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Race to the debt trap?

Spatial econometric evidence on debt in German municipalities

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Spatial econometric evidence on debt in German municipalities

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Abstract: Through an intertemporal budget constraint, jurisdictions may gain advantages in tax and spending competition by 'competing' on debt. While the existing spatial econometric literature focuses on tax and spending competition, very little is known about spatial interaction via public debt. This paper estimates the spatial interdependence of public debt among German municipalities using a panel on municipalities in the two largest German states from 1999 to 2006. We find significant and robust interaction effects between debt of neighboring municipalities, which we compare to spatial tax and spending interactions. The results indicate that a municipality increases its per capita debt by 16-33 Euro as a reaction to an increase of 100 Euro in neighboring municipalities.

Keywords:	public debt, tax and spending competition, municipality data, spatial interactions, spatial panel estimation,
JEL classification:	C23, H63, H74, R12

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1 Introduction

Large and growing public debt in many countries, such as the US, Japan and Eurozone members, is alarming policymakers and citizens. Similarly, ever-increasing sovereign debt at sub-national levels like US states or German federal states as well as at the municipality level is gaining attention. The on-going debt crisis has also spurred an academic debate focusing on the macro-economic and political economic mechanisms that drive sovereign debt. The insolvency of Detroit in 2013 put municipality debt into the spotlight.

This paper investigates spatial interdependencies between debts of local jurisdictions. While the existing spatial econometric literature focuses on tax and spending competition (see section 2), surprisingly, very little is known about spatial interaction via public debt. Does debt spread from one local jurisdiction to the other?

The theoretical conjecture for positive debt interactions between jurisdictions is the following. Political units that simultaneously compete on taxes and spending can find it worthwhile to finance current expenditures through debt instead of taxes. In the short run, increasing the level of debt allows a jurisdiction to gain an advantage over others in the competition on today's taxes and expenditures. Our argument is thus linked to the theoretical work by Jensen and Toma (1991), who show that the level of taxation does not necessarily determine public good provision when debt issuing is allowed. Their model, therefore, highlights the interrelation between spatial tax and spending competition and spatial dependencies in public debt.

Earlier research concludes that spatial tax and spending competition should not be analyzed in isolation (see Allers and Elhorst (2011) and the detailed discussion in section 2). Similar to their argument, we now emphasize that debt is an additional dimension that needs to be considered in order to understand spatial competition if jurisdictions have the discretion to shift the costs of expenditures into the future. As argued by Allers and Elhorst (2011), the understanding of competition is necessarily incomplete if not all decision parameters are considered.

The political economics literature on debt recognizes multiple mechanisms that amend the above argument. First, the decision on taxes, expenditures and debts are typically in the hands of politicians. Inherent in the democratic process, the political decision makers consider a shorter time horizon than the local constituency does, thus, favoring taxes tomorrow, i.e. debt, over taxes today. Second, a large literature on political business cycles illustrates that governments favor high spending and low taxes particularly in times of elections, which all else equal must lead to higher debt (see Nordhaus (1975), Blais and Nadeau (1992), Veiga and Veiga (2007), Foremny and Riedel (2012)).[1] Third, a literature on the strategic use of debt illustrates that political considerations lead to debt issuing instead of current taxation. Partisan politicians may incur debt instead of levying taxes not only to gain an advantage in tax competition but also to limit the opportunities of later governments (see Alesina and Tabellini (1990), Fiva and Natvik (2011)).[2]

Finally, also the particular institutional setting in Germany incentivizes municipalities to favor debt over current taxation. While municipalities have constitutionally guaranteed rights to manage their own affairs, they face little to no actual risk of insolvency. Municipalities (and investors) ultimately expect complete bail out by state governments in case of fiscal distress, such that German municipalities might see all the more benefits to strengthen their position in the tax and spending competition by going into debt.[3]

In our empirical analysis, we investigate spatial interactions in debts between German municipalities. We focus on municipalities in the two largest states, Bavaria and North Rhine-Westphalia (NRW), mainly during the 1999-2006 time period. Studying the German case is of particular interest as the German municipalities are allowed to incur debts. The fact that all municipalities (within a state) operate within a common institutional framework facilitates the identification of spatial interaction effects isolated from confounding factors, which are often of concern in cross-country studies.

In our main specification, we use a spatial Durbin model in a panel framework (Elhorst (2012)). Using this model, we present estimates for spatial interactions in debt and also

[1]Note that the above arguments raise the question why politicians get away with ever-increasing debt. Voters must ultimately realize that the debt needs to be repaid. Existing literature, however, illustrates that voters are indeed myopic. For German municipalities, Freier (2011) shows that mayors face higher chances of reelection if they increase expenditures above average levels. However, voters fail to punish local mayors as public debt is also increased above the average.

[2]Another model of strategic debt is developed by Persson and Svensson (1989). Their mechanism builds on the idea that right and left governments typically differ in the amount of desired spending. Low reelection chances increase the incentives of a conservative government to borrow in order to restrict left governments in the amount of taxation (and spending) in later periods. Empirically, Pettersson-Lidbom (2001) confirms that the strategic rationale for debt is indeed of importance in Swedish municipalities.

[3]Limitations to and consequences of municipality debt institutionalized especially in North Rhine-Westphalia are discussed in section 3.

show the effects when we use taxes and spending as outcome variables. To assess the robustness of the results, among other tests, we alternate the spatial weighting matrix, we report results for specification tests and we show that 'competition' on debt does not work via subcategories of debt where municipalities have little discretion.

Our results show significant positive interaction effects between neighboring municipalities. We find interaction coefficients for debt in the order of 0.16-0.33, meaning that an increase in the debt level of the neighboring municipalities by 100 Euro (per capita) increases debt in a municipality by 16 Euro in NRW and by 33 Euro in Bavaria (per capita). The results are significant in both states under consideration and are robust to various specifications of the spatial model. We explore various standard as well as two non-standard spatial weighting matrices, the first considering the grouping of municipalities into counties, and the second one implementing a theoretical suggestion by Janeba and Osterloh (2013). We also consider dynamic spatial lag models. Our estimates of spatial debt interaction lie in between estimates for tax and spending interaction. The results indeed indicate that local government debt interaction must be regarded as an important dimension of local spatial interaction in addition to tax and spending competition between municipalities.

The remaining analysis is structured as follows: In section 2, we discuss the relevant literature on tax and spending competition. Section 3 delineates the institutional setting in German municipalities and introduces our data. The empirical model and estimation strategy is then described in section 4 before we present and discuss our findings in section 5. The analysis is concluded in section 6.

2 Literature on fiscal competition

The theoretical literature explains horizontal fiscal interaction between local governments by three different approaches: tax or spending competition for a mobile tax base (Wildasin (1988)), yardstick competition (Salmon (1987)), or spillover effects of public goods (Case, Rosen, and Hines (1993)). These theories explain spatial interaction between spending or tax setting behavior of municipalities and can be extended to debt interaction, as we argue in the following.

In the tax competition model by Wildasin (1988), municipalities compete via a tax rate for a mobile capital base. They use the tax revenues to provide a public good. However, each municipality has an incentive to lower the tax rate incrementally to attract more capital and thus a higher tax base. Other jurisdictions will react and lower their tax rates as well. The result is a race to the bottom, where municipalities have inefficiently low tax rates, which results in an underprovision of public goods. A rich empirical literature documents the relevance of significant tax interaction (see, e.g. Ladd (1992), Büttner (2001), Bordignon, Cerniglia, and Revelli (2003), Gerard, Jayet, and Paty (2010), and Cassette, Porto, and Foremny (2012); for overviews see Brueckner (2003) and Allers and Elhorst (2005)).

The tax competition approach can also be extended to spending when municipalities compete for a tax base via expenditures that benefit private capital (see Keen and Marchand (1997)) or expenditures that attract qualified workers (see Borck, Caliendo, and Steiner (2007)). Competition in expenditures will typically result in an overprovision of certain public goods (the good that is financed with those expenditures). Note that, to the extent that the competition is targeted only to a specific group (capital owners, qualified workers), public goods that are not of interest to this group may again be provided to an inefficiently low level. Similar to tax competition, the interaction between expenditures of neighboring jurisdictions is also demonstrated empirically (see, e.g. Case, Rosen, and Hines (1993), Sole-Olle (2006), and Borck, Caliendo, and Steiner (2007); for an overview see Allers and Elhorst (2011)).

As mentioned above, the interplay between expenditure and tax competition is emphasized by Allers and Elhorst (2011). They start from the observation that both taxes and spending are ultimately linked by the same budget constraint. Considering only one of these variables in the analysis ignores the common budget constraint. Using data from municipalities in the Netherlands, they solve this problem by estimating a spatial seemingly unrelated regression model, where the property tax rate and the amount of net spending are dependent variables.[4] Note that the institutional setting in the Netherlands is such that municipalities must reach a balanced budget (and, thus, there are no intertemporal incentives for borrowing).

While Allers and Elhorst (2011) focus on taxes and spending, Jensen and Toma (1991) model tax competition when jurisdiction are free to issue debt. They show in a two-period tax competition framework with two jurisdictions that governments can have an

[4] Allers and Elhorst (2011) develop a SURE estimator for cross-sectional data. We argue that debt is best studied in a model that uses panel data.

incentive to issue debt in the first period in the presence of tax competition. In their model the direct link between the tax rate and the provision of public goods vanishes when municipalities are allowed to incur debt. To curb the effects of underprovision of public goods in a tax competition environment, jurisdictions issue public debt in the first period of the model if taxes in the jurisdictions are strategic complements. Because the model requires those debts to be repaid, the underprovision is then more severe in period 2. From Jensen and Toma (1991), we can infer that tax interactions among municipalities also lead to interdependencies in debt.[5] Given the main argument in the model, a similar theoretical argument can be used to link competition on expenditures and debt.[6]

A second argument for the existence of spatial interactions in fiscal policy is due to yardstick competition. Here, politicians are politically sensitive to neighboring changes in fiscal policy. Citizens use some observable characteristics, typically taxes or spending, to judge the performance of their politicians. In anticipation, politicians who underperform in comparison to their neighbors try to mimic these observable characteristics (Salmon (1987)). The characteristics relevant for yardstick competition are likely to include public debt, although this surprisingly has not received attention in the literature.

The third motivation for government interaction emphasizes direct spillover effects of fiscal measures. Benefits of one local government's expenditures may spill over into neighboring municipalities, for example when roads or theaters built in one municipality are used by residents of neighboring towns. Moreover, local jurisdictions may exhibit similar fiscal parameters simply for the reason of a common practice. Decision makers for fiscal policy gain information on desirable levels of taxes or expenditures by observing the activity in neighboring jurisdictions (for expenditure spillovers, see Case, Rosen, and Hines (1993)); the same may apply to debt and lead to similar developments of debt in

[5]More specifically, Jensen and Toma (1991) show that in their two-period model tax competition will result in lower taxes and more competition in the first period. As all debt has to be repaid, the model also predicts higher taxes and less intense competition in the second period. We presume that our empirical setting is related more closely to the first period effects as debt levels are increasing consistently throughout our period of observation.

