Tax Competition Effects of a Minimum Tax Rate: Empirical Evidence from German Municipalities

Thiess Buettner* FAU and CESifo

Maximilian Poehnlein* FAU

December 2023

Abstract

This paper explores the effects of a federal law that obligates previously unregulated municipalities in Germany to set a minimum tax rate on firms' taxable profits. In particular, we examine the tax-policy response of municipalities that compete locally with "tax-haven municipalities", i.e. municipalities that originally have set lower and, in some cases, even zero tax rates. The analysis distinguishes treated and not-treated municipalities based on their distance to a tax-haven. Our results show that the majority of municipalities do not change their tax policy. Apart from the tax-havens, only high-tax municipalities show a response – they reduce the business tax rate without experiencing a decline in tax revenues.

JEL-Classifications: H77; H87; H71

Keywords: *Tax Competition; Minimum Tax; Local Business Tax; Tax Havens*

*Friedrich-Alexander-University Erlangen-Nuremberg, Lange Gasse 20, 90403 Nuremberg, Germany, thiess.buettner@fau.de, maximilian.poehnlein@fau.de.

Acknowledgements: For data support we thank Axel von Schwerin. For helpful comments and discussions of earlier versions, we thank three anonymous referees as well as David Agrawal, Massimo Bordignon, Sebastian Garmann, Eckhard Janeba, Federico Revelli, Kurt Schmidheiny, Monika Schnitzer and Clémence Tricaud. For valuable research assistance we thank Ludwig Müller Flores, Benjamin Schuler and Hendrik Kirchmann.

1 Introduction

As the trend towards declining statutory corporate tax rates among developed countries continues (e.g., Auerbach 2018), the proposal of a global minimum tax has recently gained traction. While the details of the proposal involving multinationals are complex (Englisch and Becker 2019), the basic intuition is straightforward: by preventing tax havens from offering effective taxation below a certain minimum level, the constraints on tax policy from international tax competition would ease. This exerts positive effect on revenues in non-haven countries and makes higher tax rates more attractive at the margin (Janeba and Schjelderup 2023). If the minimum tax is sufficiently high, non-haven countries may set higher tax rates (Johannesen 2022). In particular, as high-tax countries face lower competitive pressure, it is likely that tax rates in these countries are further increased (Devereux 2023).

The theoretical literature on tax competition has shown, however, that the effects of the introduction of a minimum tax rate critically depend on the tax-competition strategies. In particular, the new equilibrium does not necessarily display higher rates (e.g., Keen and Konrad 2013). This calls for an empirical analysis of the effects of a minimum tax on tax policy.

The actual experience with minimum taxes is limited. The European Union (EU) has introduced various minimum taxes for excises such as taxes on diesel fuels (Evers, Vollebergh, and Mooij 2004). The EU introduced a source-based minimum withholding tax on interest income, but countries may instead opt for an information exchange with the tax payers' country of residence (Hemmelgarn and Nicodéme 2009). Minimum excise taxes on specific commodities are also implemented in the West African Economic and Monetary Union (Mansour and Rota-Graziosi 2013). Since all of these policies affect only a limited number of countries whose tax policies are subject to multiple influences, it is difficult to evaluate the international experience with minimum taxes empirically.

A more promising case is offered by the introduction of a minimum tax rate for German municipalities. These municipalities enjoy a constitutionally guaranteed right to determine the statutory tax rate for the local business tax, which is their main tax revenue source. At the end of the 1990s and in the early 2000s tax competition intensified, and several municipalities were charging very low, sometimes even zero tax rates. This sparked a political debate on local tax havens, and the federal legislator introduced a minimum tax rate in 2004. This tax law requires municipalities to charge a statutory tax rate of about 9.1% or higher on firms' taxable profits.

This paper explores the effects of the introduction of the minimum tax rate on the tax policy of German municipalities. Focusing on local tax competition, we explore whether and how competing municipalities responded to the forced tax-rate change in the tax-haven municipalities, i.e. municipalities that used to charge lower tax rates. To this end, we employ a spatial econometric approach that enables us to distinguish treated and not-treated municipalities based on the distance to the tax havens. The results show that the response of neighboring municipalities varies over the tax-rate distribution. Municipalities, that have set low or medium tax rates before implementation, show no empirical responses. Apart from tax-havens, significant tax policy changes are only found for high-tax municipalities which reduce their tax rates by about half a percentage point without experiencing a decline in tax revenue.

The paper contributes to the literature by providing empirical evidence for the impact of an introduction of a minimum tax rate on the tax policy of competing jurisdictions. Whereas the effects of a minimum tax rate have been discussed in the theoretical literature (e.g., Kanbur and Keen 1993, Janeba and Peters 1999, Wang 1999, Konrad 2009), there is little empirical research on the effects of tax limits on tax competition. Porto and Revelli (2013) examine the effect of a cap on the local tax rate of a local motor vehicle tax, which effectively introduced a maximum tax rate. Lyytikäinen (2012) is first empirical study considering the effects of a minimum tax rate. It exploits increases in statutory lower limits of local property tax rates in

Finland and finds little evidence for tax-reactions of neighboring jurisdictions. More recently, Lyytikäinen (2023) extends the analysis and studies more recent reforms after the property tax was removed from the tax base equalization scheme. The findings indicate that forced increases in tax rates partly led to increases in property tax rates of nearby municipalities.

In contrast to this discussion, we examine the impact of a minimum tax rate for a local business tax that is levied on corporate profits. This is more in line with international competition in corporate taxation and the policy debate on a global minimum tax. Yet our analysis focuses on the effects of a minimum tax rate on neighboring local jurisdictions. Nearby tax havens also play a role in the international context. For example, Hines (2005) and Desai, Foley, and Hines (2006) find a complementary role between tax havens and investments of multinationals in neighboring high-tax countries. But multinationals' profit-shifting activities with tax havens extend over larger distances and regularly exceed volumes that are predicted based on country characteristics including geographic distance (Hebous and Johannesen 2021). The dual role of tax havens as location of production and destination for profit-shifting also matters in the case of Germany's local business tax competition. This may seem surprising, since, tax advantages from profit shifting are limited to the business tax; corporation and income taxes cannot be avoided by relocating activities or profits to low-tax municipalities. Moreover, local business taxation in Germany is subject to formula apportionment, which intends to limit profit shifting. However, a major company tax reform in 2001 opened up new opportunities to avoid taxes by using what has been referred to as strategic consolidation (Buettner, Riedel, and Runkel 2011). Accordingly, profit shifting played a role in the political debate on tax-haven municipalities. Of course, a key difference to international tax policy is that in the local context a minimum tax rate can be prescribed by a higher level of government. At the international level, a global regulator does not exist and the question arises how an effective minimum tax can be implemented without participation of tax havens (Englisch and Becker 2019).

