.10
Pop. Share 18 and younger	115	0.15	0.02	0.11	0.19
Pop. Share 65 and older	115	0.21	0.02	0.16	0.29
Left-wing Mayor	115	0.52	0.49	0	1

Agglomerations include core and surrounding municipalities. Tax rate in percent, population figures (including unemployment) in 1000 inhabitants, distance in kilometers, and debt and other revenues in Euro. Table without Berlin, Hamburg, and Saarbrücken (missing due to collinearity; there is only one city in each of these states).

Table 3: Descriptive Statistics (Agglomerations of 25 km and 50 km)

Variable	Obs.	Mean	Standard Dev.	Min	Max
(Agglomerations of 25 km)					
Tax Rate Core	115	20.73	1.87	15.00	24.50
Pop. Core	115	188.73	198.32	34.72	1311.57
Pop. Agglomeration	115	971.54	955.34	129.57	4053.49
Pop. Share of Core City	115	0.26	0.16	0.03	0.63
Pop. per Surr. Munic.	115	22.73	37.26	0.89	160.61
No. of Surr. Munic.	115	64.82	41.80	11	247
Herfindahl Index	115	0.14	0.09	0.03	0.41
Distance to next City	115	30.26	18.21	2.36	89.94
Unemployment/Pop.	115	0.06	0.02	0.03	0.11
Public Debt/Pop.	115	1585654.00	2750239.00	0	21600000.00
Other Revenues/Pop.	115	484699.10	133214.70	232471.30	895548.10
Pop. Share 18 and younger	115	0.15	0.02	0.11	0.19
Pop. Share 65 and older	115	0.21	0.02	0.16	0.29
Left-wing Mayor	115	0.52	0.49	0	1
(Agglomerations of 50 km)					
Tax Rate Core	115	20.73	1.87	15.00	24.50
Pop. Core	115	188.73	198.32	34.72	1311.57
Pop. Agglomeration	115	2808.34	2556.91	304.60	10038.36
Pop. Share of Core City	115	0.09	0.08	0.01	0.43
Pop. per Surr. Munic.	115	18.23	26.64	1.37	89.78
No. of Surr. Munic.	115	254.20	154.42	48	911
Herfindahl Index	115	0.05	0.06	0.01	0.57
Distance to next City	115	30.26	18.21	2.36	89.94
Unemployment/Pop.	115	0.06	0.02	0.03	0.11
Public Debt/Pop.	115	1585654.00	2750239.00	0	21600000.00
Other Revenues/Pop.	115	484699.10	133214.70	232471.30	895548.10
Pop. Share 18 and younger	115	0.15	0.02	0.11	0.19
Pop. Share 65 and older	115	0.21	0.02	0.16	0.29
Left-wing Mayor	115	0.52	0.49	0	1

Agglomerations include core and surrounding municipalities. Tax rate in percent, population figures (including unemployment) in 1000 inhabitants, distance in kilometers, and debt and other revenues in Euro. Table without Berlin, Hamburg, and Saarbrücken (missing due to collinearity; there is only one city in each of these states).

Table 4: Descriptive Statistics (Agglomerations 10 percent and 1 percent)

Variable	Obs.	Mean	Standard Dev.	Min	Max
(Agglomerations 10%)					
Tax Rate Core	109	20.71	1.88	15.00	24.50
Pop. Core	109	193.34	202.30	34.72	1311.57
Pop. Agglomeration	109	743.70	1060.61	43.51	5866.00
Pop. Share of Core City	109	0.41	0.19	0.03	0.89
Pop. per Surr. Munic.	109	18.52	32.42	0.63	146.79
No. of Surr. Munic.	109	42.47	30.86	1	151
Herfindahl Index	109	0.23	0.15	0.05	0.80
Distance to next City	109	31.28	18.15	2.36	89.94
Unemployment/Pop.	109	0.06	0.02	0.03	0.11
Public Debt/Pop.	109	1613844.00	2822149.00	0	21600000.00
Other Revenues/Pop.	109	482225.50	135422.20	232471.30	895548.10
Pop. Share 18 and younger	109	0.15	0.02	0.11	0.19
Pop. Share 65 and older	109	0.21	0.02	0.16	0.29
Left-wing Mayor	109	0.50	0.49	0	1
(Agglomerations 1%)					
Tax Rate Core	113	20.73	1.87	15.00	24.50
Pop. Core	113	190.64	199.50	34.72	1311.57
Pop. Agglomeration	113	1379.30	2563.72	43.88	14746.02
Pop. Share of Core City	113	0.33	0.20	0.02	0.91
Pop. per Surr. Munic.	113	14.47	22.82	0.73	132.40
No. of Surr. Munic.	113	92.55	90.87	1	407
Herfindahl Index	113	0.17	0.17	0.02	0.84
Distance to next City	113	30.65	18.14	2.36	89.94
Unemployment/Pop.	113	0.06	0.02	0.03	0.11
Public Debt/Pop.	113	1596955.00	2773318.00	0	21600000.00
Other Revenues/Pop.	113	484088.10	134145.70	232471.30	895548.10
Pop. Share 18 and younger	113	0.15	0.02	0.11	0.19
Pop. Share 65 and older	113	0.21	0.02	0.16	0.29
Left-wing Mayor	113	0.52	0.49	0	1

Agglomerations include core and surrounding municipalities. Tax rate in percent, population figures (including unemployment) in 1000 inhabitants, distance in kilometers, and debt and other revenues in Euro. Table without Berlin, Hamburg, and Saarbrücken (missing due to collinearity; there is only one city in each of these states).