[6]Schultz and Sjöström (2001) present a different model of local debt, again with two periods and two districts. Local districts accumulate debt in the first period to finance a durable public good, because the debt financing ensures that immigrants arriving in the second period share their part of the burden instead of free riding. Conditional on the level of public goods, an inefficiently high level of debt is accumulated because of externalities on the other district due to migration. In a similar model by Schultz and Sjöström (2004), the median voters in each district prefer shortsighted local politicians who accumulate high debt levels, again due to the migration externality.

neighboring municipalities.

3 Institutional setting, data and descriptives

This section discusses the institutional setting in which German municipalities operate. Moreover, we introduce the data that we use in the empirical analysis and feature descriptive statistics.

3.1 Institutional setting

The municipality level is the lowest and most disaggregated level of the public institutions in Germany.[7] The main areas of local public good provision involve general administration, public order, infrastructure, cultural institutions and public transport. Together with the other government tiers, municipalities also administrate expenditures for child care, schooling and social security. Furthermore, the local level often supervises and administrates basic services such as water and energy supply or waste disposal. To finance those services, municipalities receive income from three own local taxes (two types of property taxes and a tax on local businesses) along with allocated tax revenue from local income taxes and the VAT as well as state-allocated grants. Overall, municipalities have considerable (constitutionally guaranteed) discretion in their budgeting. All decisions on the finances of a municipality are in the hands of an elected mayor and the elected local town council.[8]

Importantly for our analysis, municipalities in Germany have the right to incur debts. Municipal debt makes up about six percent of the overall public debt in Germany

[7]Besides the federal level, there are 16 federal states, about 450 counties and a total of about 12,500 municipalities. Following the Nomenclature of Territorial Units for Statistics (NUTS) developed by the European Union, all German LAU-1 and LAU-2 regions are labeled as municipalities. In addition, we include the independent cities which are NUTS3 regions, but have the same administrative tasks as municipalities.

[8]In NRW and Bavaria, voters elect mayors through majoritarian elections and councils through proportional elections. In both states, the local elections for mayor and council are held on a state-wide election date every 5 years in NRW and every 6 years in Bavaria. In our period, elections were held in 1999 and 2004 in NRW and in 2002 in Bavaria. Note that, the responsibilities of the mayors include the operative management of the administration as well as preparation of all decisions that are to be made in the council. Also, the mayor has active voting rights in the council and often heads the different spending committees of the council. Ultimately, the legislative body that makes the final decisions on all municipal affairs is the town council.

throughout our observation period. The prime lenders to German municipalities are German savings and loan associations (*Sparkassen*), German private banks as well as state run public banks (Freier and Grass (2013)). While municipalities are generally free to incur debt, the federal state authorities have extensive formal oversight rights on local borrowing. Regulations differ between the 16 federal states of Germany. In the two federal states we analyze, Bavaria and North Rhine Westphalia (NRW), municipalities must seek approval when they intend to borrow for larger infrastructure investments (such debt is part of our core debt data). Municipalities can also incur short-term debt for current expenditures (*Kassenverstärkungskredite*), which does not require formal approval of the state government in either of the two states under study during our observation period. Municipalities that, left alone, would suffer from insolvency, loose active steering rights in their municipal finances, resulting in state regulators taking over local decision making. The actual procedure is organized in different steps ranging from more oversight when the financial situation becomes critical to complete take-over when insolvency would be reached. Specifically, in 1991, the state of NRW implemented a concept in its municipal code that mandates municipalities in financial distress to present a budget consolidation plan (*Haushaltssicherungskonzept*) to the regulating authority. The plan is approved if it shows how a balanced budget can be reached within three years.[9]

The current institutional setting in Germany implicitly guarantees that the federal states stand in for public debt incurred by their municipalities. Investors are guaranteed full compensation with states bailing out local authorities. As a result, we do not see interest rate spreads as a function of the economic conditions of a municipality (see Ade (2011)). Given this institutional design, incentives to incur debt to gain an advantage in tax and spending competition are increased.

The two states in our analysis are NRW and Bavaria. There are multiple reasons why we focus on those states in particular. First, they represent two of the biggest states both

[9]In 2011 this time frame was extended to ten years. If the budget consolidation plan is not approved, the municipality is in the state of an emergency budget (Art. 82 Municipality Code NRW). In this case, only expenditures are permitted that are mandated by law or that continue necessary tasks and cannot be postponed. Conversion of debt is permitted, but credit necessary to continue investments already begun must be approved by the regulating authority. Tax rates of local taxes must stay at the last year's level. If the municipality keeps on failing to present an approvable consolidation plan, the regulating authority can limit the municipality's administrative autonomy and order saving measures or even impose them. In 2011, after our period of analysis, the state of NRW started a large active program to limit municipal debt (*NRW Stärkungspakt*).

in terms of population as well as size.[10] Together, about 37% of Germany's population resides in one of these two states. Data on municipal finances can be obtained for both states and can also be linked to relevant background information. Generally, the specific tasks and responsibilities of the municipal level in Germany differ by state, which makes state comparisons complicated. The two states in our sample, however, each put a relatively large share of the overall responsibilities in a state at the discretion of their municipalities.[11]

While our two states are similar in importance and the institution setup, there are also interesting differences. Municipalities in NRW are generally large, relatively urban and industrial. Moreover, the level of debt is comparatively high. In Bavaria, the structure is different in that there are many small to medium-sized towns, which are often rather rural and agricultural. Moreover, the overall level of debt is much lower in Bavaria than in NRW.[12]

3.2 Data and descriptive statistics

We use data from a complete panel of municipalities in the German federal states of North Rhine-Westphalia and Bavaria from 1999 until 2006.[13] In Bavaria, we observe data for all 2,056 municipalities, and in NRW, for all 396 municipalities, in each cross-section. For both states and all years, we combine the official statistics on the municipal level on fiscal variables (debt, taxes and expenditures), population data (number of inhabitants,

[10]In 2013, NRW had a population of 17.85 million inhabitants on an area of about 34,000 km^2 and is the largest German state in terms of population. Bavaria had a population of 12.67 million people (2nd largest state) and a size of about 70,500 km^2 making it the largest state in terms of area.

[11]In 2005, 50.7 percent of all state and municipal expenditures in NRW were under the control of the municipalities. The share in Bavaria was almost as high, at 47.1 %, as well. While few other states have similarly high numbers (e.g. Hesse and Baden-Württemberg), other states have a considerably lower level of local activity (East German states reach on average 44.2 %, Saarland has the lowest numbers with only 36.5 %.), see Böttcher, Junkernheinrich, and Micosatt (2010), p. 107. Importantly, states such as Rhineland-Palatinate and Lower Saxony would be even more complicated to compare, because local activity there involves an additional tier of government (*Amt*) between municipalities and counties. Moreover, states in the East can often not be compared over time as the municipal structures have seen important changes in administrative reforms.

[12]In fact, in 2009 NRW was one of the three (out of thirteen) territorial states with the largest per capita municipal debt levels in Germany, along with Rhineland-Palatinate and the Saarland, and Bavaria was one of the five states with the smallest, see Freier and Grass (2013).

[13]In various specifications in the robustness section, we additionally employ the year 1998 to provide lagged variables or to extend the observation period.

structure of the population, information on unemployment) and regional data on local GDP (on the county level). The data are provided by the Research Data Centers of the Federal and State Statistical Offices.

Descriptive statistics for all variables used in the analysis (pooled for all years and by state) are found in Table A.1 in Appendix A. Notably, NRW has much larger municipalities in terms of population, higher average per capita debt and higher unemployment rates than Bavaria. Per capita net spending (the sum of all expenditures net of obligations due to the fiscal equalization system) is somewhat higher in NRW than in Bavaria in terms of mean and median. Looking at particular spending categories, municipalities in NRW exhibit larger current operating and personnel expenditures and much higher levels of welfare spending.[14] The age structures of the population in both federal states, as indicated by the shares of persons below 15 and above 65 years of age, are similar. Net migration is defined as population inflow minus outflow, normalized by the number of inhabitants, and is a bit larger on average in Bavaria. We further collected the real growth rate in GDP at the county level (total value added, in domestic prices, deflated by the federal state consumer price index).[15]

As our main outcome variable in the empirical model, we use the per capita debt of a municipality. The data allow for a distinction between accumulated per capita debt of the core budget (*Kernhaushalt*), short term debt (*Kassenverstärkungskredite*) and debt of a municipality's public companies. In our basic models we use the sum of the core budget and the short term debt, because these are under direct control of the municipality. In further estimations, we will also analyze all three types of debt separately. As additional descriptive information, we collected data about the maturity and the lender structure of the core budget debt. Concerning the maturity of debt, both federal states show a similar structure. Regarding the structure of the lenders, Bavarian municipalities do not use loans from state public banks (*Landesbanken*) as extensively as municipalities in NRW.

[14]Bavaria includes some strong spending outliers. Most outliers with high values of per capita net spending are attributed to the municipality of Unterföhring. This municipality, which is located just outside Munich, is indeed special in that it is an exceptionally attractive business location. Among the many firms residing in that municipality are public and private media companies as well as big insurance companies such as Allianz and Swiss Re.

[15]Unfortunately, data on local GDP is not available on the level of each individual municipality. Instead, we use county level growth rates for all municipalities from a county. Note that for large urban municipalities (*kreisfreie Städte*) the municipal and the county level coincide, thus, they have individual GDP growth rates.

In addition to public debt, we examine per capita net spending and rates of the local independent taxes as dependent variables. With regard to taxes, we explore the property tax rates A and B[16] as well as the local business tax rate. All aforementioned taxes have in common that municipalities choose multipliers (labeled tax rates in Table A.1) that are applied to a uniform basic tax.[17] Since 2004 the tax rate multiplier for the local business tax must range between 200 and 800.[18]

The spatial distribution of per capita debt is depicted in Figure B.1 for NRW and Figure B.2 for Bavaria in Appendix B. We compare maps for 1999 and 2006 for each state. The maps highlight some patterns of clustering, which shift slightly over time. Moreover, we plot annual means of per capita public debt and net spending as well as the tax rate multipliers for the local business tax and the property tax B in Figures B.3 for NRW and B.4 for Bavaria in Appendix B. We observe that the per capita debt in NRW is steadily increasing whereas the increase is only moderate in Bavaria. The per capita net spendings are comparably more cyclical; however, they also show an increasing trend. In comparison the patterns for the local business tax and the property tax B are rather stable.[19]

4 Empirical model and strategy

The goal of this paper is to estimate the extent of spatial dependency of debt between German municipalities. To this end, we need to incorporate debt in a spatial panel framework. As a starting point, the simplest specification of this approach incorporates the neighboring debt into a regression framework (Spatial Lag Model - SLM):

[16]Property tax A is used for agricultural and property tax B for all other real estate. The tax bases shown in Table A.1 indicate that the property tax B is relatively more important.

[17]The effective local business tax rate in 2009 is calculated as 0.035 * multiplier, for example; see Bach and Fossen (2008) for details.