Our analysis also differs from the existing literature in terms of the methodology, as we are not concerned with estimating tax-reaction functions as in Lyytikäinen (2012), but rather examine the effects of the minimum tax rate on the distribution of tax rates. To this end, we contribute to the literature by estimating a spatial difference-in-differences model (e.g., Delgado and Florax 2015, Butts 2023), which enables us to provide empirical evidence on the effects of the minimum tax rate without the need to set up and identify a spatial interaction model.

A third feature of this paper's contribution is to test predictions that emerge from alternative theories of tax competition. If competition is characterized by strategic complementarity, the forced increase in tax rates in the tax-haven municipalities will induce neighboring municipalities to set higher tax rates. If tax competition is characterized by a leader-follower relationship, however, effects would differ along the tax-rate distribution. Predictions associated with the latter theory have rarely been analyzed empirically (Heimberger 2021). Altshuler and Goodspeed (2015) and Swank (2016) explore the consequences for tax reactions functions and found evidence for the US taking a leader position in international tax competition. While our finding that municipalities with high tax rates respond by setting lower tax rates is in accordance with this theory, it does not conform with the commonly held view that tax rates of competing jurisdictions are strategic complements. In this regard, our study contributes to the more recent empirical literature that aims at identifying spatial interaction effects causally and often does not support strategic complementarity (e.g., Agrawal, Hoyt, and Wilson 2022).

Section 2 presents a brief discussion of possible effects of a minimum tax rate on the tax-competition equilibrium based on the theoretical literature. Section 3 gives an overview of the data and institutions. Section 4 lays out the methodology employed in the empirical analysis. Section 5 presents the results. Section 6 provides a short summary and concludes.

2 Theoretical Background

The theoretical literature on tax competition often characterizes the optimal choice of the tax rate on a mobile tax base by a best-response function which determines the optimal tax rate of a jurisdiction given the choice of others. The equilibrium is typically derived as a Nash equilibrium, where all the response functions are mutually consistent. Since the choice of the tax rate by the individual government exerts a "fiscal" externality on other jurisdictions, it is intuitive that this Nash equilibrium is inefficient. In the case of capital tax competition, featured by Zodrow and Mieszkowski (1986), under certain assumptions, tax rates are strategic complements and are inefficiently low in the Nash equilibrium. In this case, all jurisdictions would benefit from a coordinated increase of the tax rate (Keen and Konrad 2013).

A minimum tax differs from a coordinated tax increase. It is a restriction of the choice set of jurisdictions and transforms the determination of the optimal tax policy into a constrained optimization problem (Revelli 2013). The constraint exerts direct effects only on those jurisdictions that opt for lower tax rates in the absence of the restriction. These jurisdictions are confronted with a binding minimum tax rate and are forced to raise their tax rate. Other jurisdictions may benefit from this move as their tax bases increase. However, they may also alter their tax policies. As Keen and Konrad (2013) show, the responses as well as the ultimate welfare effects critically depend on the tax-competition strategies of jurisdictions. In the Nash equilibrium, if tax rates are strategic complements, other jurisdictions respond by setting higher tax rates. This may ultimately result in a new equilibrium where even a jurisdiction, that is forced to increase its tax rate, experiences a welfare increase. However, if the equilibrium has a leader-follower structure, the properties of the tax-competition equilibrium differ (Wang 1999). In such a setting, the imposition of a binding minimum tax rate on one jurisdiction could induce a competing high-tax jurisdiction to lower its tax rate. In this case, the jurisdiction, where the minimum tax rate is binding, may suffer a welfare loss. The intuition behind the tax-policy response of the high-tax jurisdiction is that, without a minimum tax rate, a leader in the tax-competition game may set a relatively high tax rate in order to induce the follower to choose a higher tax rate. With a minimum tax rate, the leader may abstain from this move, since the minimum tax rate prevents the follower from choosing an aggressively low tax rate.

It is noteworthy that the ambiguity of the theoretical predictions regarding the effects of minimum tax rates arises in a standard model of capital tax competition where governments simply maximize the welfare of local residents. This ambiguity is amplified if policy makers pursue own interests. If voters lack information about the true cost of the provision of public services, self-interested policy makers may mimic the policy of benevolent governments (Besley and Case 1995) and tax competition could result in a pooling equilibrium (Bordignon, Cerniglia, and Revelli 2004). Suppose that, initially, self-interested policy makers abstain from mimicking and rather charge high tax rates. If the introduction of the minimum tax rate changes the tax rates set by benevolent governments, self-interested policy makers may reconsider their strategy. Hence, they might no longer charge high tax rates and rather mimic other jurisdictions' lower tax rates. Another rational for tax mimicking emerges with comparative performance evaluation of local tax policy by private investors. If investors plan to make irreversible investment decisions, they need to predict future tax rates. Under information asymmetry, local governments might be hesitant to alter their tax policy, as they want to avoid providing a signal about their tax preference (Buettner and Schwerin 2016). Imposing a minimum tax rate may then exert no effects on competing jurisdictions.

A comparative performance assessment can also be institutionally anchored if local jurisdictions are integrated in a redistributive system of fiscal grants, i.e. a fiscal equalization system. On the one hand, this has the effect of reducing the marginal costs of financing public services (Smart 1998). While this can lead to higher overall tax rates in a Nash equilibrium (e.g., Köthenbürger 2002, Bucovetsky and Smart 2006), tax policy strategies are not necessarily affected. On the other hand, the reference tax rate, which is used to calculate tax capacity, is of particular importance. If the reference tax rate is equal to an average of jurisdictions' tax rates and if jurisdictions have an impact on the average, as is the case in the Canadian provincial fiscal equalization system, for example, there is a stronger incentive to conform with tax policy in other jurisdictions (Hayashi and Boadway 2001).