Table 5: Local Business Taxation in Agglomerations of 15 km and 25 km

	Agglomerations of 15 km			Agglomerations of 25 km		
	(1)	(2)	(3)	(4)	(5)	(6)
Pop. Share of Core City	1.073	2.433 **		2.555 *	4.145 ***	
	(0.914)	(0.950)		(1.314)	(1.383)	
ln(No. of Surround. Munic.)	-0.601 *			-1.006 **		
	(0.346)			(0.433)		
ln(Pop. per Surround. Mun.)		0.672 *			1.050 **	
		(0.373)			(0.448)	
Herfindahl Index			0.654			1.976
			(1.009)			(1.977)
ln(Pop. Agglomeration)	1.338 ***	0.723	1.190 ***	1.532 ***	0.524	1.240 ***
	(0.312)	(0.498)	(0.308)	(0.293)	(0.504)	(0.272)
ln(Distance to next City)	0.140	0.141	0.200	0.166	0.171	0.269
	(0.226)	(0.226)	(0.228)	(0.259)	(0.260)	(0.240)
Unemployment/Pop.	-7.465	-7.519	-2.942	-6.039	-6.460	1.087
	(14.746)	(14.499)	(15.489)	(14.336)	(14.250)	(15.796)
ln(Public Debt/Pop.)	0.214 **	0.218 **	0.195 *	0.255 **	0.257 **	0.162
	(0.107)	(0.107)	(0.113)	(0.113)	(0.113)	(0.127)
ln(Other Revenues/Pop.)	-0.941	-0.949	-0.699	-0.949	-0.956	-0.692
	(1.277)	(1.275)	(1.262)	(1.245)	(1.244)	(1.214)
Pop. Share 18 and younger	-17.459 *	-16.430 *	-21.351 **	-19.061 **	-18.543 **	-26.865 ***
	(9.042)	(8.965)	(8.917)	(9.321)	(9.299)	(8.861)
Pop. Share 65 and older	-2.257	-1.809	-5.059	-2.447	-2.150	-7.669
	(5.721)	(5.650)	(5.820)	(5.491)	(5.440)	(6.590)
Left-wing Mayor	-0.105	-0.106	-0.105	-0.009	-0.006	0.008
	(0.252)	(0.251)	(0.262)	(0.240)	(0.240)	(0.255)
Constant	21.854 ***	21.380 ***	20.256 ***	22.176 ***	21.959 ***	20.432 **
	(7.235)	(7.348)	(7.505)	(7.124)	(7.146)	(7.804)
R^2	0.744	0.746	0.728	0.754	0.755	0.724
Adj. R^2	0.683	0.685	0.667	0.695	0.697	0.661
Observations	115	115	115	115	115	115

Dependent variable: tax rate of the core city of an agglomeration. OLS estimation with state fixed effects. Standard errors robust to heteroskedasticity in parentheses. A single star denotes significance at the 10 percent level, two stars at the 5 percent level, and three stars at the 1 percent level. Tax rate in percent, population figures (including unemployment) in 1000 inhabitants, distance in kilometers, and debt and other revenues in Euro. Berlin, Hamburg, and Saarbrücken are missing due to collinearity (there is only one city in each of these states).