[18]No municipalities in NRW or Bavaria were directly affected by this restriction, as indicated by the minimum and maximum values of the local business tax multiplier in the period 1999-2006.

[19]The jumps in the tax rates in NRW in 2003 are likely to be related to an increase in the standardized tax multipliers (*fiktive Hebesätze*) in that year, which are set by the state government and are used in the local fiscal equalization scheme (see Baskaran (2013), for details). As the adjustment of these standardized tax multipliers is the same for all municipalities in NRW, this is accounted for in our estimations by the time fixed effects.

$$y_{it} = \lambda \sum_{j=1}^{n} w_{ij} y_{jt} + x_{it}\beta + \mu_i + \zeta_t + \epsilon_{it}, \tag{1}$$

where y_{it} denotes per capita debt of municipality i at time t ($i = 1, \ldots, N$; $t = 1999, 2000, \ldots, 2006$). According to our argumentation, municipalities will be affected by the debt of a predefined set of neighbors. This is described by the term $\sum w_{ij} y_{jt}$, where w_{ij} is the i,jth element of a nonnegative $N \times N$ weighting matrix, W, which assigns neighboring municipalities. By assumption, a municipality cannot be a neighbor with itself and therefore the main diagonal of W equals zero. The response to neighboring municipalities is captured in the estimation parameter λ. The term x_{it} is a $1 \times K$ vector of socio-demographic variables from municipality i at time t (in further specifications, we will additionally include structural characteristics) and β is a related $K \times 1$ vector of estimation parameters. Furthermore, ϵ_{it} represents a normal, independent and identically distributed error term.[20] μ_i and ζ_t label municipality and time fixed effects (FE), respectively.

The inclusion of spatially lagged independent variables leads to the Spatial Durbin Model (SDM):

$$y_{it} = \lambda \sum_{j=1}^{n} w_{ij} y_{jt} + x_{it}\beta + \sum_{j=i}^{n} w_{ij} x_{jt}\theta + \mu_i + \zeta_t + \epsilon_{it} \tag{2}$$

where $w_{ij} x_{jt}$ represents the characteristics of neighboring municipalities and θ denotes the corresponding $K \times 1$ vector of their respective parameters.

In order to find the most adequate spatial specification, we conduct various LM and LR tests along the lines of Elhorst (2012). The test results guide us to choose the SDM over the SLM.[21]

[20] One might argue that the assumption of normal distributed error terms for Maximum Likelihood is strong and that estimates in practice may therefore be inconsistent. However, Lee (2004) shows that without the assumption of the normal distribution of the residuals, the resulting Quasi-Maximum Likelihood estimator is asymptotically consistent. These results apply here because our sample is sufficiently large.

[21] The test statistics can be reviewed in Table A.2 in the Appendix. We also tested the Spatial Durbin Model against the Spatial Error Model (SEM) in which the spatial dependency is modeled through the residuals. Our test results speak in favor of the SDM here, too. Also note that the

The panel structure of the data allow us to exclude time and municipality fixed effects by a double de-meaning procedure. Thus, we identify our models from changes in the per capita debt variable within a municipality over time. As the current local government takes the level of debt from last year as given, we interpret changes in debt as the actual decision parameters for municipal politicians.

The estimations of eq. (2) are conducted in Matlab by using routines provided by Elhorst (2012).[22] These routines estimate the model via (Quasi) Maximum Likelihood and allow us to apply the bias correction that has been proposed by Lee and Yu (2010a).[23]

To find the spatial weighting matrix W that fits the data best, we subsequently estimate the baseline SDM in (2) using various matrices suggested by the literature: binary contiguity matrices of first and second order, row normalized matrices where all municipalities within a certain radius around the municipality centroid are assigned as neighbors, and Inverse Distance Matrices with different cut-off radii with row and eigenvalue normalization. Following Elhorst (2010), we compare the log likelihood values of the models using the different weighting matrices. For both federal states, the models employing Inverse Distance Matrices with row normalization perform best among the aforementioned matrices. In NRW, the Inverse Distance Matrix with a cut-off after 15km results in the highest log likelihood value, and for Bavaria, the best cut-off radius is 20km (see Table A.3 in Appendix A).[24] Therefore, in our main specifications we will use these weighting matrices to incorporate geographical interaction. Row normalizing an Inverse Distance Matrix implies that the distance loses its cardinal interpretation. While the exact distance is relevant in the context of transportation costs, for example, in our context of fiscal interaction between municipalities it is the relative distance to neighboring munici-

SDM is a generalization of the SEM and it therefore produces correct standard errors of the coefficient estimates even when the true model has spatial autocorrelation (see Elhorst (2010), p. 14).

[22]http://www.regroningen.nl/elhorst/software.shtml.

[23]Lee and Yu (2010a) show that due to the incidental parameter problem, the estimation of a model that includes both a spatial lag and spatial residuals may be inconsistent. They derive a bias correction that allows for consistent estimation. Elhorst (2012) adopts their approach and translates their bias correction to the SAR, SER and SDM models. Due to our relatively large sample size of 396 and 2,056 observations in the cross section, we expect the bias correction to mainly affect the standard errors but not the parameter estimates (see equation (8) in Elhorst (2012)).

[24]We could not use a cut-off after 10km, since some large municipalities in NRW would have no neighbors in this case. As a cut-off after 14km leads to a smaller log likelihood, the cut-off after 15km seems to be at least a local maximum.

palities in comparison to other neighbors that is decisive, a feature well captured by row normalization.[25] In the robustness section, we will further highlight that our estimates are robust with respect to alternative weighting matrices. We will also present results for non-standard geographical weighting matrices.

As the dependent variable, we use the sum of the core budget and short term debt, as previously noted. The choice of independent variables in our benchmark specification follows the tax and spending interaction literature. We include the population size and its square plus the population structure, i.e. the shares of persons below 15 years and above 65 years of age, as indicators of the work force available in the municipality and the dependency rate. In addition, the number of unemployed persons per 100 inhabitants is included, capturing the impact of economic shocks on municipalities. In the SDM all these explanatory variables enter in levels as well as spatial lags.

In an extended model, we employ additional control variables. First, we include per capita expenditures on personnel and current operating expenditures. Municipalities have limited control over these expenditure categories, at least in the short run. Including these controls in the regression helps to identify the amount of spatial debt interaction due to deliberate decisions of local governments. Similar considerations lead to the inclusion of spending on social needs in the model. This control might be important because a reform of unemployment insurance and social assistance in Germany in 2004 (*Hartz IV reform*) shifted the costs of social assistance to the local level, which affected municipalities differently depending on the number of inhabitants eligible for benefits. We consider social spending exogenous at the municipal level because municipalities have to follow regulations set at the federal level and have very little discretion over these kinds of expenditures. Moreover, we add measures of the municipality's revenues as controls, i.e. the first time lag of the tax bases (*Grundbetrag*) both from the local business tax and the two local property taxes. We also control for county GDP growth because the ability to issue debt might be influenced by regional business cycle effects (on top of country-wide year effects that we capture with time fixed effects). Finally, we include per capita net migration because this exerts a mechanical effect on our per capita debt measures.

[25] Consider an example where municipality A has two neighbors at distances of 2km and 4km and municipality B has three neighbors at distances of 2, 4 and 6 km. By normalizing the row sums to one, the neighbor at 2km distance has a stronger influence on municipality A than on B, which is what one would expect given the influence of the third neighbor on B.

5 Results

In this section, we first present our main results for the spatial interaction in public debt. Then, we compare the findings to estimation results for taxation and expenditure interaction in the same data. In the third subsection, we compare the spatial interaction in different types of debt, before providing a number of robustness checks, including dynamic spatial lag models, in the final two subsections.

5.1 Main results

Concerning the basic specification of our model, we refer to Table 1. Column (1) presents the basic model as outlined in equation (2) for NRW and column (3) the same model for Bavaria. Throughout this section, we will refer to these results as our benchmark. We observe significant interaction effects λ of 0.163 for NRW and 0.327 for Bavaria respectively. I.e., if the neighbors increase their debt by 100 Euro per capita, a municipality will increase its own debt by 16.3 Euro per capita in NRW or 32.7 Euro in Bavaria, respectively. The estimated model in both federal states explains about 90 percent of the variation ($R^2 \approx 0.9$), which is largely due to the municipality and time fixed effects, as indicated by the large difference between R^2 and $corr\left(Y, \hat{Y}\right)^2$. Another important result is that most of the spatially lagged independent variables are significant as well. This justifies the use of the Spatial Durbin Model.[26]

Our estimates for λ are robust to the inclusion of additional control variables. We include operating and personnel expenditures, welfare spending, the local tax bases, as well as county-level GDP growth and net migration flow (see columns (2) and (4) of Table 1 for NRW and Bavaria, respectively). LR-tests (reported in the bottom of Table 1) indicate that these additional controls and their spatial lags are jointly significant.

As outlined in section 3.1, the results for NRW and Bavaria allow for an interesting comparison. Despite the relatively large differences in municipal size, the economic structure

[26] In addition, we show that the application of the SDM largely removes the spatial autocorrelation among the residuals. To test this, we extract the SDM residuals and calculate Moran's I statistic for each of the eight cross sections in the two federal states. The spatial autocorrelation among the residuals of the SDM is found to be close to zero: The Moran's I statistics range from -0.07 to 0.04 in NRW and from -0.018 to 0.008 in Bavaria, and they are statistically different from zero at the 10% level in only four out of the 16 estimations. Full results are available from the authors on request.