Although the theoretical predictions on tax policy interaction vary widely, empirical analyses have indicated that tax policy in adjacent municipalities exert significant effect on local tax bases (e.g., Buettner 2003) or voting outcomes (e.g., Bosch and Solé-Ollé 2007). Regarding the resulting tax competition strategy, the initial literature pointed at positive correlations in the tax rates of neighboring local authorities in many cases (e.g., Brueckner 2003, Revelli 2005). This could be interpreted as an indication that theoretical modeling based on the Nash equilibrium with positively sloped reaction functions is consistent with the empirical evidence. However, the earlier empirical literature often worked with spatial models in which it is difficult to distinguish between spatial interaction and spatial autocorrelation (Gibbons and Overman 2012). Subsequent work using quasi-experimental methods has often been unable to demonstrate significant interaction (e.g., Lyytikäinen 2012, Baskaran 2014).[1] Against this background, the existing empirical literature is not very conclusive on which forms of competition are most relevant in practice.

3 Data and Institutions

To explore the effects of the introduction of a minimum business tax rate, we employ annual data for German municipalities for the years 1999 to 2008.[2] These municipalities obtain a large part of their revenues from a local business tax, which is essentially a tax on profits, although

[1] For a survey, see Agrawal, Hoyt, and Wilson (2022).

[2] More detailed information on data sources is available in Appendix A.

the tax base is augmented by some additions such as interest expenses as well as deductions (cf. Freichel et al. 2020). While the law governing the business tax is a federal law, the actual tax rate is set by the municipality. Actually, German municipalities determine the so-called business tax multiplier (*Hebesatz*). In the time period under investigation, the statutory tax rate is calculated by applying this multiplier to a base tax rate of 5%. Taking into account that the tax payments are deductible from the tax base, a business-tax multiplier of say 300 results in a statutory rate of 13% ($= \frac{300\% \times 0.05}{1+0.05\times 300\%}$).[3]

Before a minimum tax rate was introduced, a number of municipalities had set their tax multipliers below a level 200. Some of them even set the multiplier to zero, resulting in a zero tax rate. In the year 2004, following a political debate about municipal "tax havens", a provision was added to the federal tax law that requires all municipalities to set a business tax multiplier of at least 200, resulting in a minimum tax rate of about 9.1% ($= \frac{200\% \times 0.05}{1+0.05\times 200\%}$). The law was finally passed on December 19, 2003 and came into force on January 1, 2004.[4]

Besides of the minimum tax, the municipalities are free to choose their business tax multiplier. Yet, in each federal state, they are integrated into a fiscal equalization system determining grants to individual municipalities. These grants provide an incentive to choose higher tax rates (e.g., Buettner 2006, Egger, Koethenbuerger, and Smart 2010, Rauch and Hummel 2016). However, the introduction of the minimum tax has no direct influence on the equalization grants.[5]

All tax-haven municipalities are located in five states in the east and north of Germany. The

[3] In the year 2008, the base tax rate was decreased to 0.035 while the deductibility of tax payments was abolished.

[4] The bill to introduce a minimum tax into the Business Tax Law was first discussed in the *Bundesrat* (upper house) on August 15, 2003 (Bundestags Drucksache 15/1517) and then introduced to the *Bundestag* (lower house) on September 8, 2003.

[5] The equalization systems faced by the municipalities under investigation are very similar, differing only slightly in the reference rates (Lenk and Rudolph 2004) and the degree of redistribution (Lenk and Rudolph 2004b). Unlike in the case of the Canadian provinces, there is no direct influence on the reference rate that is used to compute the tax capacity, however. Only few states rely on tax-rate average in order to determine the reference rate, and if so, the number of municipalities is so large that the individual jurisdiction has no direct impact on the reference rate.

estimation sample includes all municipalities in these states and in two adjacent states, as some of the tax-haven municipalities are situated close to their borders. This enables us to work with a contiguous set of regions, excluding only the urban states of Berlin, Hamburg and Bremen, where the institutional setting differs.

In the time period under investigation, in some states, reforms of the administrative boundaries of municipalities were implemented. These reforms aimed at reducing the number of municipalities by merging adjacent municipalities into larger units. In some cases, smaller municipalities are incorporated in existing municipalities. In other cases, existing municipalities are merged into new units. In order to provide a comprehensive picture of the development of the tax policy of the municipalities despite the changes in the administrative boundaries, we proceed as follows. First, we define a base period. Since a first political initiative to implement a minimum tax rate was made in the year 2003, our analysis uses the year 2002 as our base period, i.e. before the introduction of the minimum tax rate and before the debate about regulating tax havens with a federal law gained traction. We also determine the spatial association between the municipalities using this base period. Second, we construct a panel dataset for these municipalities around this period. If a merger takes place in the subsequent year, we extrapolate the development of the tax rate for each affected municipality. Depending on the type of merger, we proceed differently. Either, we assign the tax rate of the new entity to all observations starting with the first period when the merger become effective, or, if the merger contract specifies transition periods, assign the relevant tax rate.[6] In the third step, as part of the empirical analysis, we account for the mergers either by including control variables or by removing the relevant observations altogether.

Table 1 provides descriptive statistics for the 6,751 municipalities in the resulting dataset. Most

[6] In various cases, the affected municipalities sign an incorporation agreement. This addresses, among other things, the future tax policy. Typically this involves the definition of a transition period during which the original districts may pursue their own tax policy for their parts of the new entity, see Government of Saxony (Freistaat Sachsen) (2016).