Table 6: Local Business Taxation in Agglomerations of 50 km

	Agglomerations of 50 km					
	(1)	(2)	(3)	(4)	(5)	(6)
Pop. Share of Core City	8.535 ***	9.974 ***		10.035***	11.225***	
	(1.879)	(1.932)		(1.672)	(1.820)	
ln(No. of Surround. Munic.)	-1.141 **			-0.955 **		
	(0.471)			(0.435)		
ln(Pop. per Surround. Mun.)		1.146 **			0.967 **	
		(0.473)			(0.438)	
Herfindahl Index			7.905 ***			7.750 **
			(2.428)			(3.153)
ln(Pop. Agglomeration)	1.380 ***	0.246	0.582 *	1.235 ***	0.280	0.485
	(0.328)	(0.484)	(0.350)	(0.285)	(0.404)	(0.355)
ln(Distance to next City)	-0.136	-0.134	-0.100	-0.124	-0.123	-0.027
	(0.237)	(0.237)	(0.250)	(0.233)	(0.234)	(0.278)
Unemployment/Pop.	-2.061	-2.253	23.621			
	(13.353)	(13.353)	(15.023)			
ln(Public Debt/Pop.)	0.292 **	0.292 **	0.150			
	(0.118)	(0.118)	(0.099)			
ln(Other Revenues/Pop.)	-0.626	-0.635	0.820			
	(1.163)	(1.162)	(1.210)			
Pop. Share 18 and younger	-22.363 **	-22.230 **	-35.517***			
	(9.111)	(9.101)	(9.061)			
Pop. Share 65 and older	-5.038	-4.885	-16.170 **			
	(5.088)	(5.079)	(6.186)			
Left-wing Mayor	0.007	0.008	-0.018			
	(0.237)	(0.237)	(0.264)			
Constant	23.001 ***	22.933 ***	17.685 **	16.152***	16.121***	16.520***
	(6.804)	(6.799)	(7.990)	(3.172)	(3.158)	(3.343)
R^2	0.768	0.768	0.711	0.728	0.729	0.615
Adj. R^2	0.712	0.712	0.646	0.684	0.684	0.557
Observations	115	115	115	115	115	115

Dependent variable: tax rate of the core city of an agglomeration. OLS estimation with state fixed effects. Standard errors robust to heteroskedasticity in parentheses. A single star denotes significance at the 10 percent level, two stars at the 5 percent level, and three stars at the 1 percent level. Tax rate in percent, population figures (including unemployment) in 1000 inhabitants, distance in kilometers, and debt and other revenues in Euro. Berlin, Hamburg, and Saarbrücken are missing due to collinearity (there is only one city in each of these states).

Table 7: Local Business Taxation in Agglomerations with Parameter of 10 percent and 1 percent

	Agglom. with Parameter of 10%			Agglom. with Parameter of 1%		
	(1)	(2)	(3)	(4)	(5)	(6)
Pop. Share of Core City	2.787 **	4.635 ***		2.983 **	4.975 ***	
	(1.340)	(1.145)		(1.139)	(1.061)	
ln(No. of Surround. Munic.)	-0.828 ***			-0.883 ***		
	(0.282)			(0.271)		
ln(Pop. per Surround. Mun.)		0.922 ***			0.948 ***	
		(0.279)			(0.276)	
Herfindahl Index			4.623 ***			4.820 ***
			(1.204)			(1.054)
ln(Pop. Agglomeration)	1.753 ***	0.920 ***	1.107 ***	1.815 ***	0.956 ***	0.913 ***
	(0.306)	(0.269)	(0.237)	(0.329)	(0.202)	(0.194)
ln(Distance to next City)	0.175	0.178	0.090	0.235	0.231	0.076
	(0.194)	(0.191)	(0.209)	(0.224)	(0.222)	(0.217)
Unemployment/Pop.	-4.879	-5.902	-3.817	-5.521	-5.229	-7.218
	(14.051)	(13.908)	(15.236)	(13.898)	(13.670)	(15.420)
ln(Public Debt/Pop.)	0.154 *	0.161 *	0.125	0.173 *	0.184 *	0.116
	(0.093)	(0.090)	(0.107)	(0.097)	(0.096)	(0.104)
ln(Other Revenues/Pop.)	-1.736	-1.968	-0.713	-0.880	-0.879	-0.426
	(1.282)	(1.292)	(1.219)	(1.153)	(1.153)	(1.178)
Pop. Share 18 and younger	-21.471 **	-21.570 **	-21.415 **	-25.333 ***	-24.629 ***	-25.853 ***
	(8.722)	(8.676)	(9.524)	(8.549)	(8.475)	(9.295)
Pop. Share 65 and older	-7.598	-7.100	-6.055	-5.599	-4.165	-9.470 *
	(6.002)	(5.890)	(5.835)	(4.921)	(4.882)	(5.529)
Left-wing Mayor	-0.103	-0.105	-0.039	-0.144	-0.106	-0.028
	(0.263)	(0.262)	(0.271)	(0.251)	(0.247)	(0.258)
Constant	26.498 ***	27.450 ***	20.564 **	21.426 ***	20.372 ***	21.893 ***
	(7.842)	(7.948)	(7.956)	(7.562)	(7.494)	(8.201)
R^2	0.759	0.763	0.733	0.757	0.761	0.723
Adj. R^2	0.698	0.703	0.668	0.697	0.702	0.659
Observations	109	109	109	113	113	113

Dependent variable: tax rate of the core city of an agglomeration. OLS estimation with state fixed effects. Standard errors robust to heteroskedasticity in parentheses. A single star denotes significance at the 10 percent level, two stars at the 5 percent level, and three stars at the 1 percent level. Tax rate in percent, population figures (including unemployment) in 1000 inhabitants, distance in kilometers, and debt and other revenues in Euro. Berlin, Hamburg, and Saarbrücken are missing due to collinearity (there is only one city in each of these states).

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