Table 1: Spatial interactions of municipality debts 1999 - 2006

	North Rhine Westphalia		Bavaria	
	(1) Basic Model	(2) Full Model	(3) Basic Model	(4) Full Model
λ	0.163***	0.157***	0.327***	0.329***
	(0.028)	(0.028)	(0.022)	(0.022)
Population_t	-0.080***	-0.079***	0.028**	0.037***
	(0.009)	(0.009)	(0.012)	(0.014)
$\text{Population}_t^2/100,000$	0.030***	0.032***	-0.007	-0.009*
	(0.007)	(0.007)	(0.005)	(0.005)
Share young people_t	46.653***	41.544**	9.011***	10.261***
	(16.567)	(16.821)	(3.357)	(3.331)
Share old people_t	-24.860**	-26.501**	25.114***	23.191***
	(10.587)	(10.743)	(2.662)	(2.657)
Unemployed per inh._t	29.085*	30.752*	7.348	6.261
	(15.712)	(15.696)	(6.229)	(6.207)
PC personnel expend._t		0.603***		0.416***
		(0.202)		(0.053)
PC operating expend._t		-0.052		0.546***
		(0.099)		(0.046)
PC welfare spending_t		0.249**		-0.016
		(0.113)		(0.054)
Local business tax base_{t-1}		-0.006***		-0.010***
		(0.002)		(0.002)
Property tax base A_{t-1}		-0.164		0.370
		(-0.516)		(1.482)
Property tax base B_{t-1}		-0.003		-0.030
		(0.022)		(0.073)
County GDP growth_t		-5.774*		0.393
		(2.969)		(1.077)
Net mig. flow per 1,000 inh._t		1.021		-0.222
		(0.772)		(0.177)
W × Population_t	-0.038**	-0.024	-0.340***	-0.326***
	(0.017)	(0.018)	(0.038)	(0.047)
W × Population_t^2	-0.037*	-0.046**	0.130***	0.118***
	(0.021)	(0.021)	(0.020)	(0.023)
W × Share young_t	55.309*	36.245	7.140	6.916
	(30.205)	(31.725)	(11.902)	(12.017)
W × Share old_t	60.016***	52.0648***	1.818	3.788
	(17.229)	(17.659)	(6.281)	(6.387)
W × Unemployed per inh._t	15.795	20.941	25.138*	29.923**
	(24.862)	(25.027)	(13.779)	(13.791)
W × PC personnel expend._t		0.065		-0.340*
		(0.484)		(0.229)
W × PC operating expend._t		0.404		-0.133
		(0.251)		(0.204)
W × PC welfare spending_t		0.150		-0.378
		(0.244)		(0.238)
W × Business tax base_{t-1}		0.0004		0.007
		(0.005)		(0.012)
W × Property tax base A_{t-1}		-0.248		-3.756
		(0.520)		(5.333)
W × Property tax base B_{t-1}		0.027		0.100
		(0.034)		(0.416)
W × County GDP growth_t		4.959		-0.281
		(3.982)		(1.557)
W × Net mig. flow per 1,000 inh._t		1.686		1.827**
		(1.853)		(0.791)
No. of municipalites	396	396	2,056	2,056
No. of observations	3,168	3,168	16,448	16,448
R^2	0.9227	0.9236	0.8915	0.8935
$\text{Corr}^2\left(Y,\hat{Y}\right)$	0.1501	0.1606	0.0279	0.0455
Log-likelihood	-21,330.159	-21,311.004	-111,030.840	-110,878.870
LR-Test Full vs. Basic		38.31***		303.91***

Notes: The dependent variable is the sum of debt from the core budget and short term debt of a municipality, λ denotes the spatial interaction effect. All models are estimated with maximum likelihood and are bias corrected. Year and municipality fixed effects are taken into account by double demeaning. W is a row normalized Inverse Distance Matrix with a cut-off after 15(20)km for NRW (Bavaria). Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ *Source*: Own calculations.

and particularly the debt level, the results for the estimated interaction effects are positive and highly significant in both federal states. The fact that the independent results point into a similar direction for both states highlights that the evidence is not confined to only one particular sample. However, the fact that the effects are smaller in NRW may highlight that the degree of interaction is potentially limited when municipalities face constraints. In particular, the high debt level in many municipalities in NRW may restrict them in incurring additional debt in response to their neighbors' policies.

5.2 Comparison between spending, taxes and debt

This section compares the spatial interaction effects of debt, spending, and the three different tax rate multipliers. In order to keep the results comparable, we will use the same independent variables from the benchmark model and only change the dependent variable. This comparison is conducted in Table 2. Column (1) repeats the results from the benchmark specification with per capita debt as the dependent variable. Table 2 now allows for the comparison of the spatial debt interaction effect with the interaction effects of net spending amounts (column (2)), the local business tax rate multiplier (column (3)) and the two property tax rate multipliers (columns (4) and (5)).

The results show a relatively large interaction effect among the local business tax rates of 0.290 (0.472) for NRW (Bavaria). Thus, a municipality in NRW will increase its multiplier by 0.290 basis points if its neighboring municipalities increase theirs by one basis point. Similarly for the non-agricultural property tax B, we find an effect of 0.389 (0.343) for NRW (Bavaria). In comparison, the spatial interaction between net spending is rather low with an effect of 0.098 (0.156) for NRW (Bavaria): A municipality in NRW will increase its expenditure by 9.8 Euro if its neighbors increase spending by 100 Euro. All these coefficients are significant at the one percent level.[27]

This comparison is interesting for at least two reasons. First, we highlight that using the same set of municipalities, the same control variables and the identical spatial econometric approach, we can show spatial interdependence between German municipalities not only in debt, but also in taxes and spending. Second, the estimated interaction effect for debt lies in between the smaller effect for spending and the larger effect for tax rates

[27]Note that, the spatial interaction effects do not depend on the choice of units, so the effects for tax rates can be directly compared to the effects for spending and debt amounts. Accordingly, a standardization of the dependent variables (to mean 0 and standard deviation of 1) does not change the results.

in both states, which may give an indication that higher debt is indeed used to compete more fiercely in taxes, while adapting expenditures to a smaller extend. Overall, we believe that our results correspond nicely with the predictions given by Jensen and Toma (1991), where (in the first period of their model), jurisdiction interact strongly in debts to gain an advantage in the tax competition.

Table 2: Comparison of debt, spending and tax interaction

Basic model with X_{it} and WX_{it} from 1999 - 2006					
Interaction	(1) PC debt	(2) PC net spend	(3) Business tax	(4) Prop tax A	(5) Prop tax B
λ NRW	0.163***	0.098***	0.290***	0.127***	0.389***
Standard error	(0.028)	(0.029)	(0.026)	(0.029)	(0.024)
λ Bavaria	0.327***	0.156***	0.472***	0.360***	0.343***
Standard error	(0.022)	(0.025)	(0.019)	(0.021)	(0.021)

Notes: All models are estimated using the maximum likelihood method and are bias corrected. Independent variables in all specifications are: population, population^2, share of young people, share of old people and unemployed per 100 inhabitants. The averaged neighboring equivalents are included as well as independent variables. Year and municipality fixed effects are taken into account by double demeaning. W is a row normalized Inverse Distance Matrix with a cut-off point after 15 (20) km for NRW (Bavaria). Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source*: Own calculations.

5.3 Spatial interactions in different types of debt

So far, we show that spatial correlation via debt indeed exists among German municipalities. In this section, we will analyze different types of debt to explore in more detail where the interaction takes place. First, we will separate the municipality per capita debt used in the main analysis into the core budget and the short term debt and re-estimate our benchmark model using these debt components. Particularly in NRW, it is likely that municipalities interact with their debt mainly through short term debt, as those debts are less strictly regulated and remain available even when the core budget is in distress. Then, we will repeat our analysis for debt issued by local public companies and the sum of all three debt categories.

Descriptive results from dividing the per capita debt into the regular core budget and short term debt are depicted in Figure B.5 in Appendix B. The graphs demonstrate that municipalities in NRW have increasingly gone into short term debt in our observation period, whereas Bavarian municipalities use this form of debt far less extensively (note the different scales). This is also confirmed when looking at the share of municipalities using short term debt as shown in Figure B.6 in Appendix B. The share of municipalities using short term debt in Bavaria is rather stable around ten percent. In contrast, the share in NRW increases monotonically from about twenty percent in 1998 to 50 percent in 2006.

Debt of local public companies is substantive in NRW (see Table A.1), but not so in Bavaria. This category is interesting for a comparison, because local governments only have limited control over this type of debt. Since local public companies underlie regulation, often have private companies as additional stakeholders, and sometimes are joined ventures of a number of municipalities, a single municipal government is often not in a position to exercise full control over their debt policy.

Table 3: Separate debt classes 1999 - 2006

Basic model with X_{it} and WX_{it} from 1999 - 2006 an different kind of debt				
Interaction	(1) PC core budget	(2) PC short term	(3) PC public company	(4) $\sum$ (1) - (3)
λ NRW	0.021	0.346***	-0.058*	0.148***
Standard error	(0.030)	(0.025)	(0.031)	(0.028)
λ Bavaria	0.329***	0.181***	-0.032	0.333***
Standard error	(0.022)	(0.024)	(0.028)	(0.021)

Notes: All models are estimated using the maximum likelihood method and are bias corrected. The same control variables as in Table 2 are included. Year and municipality fixed effects are taken into account by double demeaning. W is a row normalized Inverse Distance Matrix with a cut-off after 15(20)km for NRW (Bavaria). Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ *Source*: Own calculations.

The results for the subcategories of debt appear in Table 3. The results considering the core budget, the short term debt and the debt of public companies as dependent variables are presented in columns (1), (2), and (3). Estimations using the sum of all three types of debt are reported in column (4). In NRW we observe that the interaction among the core budget debt is not significant, while the interaction among short term debt is larger than when the sum is considered in the benchmark model. This indicates that municipalities in NRW interact via their short term debt. This can be explained with the institutional setting and debt situation in NRW. As debt levels are generally high, and the core budget (here in particular investment spending) is under state regulation, the limits in this type of debt seem to be exhausted. Instead, municipalities seem to turn to short term debt, in which no institutional boundaries exist (in our observation period) to limit further debt issuing. The interaction close to zero for public company debt (although statistically significant at the 10 % level) shows that municipalities do not (or cannot) use this kind of debt as an instrument to finance interaction.[28]

Regarding the interaction in Bavaria, the effect does not change much when comparing the full per capita debt to the debt in the core budget. The interaction among the short term debts is smaller; as mentioned before, only about 10 % of the observations in Bavaria exhibit any positive short term debt. As in NRW, we detect a small negative spatial interaction between public company debt, which here is insignificant. Generally, we conclude that spatial interaction in Bavaria is mainly through core budget debt, which is reasonable as debt levels in Bavarian municipalities are low, and one would not expect constraints in adapting the core debt.

In both states, the estimated magnitude of debt interaction remains similar as in the benchmark estimations when we consider the sum of all three types of debt. Thus, the estimates are robust to the inclusion of public company debt. We prefer the benchmark model without public company debt because these are typically not under full control of municipal governments, as mentioned before.

As noted, the municipalities in NRW do not have as much financial leeway as their Bavarian counterparts. For a shortened panel from 2002 until 2006, we obtained data on whether an individual municipality in NRW was required to present a budget consolidation plan to the regulating state authorities because of the inability to balance the budget (see section 3.1). 28.24% of the observations in NRW fall under this financial supervision status at least once in this period. To investigate spatial interactions, we interpret the presence of a budget consolidation plan as an indicator of having reached a ceiling for debt and estimate a linear model using this indicator as a binary dependent variable. We include the explanatory variables from our benchmark model, as well as the per capita debt in the core budget and in the short term.

Corresponding to our results above, we find spatial correlation ($\lambda = 0.063$, $SE = 0.037$) in the probability of reaching the debt ceiling (in this sense) which is significant at the ten percent level. This coefficient implies that the likelihood of running into a situation that requires a municipality to presenting a budget consolidation plan to the state authorities

[28]The fact that we find zero effects in the core budget and close to zero for the debt in public companies highlights that our main finding of positive debt spillovers in the benchmark model reflects economically meaningful interaction and not some pure mechanical effect that would show up in any dependent variables.

increases by 6 percentage points if its neighbors are in this situation. Given the baseline probability, we consider this to be a fairly large effect, which highlights that we might indeed be observing a race to the debt trap in NRW.

5.4 Robustness checks

We conduct several robustness checks for the main specification with public debts. Table 4 provides the results, where row (1) presents the benchmark results for comparison. First, in line (2) we extend the panel by additionally including 1998.[29] In row (3), we use the first lag instead of contemporaneous independent variables, and in row (4), we add a trend instead of year fixed effects. None of these variations changes the estimated spatial interaction effect of debt significantly. The estimated coefficients in row (5) do not change much either when we omit the bias correction described in section 4. However, it is worth noting that without the bias correction, we would overestimate the significance of the interaction effect in Bavaria (corresponding t-value of 19.4 instead of 14.9).