Table 1: Descriptive Statistics

	Mean	Median	Std. dev.	Min	Max
Population	4346.43	1001.00	15989.63	3.00	518088.00
Population density	116.23	61.06	180.76	0.66	2537.91
Business tax multiplier	314.53	300.00	39.89	0.00	510.00
Business tax revenue (in € per capita)	239.29	49.90	8751.66	-7584.58	1.26e+06
Employees per capita[a]	0.19	0.15	0.19	0.00	8.56
Firms per capita[a]	0.02	0.02	0.02	0.00	1.74
Incorporated in existing municipality	0.05	0.00	0.22	0.00	1.00
Incorporated in new municipality	0.03	0.00	0.16	0.00	1.00
Inclusion of a municipality	0.02	0.00	0.13	0.00	1.00

Notes: Statistics for the total sample 6,751 municipalities in the years 1999 to 2008. [a] missing values encountered

Table 2: Variable Means in the Years 1999 to 2002 by Sample

Municipalities	All	Tax havens	Neighbors	Other
Population	3539.85	999.63	2520.77	3690.38
Population density	116.16	46.67	105.95	117.89
Business tax multiplier	308.74	170.87	299.74	310.63
Business tax revenue per capita	150.45	368.49	278.70	132.00
Employees per capita[a]	0.19	0.26	0.21	0.19
Establishments per capita[a]	0.02	0.06	0.02	0.02
No. Municipalities	6,751	30	796	5,925

Notes: Average characteristics based on different samples for municipalities in the years 1999 to 2002. There are 6,751 municipalities in the total sample, 30 in the sample of tax-haven municipalities, 796 municipalities neighboring to the tax-haven municipalities (within 15km radius) and 5,925 other municipalities. [a] missing values encountered.

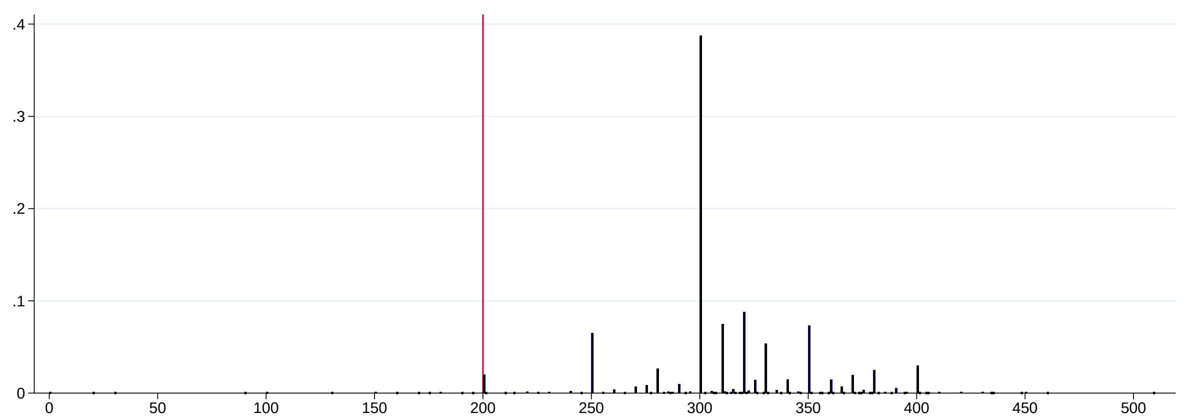
of the municipalities are rather small; the average population is around 4,350 residents, the median population number is about 1,000 residents. As some cities are included, the maximum population number is around half a million residents. The business tax multiplier shows considerable variation, ranging from 0 to 510, thus implying a range in the tax rate from 0% to 20.3%. While displaying considerable variation, the mean of the tax revenues per capita is 239 €. The maximum amount exceeds even a million € per capita. The minimum is negative, indicative of a case, where reimbursements of advance tax payments exceed regular tax receipts. A small fraction of observations refers to municipalities that are merged into larger units, in most cases (5% of observations) they are incorporated in existing municipalities.

Table 2 reports means of variables for the years before the introduction of the minimum tax for the whole sample and for three subsamples. The latter includes the group of tax-haven municipalities. We also report means for neighboring municipalities, which are located close to the tax-haven municipalities. Obviously, the definition of this group requires to take account of the spatial structure of the municipalities, and we provide the details in the subsequent section. For now, it may suffice to say that in the base-line specification neighbors comprise all municipalities located in distance of up to 15km from a tax-haven municipality. The last subsample refers to all other municipalities.

As the table shows, thirty municipalities are classified as tax-haven municipalities. The mean business tax multiplier in the years 1999 to 2002 for this group is 171 – below the minimum rate of 200 and equivalent to a statutory tax rate of only 7.9%. However, within these four years their tax policy became more aggressive. After rules for formula apportionment were alleviated in 2001, tax-rates were further reduced and the mean business tax multiplier reached 126 in the year 2002, equivalent to a statutory tax rate of 5.9%. On average, the adjustment required to comply with the minimum tax amounts to 74 multiplier points, equivalent to tax-rate increase by 3.2 percentage points. Three of the tax-haven municipalities even had charged tax multipliers of zero and had to adjust their multiplier by the full 200 multiplier points.

The second group of neighboring municipalities comprises almost 800 jurisdictions: For them, the average business tax multiplier is about 300 (equivalent to a statutory tax rate of 13%). Comparing tax-haven and neighboring municipalities reveals some interesting facts. First of all, tax-haven municipalities are small in terms of population relative to the neighboring jurisdictions. This is consistent both with theoretical predictions (e.g., Hansen and Kessler 2001 and Kanbur and Keen 1993), and with empirical findings regarding international tax havens (Dharmapala and Hines 2009). Despite being small, and even though some of them charge zero tax rates, local tax havens actually report higher tax revenues per-capita amounting to 369 €