In addition, one might wonder whether the interaction along the boundaries of the federal states to other federal states in Germany or to other countries might differ. There may be little or no interaction across the borders to other countries; Cassette, Porto, and Foremny (2012) show that no tax competition exists between French and German municipalities along the Rhine Valley. On the other hand, Geys and Osterloh (2013) find that municipalities near a subnational or international border perceive stronger competitive pressure from across the border in the struggle to attract firms. In our framework, structural differences between municipalities at a border and other municipalities should be captured by the municipality fixed effects. To investigate whether border municipalities influence our results, in specification (6), we remove municipalities that share a border with another federal state or another country, and find similar spatial interaction effects as in the benchmark model.[30]

In the estimations reported so far, we account for municipal and time fixed effects. As these unobserved effects are likely to be correlated with the dependent and independent variables, an estimation not accounting for these fixed effects is likely to be biased. In row (7), we nevertheless report such estimates for comparison. We observe an increase in the

[29] We do not include 1998 in our benchmark specification because we use lagged independent variables in various robustness checks of the model.

[30] The number of cross section units decreased from 396 to 291 in NRW and from 2,056 to 1,776 in Bavaria.

point estimates of the interaction coefficient both for Bavaria and NRW, which indicates that these estimates of the spatial interaction effect are biased upwards. The analysis of spatial interactions based on cross-sectional data, where time and unit fixed effects cannot be controlled for, must thus be regarded with caution. The spatial interaction effects in this model without fixed effects are identified not only by changes in debt over time, but also by debt level differences between municipalities.

As a placebo test, row (8) shows the results of using a random spatial weighting matrix instead of the matrix capturing the actual spatial distribution of the municipalities. This idea is similar to tests conducted by Case, Rosen, and Hines (1993) and Geys (2006), who construct a placebo weighting matrix based on an alphabetical order. For our experiment, we generate a row normalized radii weighting matrix with a cut-off after 15 (20) km for NRW (Bavaria) as in the benchmark model, but with randomly assigned neighbors. To generate the number of random neighbors for each municipality, we take the mean and standard deviation of the number of neighboring municipalities from the real geographical distribution and draw from a normal distribution with corresponding first and second moments. Reassuringly, the results using the placebo random weighting matrix do not show any significant interaction effects.

Table 4: Spatial interactions of municipality debts: Robustness checks

	North Rhine Westphalia			Bavaria		
Specifiation	λ	Standard error	N	λ	Standard error	N
(1) 1999 - 2006	0.163***	(0.028)	3,168	0.327***	(0.022)	16,448
(2) 1998 - 2006	0.159***	(0.027)	3,564	0.339***	(0.020)	18,504
(3) X_{t-1} instead of X_t	0.163***	(0.028)	3,168	0.330***	(0.022)	16,448
(4) Trend instead of time FE	0.200***	(0.028)	3,168	0.347***	(0.017)	16,448
(5) No bias correction	0.156***	(0.028)	3,168	0.330***	(0.017)	16,448
(6) No outer boundary	0.199***	(0.027)	2,328	0.368***	(0.022)	14,208
(7) No fixed effects	0.277***	(0.027)	3,168	0.664***	(0.025)	16,448
(8) Placebo weight	0.013	(0.041)	3,168	0.010	(0.045)	16,448

Notes: The dependent variable is the sum of debt from the core budget and short term debt of a municipality. All models are estimated using the maximum likelihood method. Independent variables in all specifications are: population, population^2, share of young people, share of old people and unemployed per 100 inhabitants. The averaged neighboring equivalents are included as well as independent variables. W is a row normalized Inverse Distance Matrix with a cut-off point after 15 (20) km for NRW (Bavaria). (1) estimates the basic model from 1999 - 2006. (2) estimates the basic model from 1998 - 2006. (3) uses the first lag instead of the contemporaneous independent variables. (4) replaces the time fixed effects by a linear time trend. (5) applies the basic specification, however no bias correction is conducted. (6) uses the specification from (1), but frontier municipalities are excluded. (7) drops both municipality and time fixed effects. (8) estimates the basic model with a Placebo row normalized 15 (20) km radii matrix with randomly assigned neighbors that has the same first and second moments as its real counterpart. Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source*: Own calculations.

We also assess the robustness of our results with respect to the definition of neighboring municipalities by estimating the benchmark model with different specifications of the spatial weighting matrix. In section 4, we note that we tested the standard matrices used in the literature to choose the matrix that best fits the data for our benchmark model, as indicated by the highest log likelihood value. We considered binary contiguity matrices, matrices assigning all municipalities within a certain radius as neighbors, and Inverse Distance Matrices with row or eigenvalue normalization. We identified Inverse Distance Matrices with row normalization and a cut-off radius of 15 and 20 km as the best weighting matrices for NRW and Bavaria, respectively. Table A.3 in Appendix A not only reports the log likelihood values, but also the estimated coefficients of spatial debt interaction when the various weighting matrices are used. They are always positive and highly significant. The point estimate tends to become larger when Inverse Distance Matrices with eigenvalue normalization or larger cut-off radii are used, so the lower estimates of our preferred benchmark model estimates are conservative. The result that spatial debt interaction in Bavaria is stronger than in NRW is also stable across almost all matrices.

In addition, we construct non-standard geographical weighting matrices, which reflect the particular institutional setting of municipalities in Germany, and use them to re-estimate our benchmark model. The first matrix, which we refer to as county matrix, codes all municipalities within a particular county as neighbors. 2,031 of the 2,056 municipalities in Bavaria belong to 71 counties, the remaining 25 municipalities are independent cities; in NRW, 373 of the 396 municipalities belong to 30 counties, and 23 are independent cities (here we include Aachen, which is partly independent). We assign all independent cities (which are independent from counties) within each federal state as neighbors to each other, as their similarity makes them likely to interact more with one another. The idea behind this weighting matrix is that mayors from municipalities within a county have regular institutional exchange in party meetings or county events. It is likely that these meetings intensify information spillovers and may directly or indirectly affect the decisions of politicians to incur debt.

As the second non-standard spatial weights, we constructed weighting matrices inspired by the theoretical work by Janeba and Osterloh (2013). They argue that urban centers compete with other centers as well as with their surrounding municipalities while smaller municipalities only compete locally. We implement this approach by assigning all large municipalities with a population above a certain threshold (30k, 50k) in 1998 as neighbors. In addition, they are neighbors as well with their surrounding municipalities within a radius of 20km from their centroid. All other municipalities exclusively regard municipalities within a radius of 20km as their neighbors.

The results for these novel matrices also indicate positive and significant spatial debt interaction in both states. The point estimates obtained from using the matrices suggested by Janeba and Osterloh (2013) are similar to the benchmark estimates using the Inverse Distance Matrices with row normalization and 15 (20) km cut-off radii (the standard errors widely overlap). The county matrix generates a larger point estimate in NRW and a smaller point estimate for Bavaria. Interestingly, the log likelihood value becomes even larger when the innovative county matrix is used in NRW than when the best traditional matrix is used, so the county matrix seems to reflect the spatial debt interaction in NRW particularly well.[31]

5.5 Dynamic spatial panel models

One might argue that per capita debt implies a strong path dependency. To assess the relevance of dynamics for our estimated spatial debt interaction of interest, we also apply a dynamic panel Quasi Maximum Likelihood (QML) estimator. Specifically, we use the SDM from (2) and include the first time lag as well as the first time lag of the spatial lag. Yu, de Jong, and Lee (2008) derive this dynamic estimator with spatial fixed effects. Lee and Yu (2010c) extend this routine to additionally include time fixed effects. The resulting model can be written as follows:

$$y_{it} = \tau y_{it-1} + \lambda \sum_{j=1}^{n} w_{ij} y_{jt} + \eta \sum_{j=1}^{n} w_{ij} y_{jt-1} + x_{it}\beta + \sum_{j=i}^{n} w_{ij} x_{jt}\theta + \mu_i + \zeta_t + \epsilon_{it} \qquad (3)$$

In (3), τ denotes the coefficient of the first time lag and η the coefficient of the first time lag of the spatial autoregressive coefficient. This specification does not only allow us to control for possible path dependency of debt, furthermore it allows to determine whether the spatial process occurs simultaneously or with a time lag.[32] To account for the occurring bias due to the dynamic part of the model, Lee and Yu (2010c) use asymptotic theory to derive a bias correction, which is incorporated in their estimator.[33]

[31] We nevertheless decide to use the Inverse Distance Matrix in our benchmark model to facilitate comparisons with the literature. It also leads to the smaller, more conservative point estimate.

[32] The estimation routines for the dynamic QML estimator including the dynamic bias correction can be found at http://www.regroningen.nl/elhorst/software.shtml.

[33] For a detailed description of the bias correction of the dynamic part, see equation (17) in

The model is stable if $\tau+\lambda+\eta<1$. If the model is unstable, Lee and Yu (2010b) propose an additional method labeled Spatial First Differences (SFD), where each variable is taken in deviation of its spatially lagged value, which eliminates the time fixed effects. Due to the SFD transformation, we lose one observation per cross section. We successfully check the correct transformation by the test suggested in Elhorst, de Haan, and Zandberg (2013). The condition for stability is $\tau+\omega_{max-1}(\lambda+\eta)<1$ now, where ω_{max-1} denotes the second largest eigenvalue of W which is unequal to one.

We estimate (3) using the estimator suggested in Lee and Yu (2010c) and the SFD model using the estimator proposed in Yu, de Jong, and Lee (2008). Due to the fact that T is rather small in our panels, we additionally consider a dynamic model in a GMM framework as proposed by Arellano and Bover (1995) and Blundell and Bond (1998). This estimator also allows us to include the spatial lag and the time lag and can be used for a comparison with the aforementioned QML estimators.

The results from the dynamic specifications appear in Table 5. Columns (1) and (4) apply equation (3) and column (2) and (5) the SFD model for NRW and Bavaria, respectively. We obtain estimates for the coefficients of the time lag of per capita debt that are significantly larger than zero in both states; the point estimate is even larger than one in NRW, indicating exploding debt in the observation period. Importantly, the spatial interaction effect λ remains positive and highly significant in the dynamic estimations. Moreover, we find that the spatial interaction effect occurs simultaneously, because the first lag of the spatial interaction effect is not significantly different from zero. This indicates that a time lag of spatial interaction can safely be removed from the model. The results indicate instability of the debt process, especially in NRW, even when estimating the SFD model.

In columns (3) and (6), we employ a dynamic SAR model within a GMM framework as proposed by Arellano and Bover (1995) and Blundell and Bond (1998). Here, we include the term $\lambda\sum_{j=1}^{n} w_{ij}y_{jt}$ as additional endogenous variable.[34] As advised by Kelejian and

Yu, de Jong, and Lee (2008) for only spatial FE and equation (17) in Lee and Yu (2010c) for spatial and time FE.