Figure 1: Distribution of Pre-Reform Business Tax Multipliers



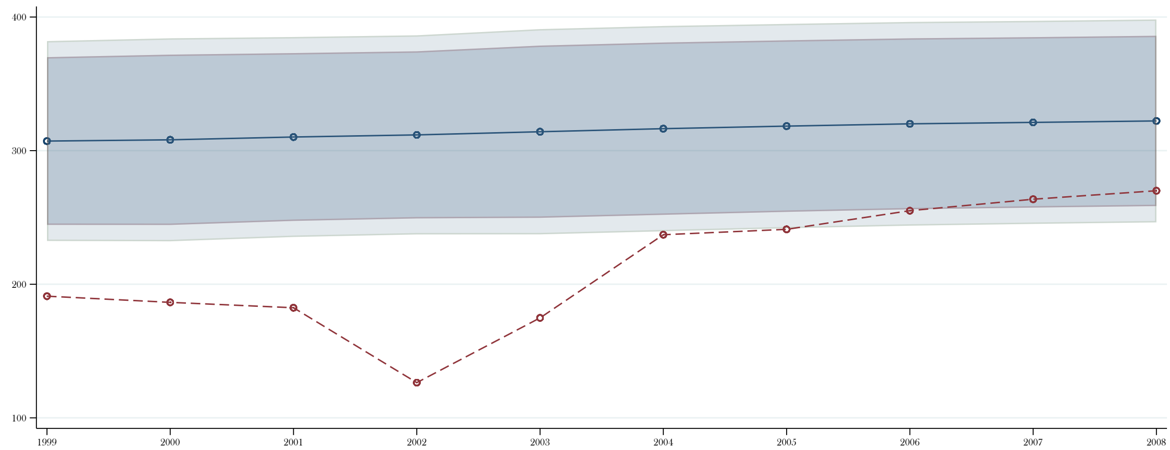
Notes: Histogram of business tax multipliers in the year 2002 for all seven states. The red vertical line indicates the minimum tax multiplier of 200.

on average. This figure is about 2.5 times higher than the sample average of about 151 €. Also the employment density as well as the number of firms per-capita is relatively high. This points to a greater locational attractiveness, which may of course be driven by the low tax rate. Even though neighboring municipalities are bigger relative to the tax-havens, they are still smaller and display lower population density than the rest of the sample. This indicates that tax-havens are located in the periphery rather than in the more metropolitan areas.

A histogram of the pre-reform distribution of business tax multipliers in the year 2002 is provided by Figure 1. While most municipalities are charging tax rates well above the minimum level of 200, the graph shows spikes at specific rates, such as at a business tax rate of 300. It should be emphasized that in the year 2002, there is no restriction regarding the level of the multiplier. Hence, the characteristic spikes in the tax-rate distribution indicate that a large number of jurisdictions is pursuing a passive tax policy, where the local business tax multiplier is just set equal to a general reference value. In fact, the spike at a business tax multiplier of 300 is most prevalent in the state of Thuringia, where it is the reference value in the state's fiscal equalization scheme.[7] The fact, that so many municipalities charge identical tax rates, can been

[7]Figure B.1 in the Appendix provides separate histograms for each state indicating that Brandenburg, Mecklenburg-Vorpommern, Sachsen-Anhalt and Thüringen all show characteristics spikes at a business tax mul-

Figure 2: Average Business Tax Multipliers



Notes: Solid line depicts the mean business tax multipliers together with and 95% (dark grey) and 90% (ligh grey) confidence bounds for all municipalities except tax-haven municipalities in the year 1999 to 2008. Dashed line depicts the mean business tax multiplier for municipalities charging a multiplier below 200 in 2002.

rationalized as some form of pooling equilibrium, which may arise under yardstick competition (Buettner and Schwerin 2016).

Figure 2 depicts the development of the mean business tax multiplier over time. The dashed line reports the mean tax rate for the tax-haven municipalities, the solid line shows the mean business tax multiplier in other municipalities. As the graph shows, until the year 2003, the average tax multiplier in the tax-haven municipalities was significantly below the rest of the sample. As noted above, tax-haven municipalities have tended to lower their business tax multiplier and the average figure shows a minimum in the year 2002. After the minimum tax rate was introduced, the average multiplier of these municipalities increases and gradually exceeds the 90th percentile of the cross-sectional distribution. Despite the increase of tax rates, average tax revenues tend to decline.[8]

tiplier of 300. The only difference is Schleswig-Holstein, where the modal value is at a level of 310, corresponding to the higher local reference figure (Lenk and Rudolph 2004).

[8] See Figure B.4 in the Appendix.

4 Methodology

Denoting the period before the minimum tax was implemented with $t = 0$, the local discretion in tax policy results in a tax-rate distribution: τ_{i0} for jurisdictions $i = 1, ...M$. The imposition of the minimum tax rate $\underline{\tau}$ forces jurisdictions, where it is binding, to set a higher tax rate. Formally, jurisdiction k with a tax rate $\tau_{k0} \in [0, \underline{\tau}]$ is forced to increase its tax rate after implementation by at least $\Delta\underline{\tau}_k = \underline{\tau} - \tau_{k0}$. This forced increase in the tax rate constitutes a tax-policy shock which may trigger changes in the tax policy also of competing jurisdictions.

Following the empirical literature on local policy interactions (e.g., Agrawal, Hoyt, and Wilson 2022), the set of competing jurisdictions is operationalized by neighboring jurisdictions. More precisely, we assume that the forced increase of the tax rate creates a *spatial* tax-policy shock which exerts a treatment effect on jurisdictions that are in a certain geographical proximity.

To construct the spatial tax-policy shock we employ methods of spatial statistics (e.g., Griffith 2012) and define a set of weights $\mathsf{w}[i, j]$ for any pair of jurisdictions i and j in the dataset. If a jurisdiction j is considered to be neighboring to jurisdiction i, $\mathsf{w}[i, j] = 1$, else the weight is zero, $\mathsf{w}[i, j] = 0$. We classify neighbors by setting a cut-off distance between the geo-referenced administrative centers of the jurisdictions. This enables us to define the neighborhood W_i for each jurisdiction i by stating that $k \in \mathsf{W}_i$, if $\mathsf{w}[i, k] = 1$.