[34]In this setting we do not include the term $\eta\sum_{j=1}^{n} w_{ij}y_{jt-1}$, because separate identification of λ and η by GMM is weak due to the similarity of these terms and their instruments. The omission should not bias the estimation because the QML results indicate that η is insignificant.

Table 5: Dynamic specifications

	North Rhine Westphalia			Bavaria		
	(1) BC-QML	(2) Spat-FD	(3) GMM	(4) BC-QML	(5) Spat-FD	(6) GMM
τ	1.138***	1.138***	1.071***	0.907***	0.907***	0.955***
	(0.013)	(0.013)	(0.016)	(0.006)	(0.006)	(0.015)
λ	0.157***	0.155***	0.083***	0.166***	0.157***	0.100***
	(0.028)	(0.028)	(0.030)	(0.025)	(0.031)	(0.026)
η	0.052	0.049	-	-0.029	-0.026	-
	(0.047)	(0.047)		(0.034)	(0.039)	
$\tau + \lambda + \eta$	1.348***	1.342***	-	1.044***	1.038***	-
Standard error $\tau + \lambda + \eta$	(0.033)	(0.033)	-	(0.023)	(0.023)	-
$\tau + \omega_{max-1}(\lambda + \eta)$	-	1.341	-	-	1.038	-
Log-likelihood	-19,038	-18,792	-	-99,983	-99,692	-
Hansen test	-	-	0.137	-	-	0.176
Arellano Bond test	-	-	0.559	-	-	0.296
N	3,168	3,160	3,168	16,448	16,440	16,448

Notes: Independent variables in all specifications are: population, population^2, share of young people, share of old people and unemployed per 100 inhabitants. The averaged neighboring equivalents are included as well as independent variables in (1),(2),(4) and (5). W is a row normalized Inverse Distance Matrix with a cut-off point after 15 (20) km for NRW (Bavaria). (1) and (3) estimate the BC-QML with spatial and time FE from Lee and Yu (2010c). (2) and (5) estimate the BC-QML using Spatial First Differences as proposed in Lee and Yu (2010b) and applying the estimator with spatial FE by Yu, de Jong, and Lee (2008). (3) and (6) estimate a GMM as outlined in Arellano and Bover (1995); Blundell and Bond (1998). Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source*: Own calculations.

Robinson (1993), we employ $\sum_{j=1}^{n} w_{ij}x_{jt}$ as an instrument for $\lambda \sum_{j=1}^{n} w_{ij}y_{jt}$. Specifically, for the instrument we only use the spatially lagged number of unemployed per capita since Büttner (2001) notes that neighboring demographic variables are likely to be correlated with the error term. We report the p-values for the Arellano Bond test statistic for AR(2) correlation and the Hansen over-identification test statistic. Both tests are passed, which indicates that the estimated GMM is feasible. Again we observe a positive and significant influence of the first time lag of debt and positive and significant spatial debt interaction, as in the QML estimations, which highlights that the results are not very sensitive to the choice of estimator. Since the dynamic estimates may suffer from the relatively small number of time periods in our samples, we abstain from overinterpreting the dynamic effects and take from the estimation of the dynamic models that the spatial interaction effects of debt we are interested in are robust and seem to occur simultaneously, which increases confidence in our benchmark model.

6 Conclusion

We provide evidence for spatial interdependence between municipality debt in Germany. Our spatial econometric estimates are based on municipality panel data from the two federal states of NRW and Bavaria and take into account municipality and time fixed effects. The results suggest that a municipality increases its per capita debt by 16 Euro (in NRW) or 33 Euro (in Bavaria) if its neighboring municipalities increase their debt by 100 Euro per capita on average. The results are robust across numerous econometric specifications of spatial panel models, including various standard and two novel, non-standard definitions of spatial weighting matrices, as well as dynamic spatial lag models.

Interestingly, the estimated degree of spatial debt interaction lies in between larger estimates for the spatial interaction of taxes and smaller estimates for spatial spending interactions. Local governments seem to use debt to support their engagement in tax competition while adjusting their level of expenditures to a smaller extent. The possibility to incur debt allows local governments in Germany to undercut their neighbors' current tax rates without reducing current expenditures correspondingly. Political economic reasons such as politicians' incentives within relatively short electoral cycles may partly explain such a myopic behavior, especially because municipalities can expect a bail-out from the federal state in case of insolvency.

The new evidence that debt growth tends to spread across jurisdictions supports the view that stronger mechanisms are needed to curb trends of rising public debt. Possible approaches include strong regulation, e.g. implemented at a higher level of government (cf. Epple and Spatt (1986); Krogstrup and Wyplosz (2010)), or a market solution by maintaining a credible thread of insolvency which would punish excessive public debt at the level of local jurisdictions by higher interest rates. Further research is necessary to assess the impact of such actions on spatial debt interaction and their effectiveness in limiting the growth of local public debt.

References

Ade, F. (2011): "Do creditors discipline local governments," in *Local public choice: five essays on fiscal policy, interest rates, and elections.* Dissertation Humboldt University.

Alesina, A., and G. Tabellini (1990): "A positive theory of fiscal deficits and government debt," *Review of Economic Studies*, 57(3), 403 – 414.

ALLERS, M., AND J. ELHORST (2005): “Tax mimicking and yardstick competition among local governments in the Netherlands,” *International Tax and Public Finance*, 12, 493 – 513.

ALLERS, M. A., AND J. P. ELHORST (2011): “A simultaneous equations model of fiscal policy interactions,” *Journal of Regional Science*, 51, 271 – 291.

ARELLANO, M., AND O. BOVER (1995): “Another look at the instrumental variable estimation of error-components models,” *Journal of Econometrics*, 68, 29 – 51.

BACH, S., AND F. M. FOSSEN (2008): “Reforming the German local business tax - Lessons from an international comparison and a microsimulation analysis,” *FinanzArchiv - Public Finance Analysis*, 64(2), 245 – 272.

BASKARAN, T. (2013): “Identifying local tax mimicking: Administrative borders and a policy reform,” *CEGE Discussion Papers*, 157, 1 – 53.

BLAIS, A., AND R. NADEAU (1992): “The electoral budget cycle,” *Public Choice*, 74(4), 389 – 403.

BLUNDELL, R., AND S. BOND (1998): “Initial conditions and moment restrictions in dynamic panel data models,” *Journal of Econometrics*, 87, 115 – 143.

BORCK, R., M. CALIENDO, AND V. STEINER (2007): “Fiscal competition and the composition of public spending: Theory and evidence,” *FinanzArchiv*, 63, 264 – 276.

BORDIGNON, M., F. CERNIGLIA, AND F. REVELLI (2003): “In search of yardstick competition: A spatial analysis of Italian municipality property tax setting,” *Journal of Urban Economics*, 54, 199 – 217.

BÖTTCHER, F., M. JUNKERNHEINRICH, AND G. MICOSATT (2010): “Kommunaler Finanz- und Schuldenreport Nordrhein-Westfalen [Municipal financial and debt report North-Rhine Westphalia],” Bertelsmann Stiftung. Gütersloh.

BRUECKNER, J. K. (2003): “Strategic interaction among governments: An overview of empirical studies,” *International Regional Science Review*, 26, 175 – 188.

BÜTTNER, T. (2001): “Local business taxation and competition for capital: The choice of the tax rate,” *Regional Science and Urban Economics*, 31, 215 – 245.

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

Cassette, A., E. D. Porto, and D. Foremny (2012): "Strategic fiscal interaction across borders: Evidence from French and German local governments along the Rhine Valley," *Journal of Urban Economics*, 72, 17 – 30.

Elhorst, J. P. (2010): "Applied spatial econometrics: Raising the bar," *Spatial Economic Analysis*, 5, 9 – 28.

——— (2012): "Matlab software for spatial panels," *International Regional Science Review*, DOI: 10.1177/0160017612452429, 1 – 17.

Elhorst, J. P., J. de Haan, and E. Zandberg (2013): "The impact of Interaction effects among neighboring countires in financial liberalization and reform: A dynamic spatial panel data approach," *Spatial Economic Analysis*, DOI:10.1080/17421772.2012.760136, 1 – 21.

Epple, D., and C. Spatt (1986): "State restrictions on local debt - Their role in preventing default," *Journal of Public Economics*, 29, 199 – 221.

Fiva, J., and G. Natvik (2011): "Do re-election probabilities influence public investment?," in *CESifo Conference Papers*.

Foremny, D., and N. Riedel (2012): "Business taxes and the electoral cycle," *FZID Discussion Papers*, 43, 1 – 34.

Freier, R. (2011): "Incumbency as the major advantage: The electoral advantage of parties for incumbent mayors," *DIW Discussion Paper*, 1147, 1 – 30.

Freier, R., and V. Grass (2013): "Kommunale Verschuldung in Deutschland: Struktur verstehen - Risiken abschätzen [Municipal debt in Germany: Understanding structure - Assessing risks]," DIW Wochenbericht - 16.

Gerard, M., H. Jayet, and S. Paty (2010): "Tax interactions among Belgian municipalities: Do interregional differences matter?," *Regional Science and Urban Economics*, 40, 336 – 342.

Geys, B. (2006): “Looking across borders: A test of spatial policy interdependence using local government efficiency ratings,” *Journal of Urban Economics*, 60, 443 – 462.

Geys, B., and S. Osterloh (2013): “Borders as boundaries to fiscal policy interactions? An empirical analysis of politicians’ opinions on rivals in the competition for firms,” *Journal of Regional Science*, 53, 583 – 606.

Janeba, E., and S. Osterloh (2013): “Tax and the city - A theory of local tax competition,” *Journal of Public Economics*, 106, 89–100.

Jensen, R., and E. F. Toma (1991): “Debt in a model of tax competition,” *Regional Science and Urban Economics*, 21, 371 – 392.

Keen, M., and M. Marchand (1997): “Fiscal competition and the pattern of public spending,” *Journal of Public Economics*, 66, 33 – 53.

Kelejian, H. H., and D. P. Robinson (1993): “A suggested method of estimation for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model,” *Papers in Regional Science*, 72, 297 Ű 312.

Krogstrup, S., and C. Wyplosz (2010): “A common pool theory of supranational deficit ceilings,” *European Economic Review*, 54, 269 – 278.

Ladd, H. F. (1992): “Mimicking of local tax burdens among neighboring counties,” *Public Finance Quarterly*, 20, 450 – 467.

Lee, L.-F. (2004): “Asymptotic distributions of quasi-maximum likelihood estimators for spatial autoregressive models,” *Econometrica*, 72(6), 1899 – 1925.

Lee, L.-F., and J. Yu (2010a): “Estimation of spatial autoregressive panel data models with fixed effects,” *Journal of Econometrics*, 154(2), 165 – 185.

——— (2010b): “Some recent developments in spatial pael data models,” *Regional Science and Urban Economics*, 40(2), 255 – 271.

——— (2010c): “A spatial dynamic panel data model with both time and individual fixed effects,” *Econometric Theory*, 26, 564 – 597.

Nordhaus, W. (1975): “The political business cycle,” *Review of Economic Studies*, 42, 169 – 190.