We strive to avoid parametric assumptions about how the tax-policy shock exerts effects across space. In the baseline specification, we set the value for the tax-policy shock to one if at least one municipality in the neighborhood has charged a tax rate below the minimum rate. Based on jurisdiction i's neighborhood, the tax-policy shock is formally defined as

$$\text{Tax-shock}_i = \begin{cases} 1 & \text{if} \quad \exists k \in \mathsf{W}_i : \tau_{k0} < \underline{\tau} \\ 0 & \text{if} \quad \forall k \in \mathsf{W}_i : \tau_{k0} > \underline{\tau} \end{cases}$$

Given the definition of the tax-policy shock, we explore the effects on other jurisdictions' tax policies. A convenient way to operationalize the empirical estimation of the treatment effect is to run a regression

$$y_{i,t} = \alpha_i + \beta\, \mathsf{I}_t\, \text{Tax-shock}_i + \gamma_t + u_{i,t}, \qquad \forall i : \tau_{i0} > \underline{\tau}, \tag{1}$$

where $\mathsf{I}_t = 1$ in the years after the minimum tax rate is introduced, and else $\mathsf{I}_t = 0$. $y_{i,t}$ indicates the outcome variable. γ_t reflects year-specific fixed effects.[9] α is a municipality-specific fixed effect which captures all time-invariant characteristics including the spatial interdependence in the cross-sectional distribution (Case 1991).

In the basic specification the dependent variable is the business tax multiplier and β measures the treatment effect of the spatial tax-policy shock on the local tax rate. Note that our specification does not aim at estimating the slope of a tax-policy reaction function, which is the focus in the literature on interactions between jurisdictions in tax competition (e.g., Brueckner 2003, Agrawal, Hoyt, and Wilson 2022): In contrast, the tax-policy shock in regression (1) does not report the actual tax rate change in the tax haven. Rather, it indicates whether a nearby tax haven is required to adjust its tax rate due to the minimum tax. We therefore follow a reduced-form approach and directly explore the effect of the introduction of a binding minimum tax rate on neighboring jurisdictions' tax policy. This enables us to determine the effect on the tax rate distribution – without the need to determine tax-policy reaction functions. Our specification can be regarded as a spatial difference-in-differences approach (e.g., Delgado and Florax 2015, Butts 2023). In fact, as our focus is on the neighbors of tax-haven jurisdictions, β gives the average *indirect* treatment effect (AITE). It captures both the response to the tax policy change in the nearby tax-haven as well as the resulting tax-policy interaction among the neighboring municipalities. By excluding tax-haven municipalities from the estimation sample, we ensure

[9] In order to take account of the post-unification transition, in the baseline specification, we also add a separate set of year-specific fixed effects for the five east German states.

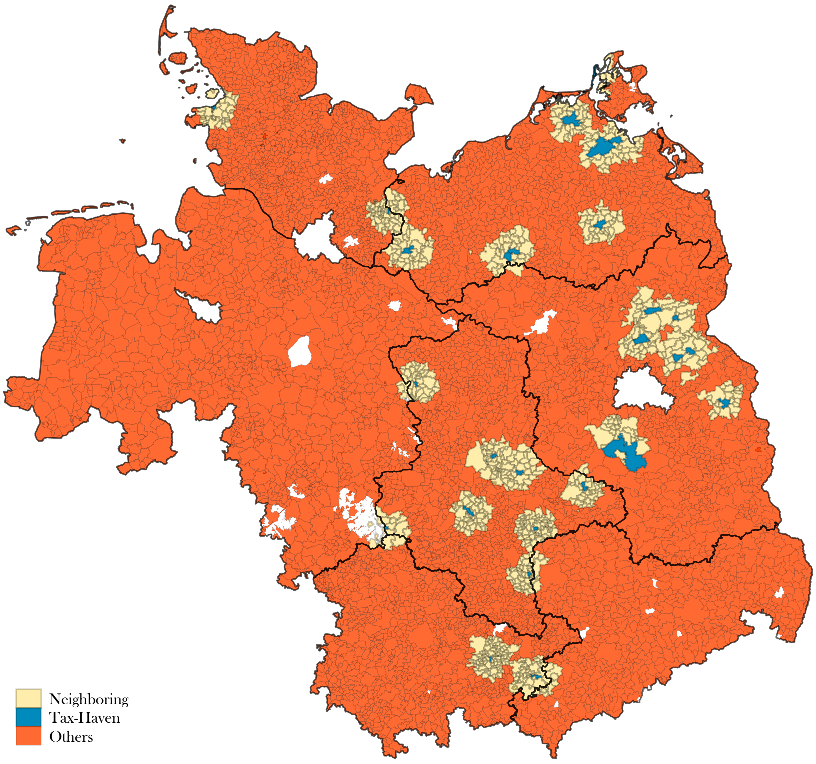
that the control group consists of units that are neither treated directly nor indirectly (Delgado and Florax 2015).

The basic specification uses a simple binary indicator capturing the presence of a tax-haven municipality in the neighborhood, which provides us with an estimate of the AITE of the tax-policy shock. To take account of differences in the intensity of the shock we also employ a specification, where the shock is scaled between 0 and 1 depending on the largest required tax-rate adjustment in a nearby tax-haven municipality. A value of unity indicates that this municipality has previously set the tax rate to zero and is forced to increase the business tax multiplier by a maximum of 200 points, a value of 0.5 indicates that the business tax multiplier is increased by 100 points, etc. Another specification relates the number of tax-haven municipalities to the total number of neighboring municipalities and take a spatial average of the tax-policy shock indicator $\sum_k \omega[i,k] \, 1(\tau_{k0} < \underline{\tau})$, where the weights are the above spatial weights scaled with the total number of neighbors. A still different specification simply rests on a spatial average of the required increase in the tax rate among all neighboring municipalities $\sum_k \omega[i,k] \max(0, \Delta\underline{\tau}_k)$. Whereas the latter two specifications are more in line with the conventional approach to defining spatial lags in the spatial-econometrics literature (e.g., Anselin 2002), they rest on specific assumptions on the tax-policy response and imply that the tax-policy shock has a maximum impact, if the neighborhood entirely consists of tax-haven municipalities.

The basic specification presumes that all jurisdictions exposed to the tax-policy shock respond in the same way. The theoretical discussion, however, suggests that the response might differ depending on the tax-competition strategy of the respective jurisdictions. In particular, those jurisdictions that have set a relatively high tax rate before the introduction of the minimum tax rate may respond differently than those that have set lower tax rates. This suggests exploring treatment heterogeneity based on the initial tax rate distribution.

The identification of the treatment effect is based on the assumption that exposure to the tax-

Figure 3: Map of Treated Municipalities: Neighbors Defined by 15km Radius



Notes: Tax-haven municipalities are municipalities with a tax rate below the minimum rate in 2002. Municipalities are depicted as neighboring, if they are in a 15km radius of tax-haven. The urban states of Berlin, Hamburg and Bremen are left blank. Grey lines indicate municipal, solid black lines state boundaries.

policy shock is localized. Municipalities further away are not affected and, by assumption, are subject to the same trend. A precondition is that the effects of a local shock are subject to some form of distance decay (Fotheringham 1981) such that more distant municipalities can serve as a control group. In our context, this requires that both the response to a change in a nearby tax-haven municipality as well as the resulting interaction of the tax policy changes among neighboring municipalities become weaker with larger distance to the tax haven municipality.

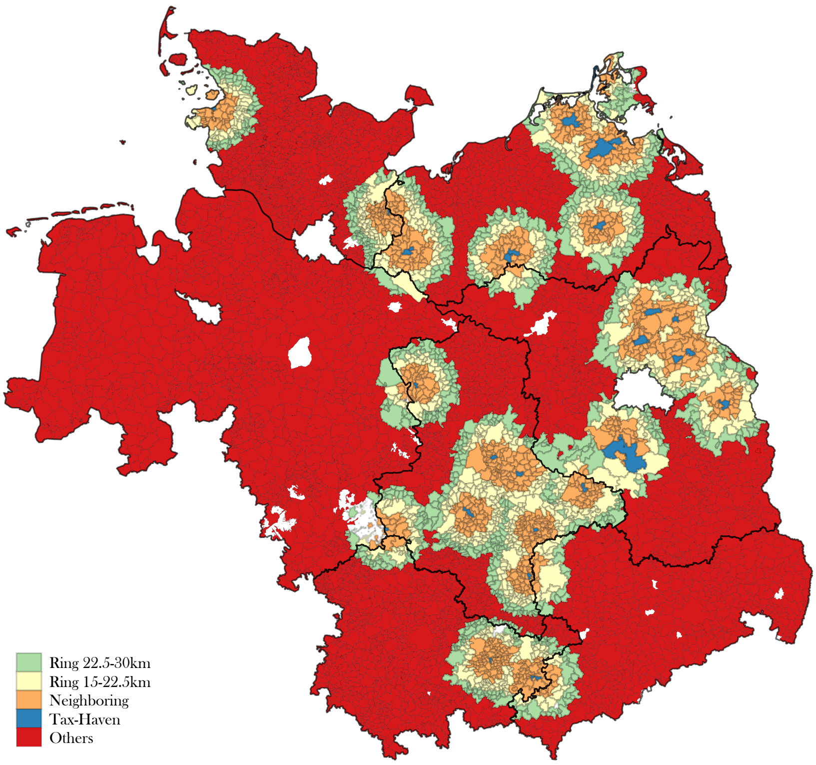
In our baseline specification, we employ a spatial structure, where all municipalities in a 15km radius of a specific jurisdiction are considered as neighbors (for the geographic information see Appendix A). This choice is based on the assumption that competition between locations is particularly intense when the locations are within a usual commuting distance of workers. Indeed, within this distance, relocation of production or the wage bill, to optimize the shares in the formula apportionment, would be possible without replacing the entire workforce. Our choice of 15km is based on the fact that, in the years under consideration, this distance reflects the average commuting distance in Germany.[10]

Figure 3 provides a map illustrating neighboring municipalities based on the 15km distance. The blue (dark) spaces indicate tax-haven municipalities. In most cases these municipalities are fully surrounded by neighboring municipalities indicated by yellow (bright) spaces. As the neighborhood is based on the distance between the geo-referenced administrative centers of municipalities and not on the existence of a common border, in some cases, adjacent spaces are not included in the group of neighbors. However, this reflects a specific topographic situation, e.g., cases where the geo-referenced administrative center is located at the edge of the respective municipal area. Note that the map also shows a number of white spaces. This partly reflects special administrative structures in which the tasks of the municipalities are assigned to other units, such as the urban states of Berlin, Hamburg, Bremen. In other cases, the white spots reflect areas that are not associated to municipalities, mostly situated in national parks or in military training grounds. However, these areas do not participate in tax competition and therefore be neglected.

Although we base the definition of neighbors on the commuting behavior of workers, it is possible that the tax policy exerts significant effects on municipalities that are more distant. To explore the spatial extension of the tax-policy shock effects, we define groups of observations with greater distance from the tax-haven municipalities. This approach enables us to approximate and test the slope of what has been referred to as a spatial "treatment effect curve" in the analysis of geo-coded micro data (e.g., Butts 2023). More specifically, we extend the maximum distance from 15km to 22,5km and up to 30km. As Table 3 shows, each of these expansions roughly adds the same number of observations to the group of treated municipalities.

[10]The average commuting distance increased from 14.6km in 1999 to 16.6km in 2013 (Pütz 2015).

Figure 4: Map of Ring Specification



Notes: Tax-haven municipalities are municipalities with a tax rate below the minimum rate in 2002. Municipalities are depicted as neighboring, if they are in a 15km radius of a tax haven. The rings indicate groups of municipalities with greater distance to the tax havens, i.e. in 15 to 22.5km and in 22.5 to 30km distance. The urban states of Berlin, Hamburg and Bremen are left blank. Grey lines indicate municipal, solid black lines state boundaries.

The upshot of the extensions is shown in Figure 4. Municipalities categorized as neighbors of tax-havens are indicated as above. In addition, the map highlights the jurisdictions that belong to groups with greater distance around the tax-havens. The figure also indicates that a further extension is not feasible: already at a distance of 30km, the tax-policy shocks display considerable overlap. If we extend the distance further, municipalities in entire states will be considered treated and much more structure is required to deal with municipalities that are subject to tax-policy shocks from multiple tax-havens. Hence, we reach the limits of the methodology. Though likely captured in the year-fixed effects, effects over larger distances such as inter-regional competition effects as in Janeba and Osterloh (2013) cannot be identified.