PERSSON, T., AND L. SVENSSON (1989): "Why a stubborn conservative would run a deficit: Policy with time-inconsistent preferences," *The Quarterly Journal of Economics*, 104(2), 325 – 345.

PETTERSSON-LIDBOM, P. (2001): "An empirical investigation of the strategic use of debt," *Journal of Political Economy*, 109(3), 570 – 583.

SALMON, P. (1987): "Decentralisation as an incentive scheme," *Oxford Reviews of Economic Policy*, 3, 24 – 43.

SCHULTZ, C., AND T. SJÖSTRÖM (2001): "Local public goods, debt and migration," *Journal of Public Economics*, 80, 313 – 337.

——— (2004): "Public debt, migration and shortsighted politicians," *Journal of Public Economic Theory*, 6(5), 655 – 674.

SOLE-OLLE, A. (2006): "Expenditure spillovers and fiscal interactions: Empirical evidence from local governments in Spain," *Journal of Urban Economics*, 59, 32 – 53.

VEIGA, L., AND F. VEIGA (2007): "Political business cycle at the municipal level," *Public Choice*, 131(1 - 2), 45 – 64.

WILDASIN, D. E. (1988): "Nash equilibira in models of fiscal competition," *Journal of Public Economics*, 35, 229 – 240.

YU, J., R. DE JONG, AND L.-F. LEE (2008): "Quasi-maximum likelihood estimators for spatial dynamic panel data with fixed effects when both n and T are large," *Journal of Econometrics*, 146, 118 – 134.

A Appendix - Tables

Table A.1: Descriptive statistics 1999 - 2006

	Median	Mean	Std. Dev.	Min	Max
	Panel 1: North Rhine Westphalia, n=3,168				
Sum of per capita core budget and short term debt	857	997	729	0	6,069
Per capita core budget debt	780	860	578	0	3,927
Per capita short term debt	0	137	334	0	4,465
Per capita public company debt	214	434	517	0	3,964
Population	21,602	45,574	86,893	4,249	989,766
Share young people (<15 yrs)	17.03	17.17	1.92	11.98	25.67
Share old people (>65 yrs)	23.01	22.44	3.60	10.55	34.91
Unemployed per 100 inh.	3.64	3.88	1.14	1.73	10.78
Net migration per 1,000 inhabitants	1.92	2.52	7.07	-101.93	59.24
Growth of gross domestic product (county level)	0.48	0.41	2.34	-9.94	10.82
Per capita personnel expend.	317	344	106	158	806
Per capita operating expend.	286	305	102	83	1,084
Per capita welfare spending	158	232	175	23	1,327
Per capita net spending	1,189	1,272	426	495	4,560
Tax base bus. tax in 1,000 Eur	1,472	4,167	12,698	-464	226,683
Tax base prop. tax A in 1,000 Eur	35	42	32	-635	222
Tax base prop. tax B in 1,000 Eur	583	1374	3,035	58	38,434
Tax rate local business tax	403.0	404.8	27.4	300.0	490.0
Tax rate property tax A	205.0	214.0	38.2	110.0	400.0
Tax rate property tax B	375.0	365.5	49.6	200.0	530.0
Per capita loan credit and loan assoc.	65	176	273	0	2,610
Per capita loan public state banks	185	279	306	0	1,899
Per capita loan private banks	248	323	307	0	1,837
Per capita loan maturity < 1 year	29	38	43	0	653
Per capita loan maturity $1 - 5$ years	90	111	96	0	1,049
Per capita loan maturity > 5 years	562	645	486	0	3,594
	Panel 2: Bavaria, n = 16,448				
Sum of per capita core budget and short term debt	599	714	626	0	14,139
Per capita core budget debt	592	700	613	0	14,139
Per capita short term debt	0	13	70	0	2,221
Per capita public company debt	0	0.7	13	0	510
Population	2,754	6,014	31,031	193	1,294,608
Share young people (<15 yrs)	17.58	17.53	2.29	6.60	25.33
Share old people (>65 yrs)	20.79	20.53	4.61	6.74	46.19
Unemployed per 100 inh.	2.59	2.75	1.03	0	8.801
Net migration per 1,000 inhabitants	2.38	2.77	11.91	-121.44	119.46
Growth of gross domestic product (county level)	1.35	1.14	3.34	-15.38	19.21
Per capita personnel expend.	237	254	101	34	3,145
Per capita operating expend.	185	208	108	22	1,831
Per capita welfare spending	70	88	71	0	1,154
Per capita net spending	1,055	1,178	668	149	21,514
Tax base bus. tax in 1,000 Eur	94	613	5,629	-1,554	299,856
Tax base prop. tax A in 1,000 Eur	9	11	9	-14	86
Tax base prop. tax B in 1,000 Eur	58	177	1,249	-45	53,638
Tax rate local business tax	320	323	24	240	490
Tax rate property tax A	320.0	325.9	56.7	140.0	800.0
Tax rate property tax B	310.0	321.8	49.4	150.0	800.0
Per capita loan credit and loan assoc.	112	219	302	0	4,180
Per capita loan public state banks	0	87	256	0	10,415
Per capita loan private banks	260	360	397	0	6,211
Per capita loan maturity < 1 year	46	65	84	0	1,987
Per capita loan maturity $1 - 5$ years	130	157	151	0	3,972
Per capita loan maturity > 5 years	344	455	496	-4,020	12,005

Source: Own calculations based on official statistics provided by the Federal Statistical Office.

Table A.2: Specification tests for spatial panels 1999 - 2006

	NRW		Bavaria	
(Robust) LM test Spatial Lag vs OLS	(78.63***)	83.28***	(41.10***)	547.99***
(Robust) LM test Spatial Error vs OLS	(41.18***)	45.83***	(9.52***)	516.42***
LR test SDM vs Spatial Lag	70.78***		131.08***	
LR test SDM vs Spatial Error	99.97***		131.70***	
Spatial Hausman Test Fixed vs Random Effect	385.51***		166.47***	

Notes: All models are estimated with population, population^2, share of young / old people and unemployed per inhabitant as independent variables. Year and municipality fixed effects are taken into account by a double demeaning. W is a row normalized Inverse Distance Matrix with a cut-off point after 15 (20) km for NRW (Bavaria). Test statistics are significant at: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ *Source*: Own calculations.

Table A.3: Spatial weights model comparison

	NRW		Bavaria	
Weight specification	λ	Log-likelihood	λ	Log-likelihood
Binary Contiguity First Order	0.137*** (0.027)	-21,349.782	0.156*** (0.012)	-111,111.21
Binary Contiguity Second Order	0.287*** (0.041)	-21,343.501	0.233*** (0.019)	-111,061.28
Neighbors within 15km	0.191*** (0.029)	-21,333.954	0.242*** (0.020)	-111082.03
Neighbors within 20km	0.229*** (0.037)	-21,343.292	0.288*** (0.025)	-111059.83
Neighbors within 25km	0.324*** (0.042)	-21,336.966	0.249*** (0.032)	-111074.97
Neighbors within 30km	0.403*** (0.046)	-21,334.917	0.245*** (0.038)	-111083.67
Inverse Distance 14km (row norm)	0.127*** (0.027)	-21,335.176	0.262*** (0.017)	-111,055.93
Inverse Distance 15km (row norm)	0.163*** (0.028)	-21,330.158	0.277*** (0.018)	-111,051.57
Inverse Distance 20km (row norm)	0.209*** (0.036)	-21,333.959	0.327*** (0.022)	-111,030.84
Inverse Distance 25km (row norm)	0.253*** (0.041)	-21,334.262	0.294*** (0.027)	-111,050.65
Inverse Distance 30km (row norm)	0.277*** (0.047)	-21,337.922	0.282*** (0.031)	-111,062.40
Inverse Distance 15km (eigen norm)	0.237*** (0.041)	-21,345.859	0.476*** (0.029)	-111,058.17
Inverse Distance 20km (eigen norm)	0.272*** (0.047)	-21,352.520	0.514*** (0.030)	-111032.63
Inverse Distance 25km (eigen norm)	0.337*** (0.051)	-21,348.647	0.480*** (0.034)	-111,034.36
Inverse Distance 30km (eigen norm)	0.417*** (0.055)	-21,343.107	0.482*** (0.036)	-111,033.74
County	0.293*** (0.030)	-21,303.260	0.236*** (0.022)	-111,127.29
Radius 20km, pop>30,000	0.204*** (0.037)	-21,334.851	0.316*** (0.025)	-111,070.03
Radius 20km, pop>50,000	0.199*** (0.037)	-21,337.969	0.316*** (0.025)	-111,079.41

Notes: The dependent variable is the sum of debt from the core budget and short term debt of a municipality, λ denotes the spatial interaction effect. All models are estimated using the bias corrected maximum likelihood method. Independent variables in all specifications are: population, population^2, share of young people, share of old people and unemployed per 100 inhabitants. The averaged neighboring equivalents are included as well as independent variables. The specification of W is described in each row. Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Source*: Own calculations.

B Appendix - Figures

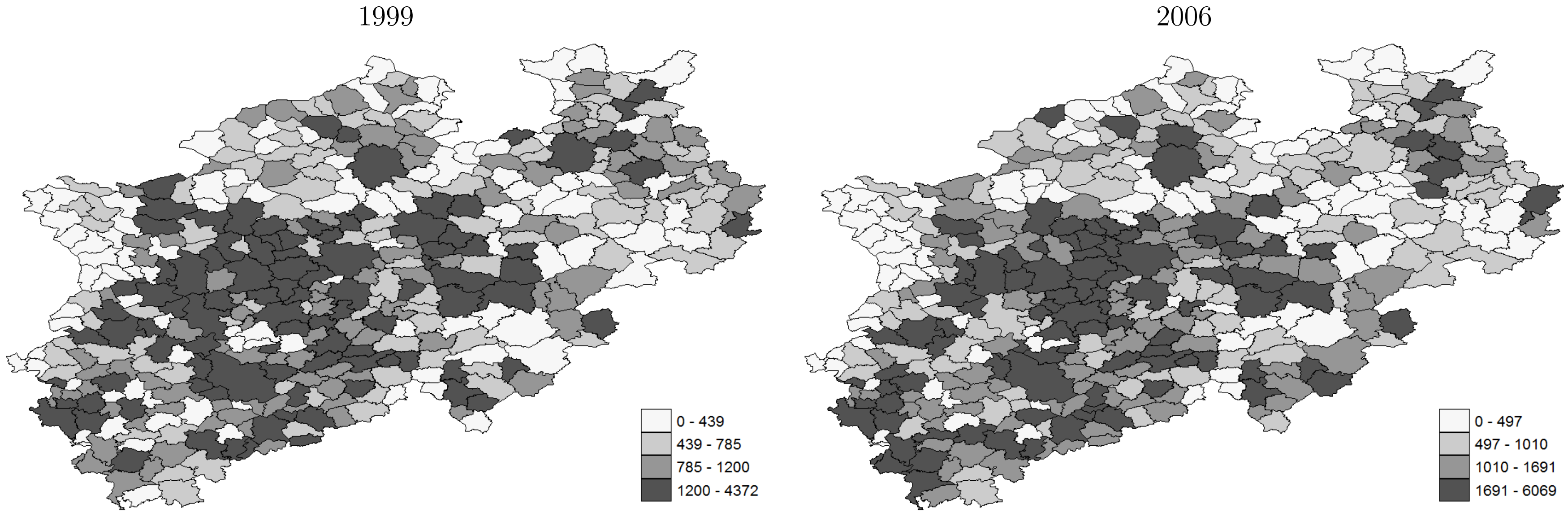

Figure B.1: Quartile map of per capita debt in NRW in 1999 and 2006

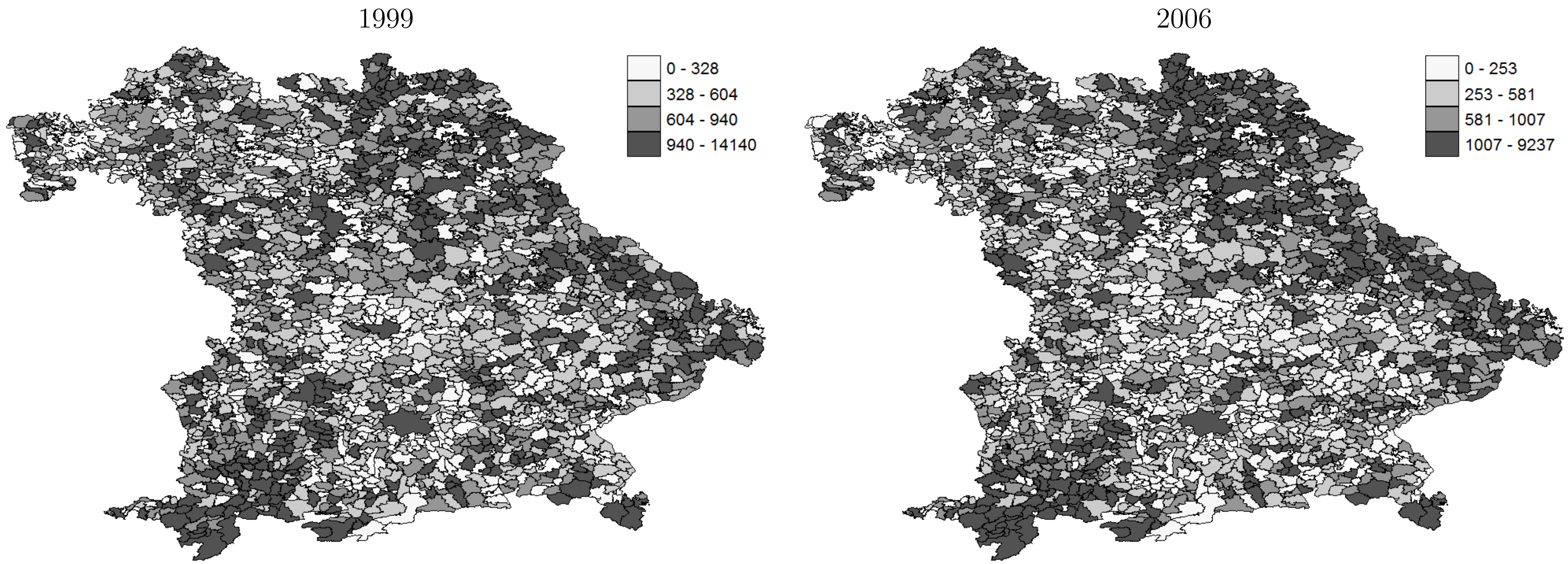

Figure B.2: Quartile map of per capita debt in Bavaria in 1999 and 2006

Figure B.3: Policy parameters in means by year for NRW

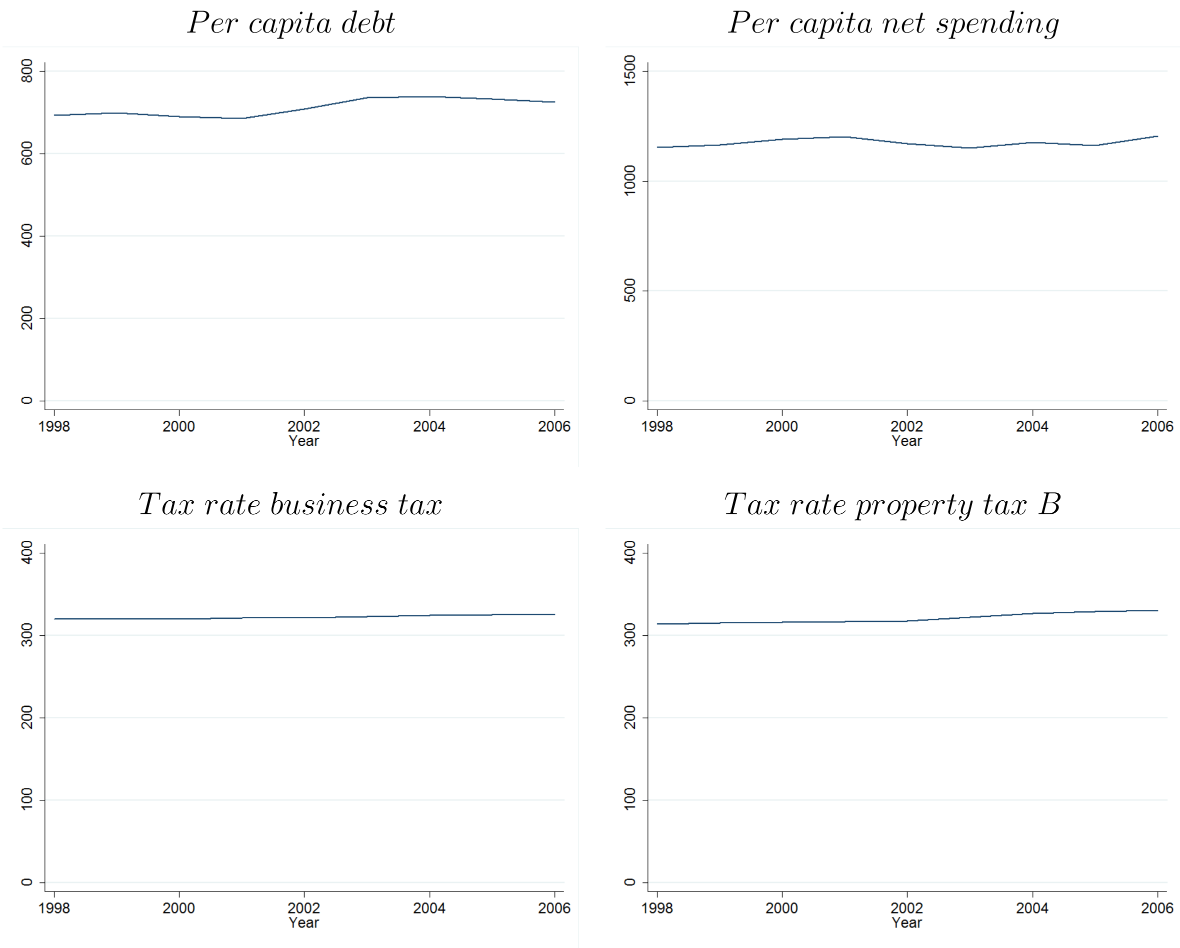

Figure B.4: Policy parameters in means by year for Bavaria

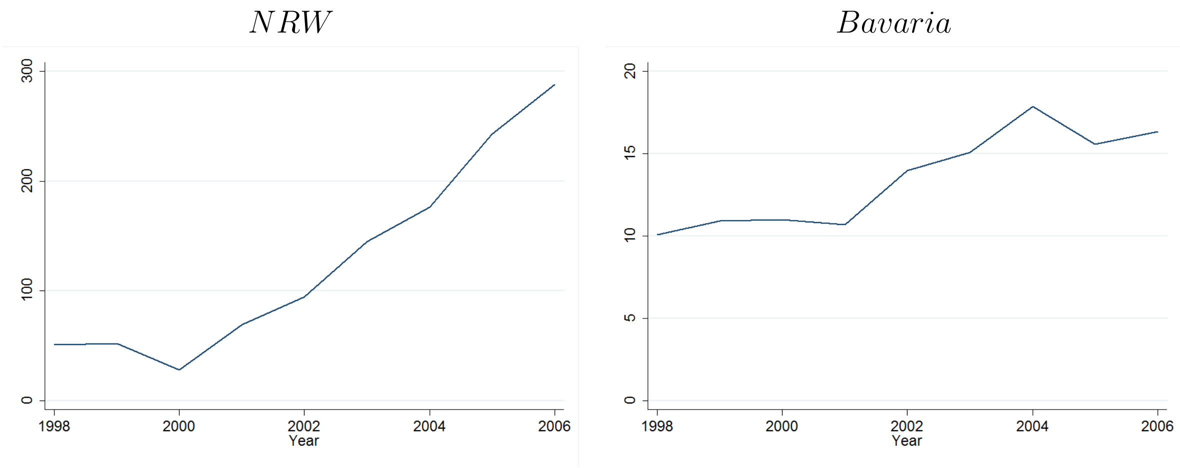

Figure B.5: Mean per capita short term debt 1998 - 2006

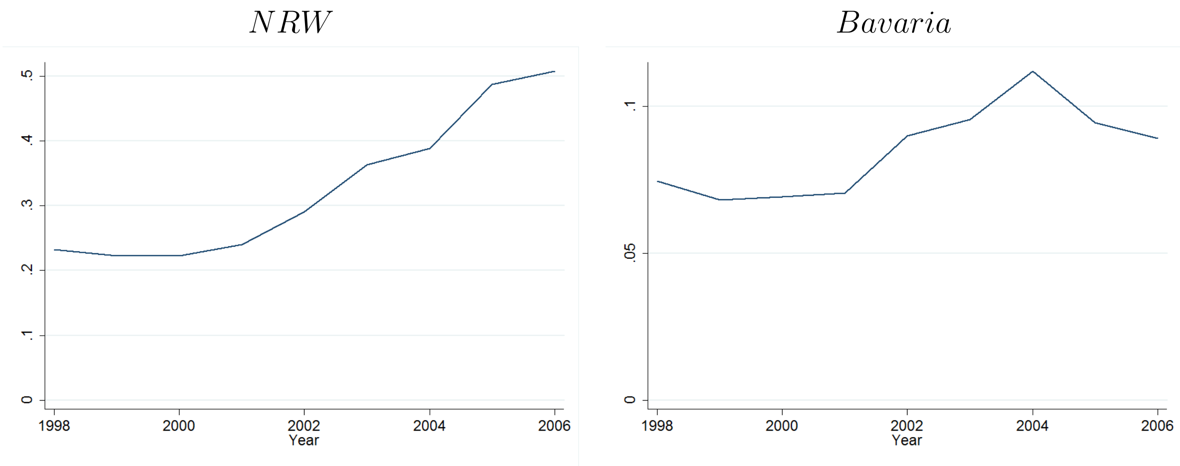

Figure B.6: Share of municipalities using short term debt 1998 - 2006

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