A general issue in spatial regression analysis is the possible existence of spatial error-correlation: local shocks that affect the tax policy in a neighboring jurisdiction might be correlated with

Table 3: Alternative Definitions of Neighbors

	Distance		
	Minimum	Maximum	Number
Basic group of neighbors	0	15km	796
First extension	15km	22.5km	783
Second extension	22.5km	30km	825

Note: Number of municipalities within the specified distance to a tax-haven municipality.

shocks in other neighboring jurisdictions. For robust inference, we follow Conley (1999) and provide spatial autocorrelation consistent standard-error estimates. Another concern with standard-error estimates are random-group effects, which may arise from serial correlation at the level of municipalities. Therefore, we employ two-way clusters (Correia 2019). More specifically, we follow Hsiang (2010), Fetzer (2021) and Colella et al. (2019) and combine spatial autocorrelation consistent standard errors based on Conley (1999) with a Bartlett kernel estimate of serial correlation at the level of the municipality.[11]

For the definition of spatial effects we rely on the administrative division and boundaries in 2002. Changes that occurred in subsequent years due to mergers are problematic if the merger involves tax havens or takes place between municipalities that are categorized as treated and control observations. The corresponding observations are removed. However, mergers can also have effects on tax policy if they occur within the two groups of treated and control observations. In particular, if a municipality joins an existing municipality, it may have to adjust to the new tax rate. Even if the involved municipalities charge the same tax rates, the merger may result in a revision of tax policy, due to positive effects on local economic activity (Egger, Koethenbuerger, and Loumeau 2022). In order to control for the possible effects on local tax policy, the basic specification includes dummy variables for the three types of municipal mergers. As a robustness check, we also report results of specifications, where all observations associated with mergers are dropped.

[11]Regressions for subsamples report heteroscedasticity and serial correlation consistent standard errors.

With the business tax multiplier as outcome variable, the basic specification explores differences in the relative development of tax rates. Yet, this development does not only reflect revisions of the own local tax policy, but also changes in other jurisdictions' tax policies. In order to check whether the observed developments are actually associated with an active revision of the municipalities' tax policies, we explore the dynamics of tax rate policies. To do so, we replace the dependent variable with a binary indicator that indicates whether the tax rate is adjusted. More specifically, if the business tax multiplier in municipality i in year t differs from the previous period $t-1$, the indicator has unit value; if the tax multiplier remains unchanged, the indicator is zero. Formally, with the binary indicator of tax rate changes as dependent variable, the estimation model is a linear probability model, where β measures the AITE on the probability of adjusting the tax rate.

5 Results

Basic Results

Results from basic panel regressions are reported in Table 4. The dependent variable is the actual business tax multiplier. Column (1) reports results obtained using the full sample. The tax-policy shock indicator shows a small negative, but statistically insignificant effect, indicating that municipalities located close to tax-haven jurisdictions do not change their tax policy when the minimum tax is introduced. Column (2) includes controls for municipal mergers. While the effect of the tax-policy shock is not much affected, the signs for the controls indicate that mergers have some effects. In particular, municipalities that are incorporated into an existing municipality tend to increase the multiplier. This is intuitive, as those incorporations tend to involve small municipalities that typically show low tax rates. Column (3) reports the result of specification (1) after removing all observations that are associated with a merger and confirms

Table 4: Basic Regression Results

	(1)	(2)	(3)
Tax-shock	-0.856	-0.693	-1.525 *
	(1.032)	(0.956)	(0.873)
Incorp. in existing munic.		16.894 ***	
		(2.192)	
Incorp. in new munic.		-0.774	
		(1.779)	
Inclusion of another munic.		3.162 **	
		(1.444)	
Municipality FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2	0.882	0.885	0.909
N	65,388	65,388	60,767

Notes: Dependent variable is the business tax multiplier. The specification in column (2) includes binary controls for mergers, distinguishing incorporation in existing municipality from incorporation in a new municipality and the inclusion of another municipality. Specification (3) excludes municipalities after any type of merger took place. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. Standard errors are heteroscedasticity and autocorrelation robust, as well as spatial autocorrelation consistent based on Conley (1999). The distance cut-off for spatial correlation is set to 30km and the lag cut-off for temporal correlation to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

the small negative effect of the tax-policy shock on the tax multiplier.

Quantitatively, the estimated effect of the tax-policy shock is very small. It points to a decline of the business tax multiplier of 1 to 2 points. Evaluated at the mean business tax multiplier in the neighboring regions of 300 (see Table 2), this translates into a reduction of the statutory business tax rate by around 0.04 to 0.08 percentage points.

Effects along the Tax Rate Distribution

To explore whether the empirical effect of the tax-policy shock varies across the tax-rate distribution, Table 5 reports results from regressions where the tax-shock variable is interacted with the level of the tax rate. As in Table 4, column (1) reports results obtained while ignoring municipal mergers, column (2) reports results where dummy variables for municipal mergers are included, whereas column (3) reports results where observations associated with any municipal

Table 5: Results: Interaction with Initial Tax Rate

	(1)	(2)	(3)
Tax-shock	62.030 ***	59.425 ***	36.702 ***
	(10.006)	(9.459)	(9.399)
Tax-shock × tax mult. in 2002	-0.209 ***	-0.200 ***	-0.127 ***
	(0.033)	(0.031)	(0.031)
Incorp. in existing munic.		16.603 ***	
		(2.170)	
Incorp. in new munic.		-0.622	
		(1.757)	
Inclusion of another munic.		3.445 **	
		(1.445)	
Municipality FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2	0.883	0.886	0.910
N	65,388	65,388	60,767

Notes: Dependent variable is the business tax multiplier. The specification in column (2) includes binary controls for mergers, distinguishing incorporation in existing municipality from incorporation in a new municipality and the inclusion of another municipality. Specification (3) excludes municipalities after any type of merger took place. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. Standard errors are heteroscedasticity and autocorrelation robust, as well as spatial autocorrelation consistent based on Conley (1999). The distance cut-off is set to 30km and the lag cut-off for temporal correlation to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

mergers are dropped.

All specifications point at a negative effect of the tax-policy shock, provided the initial tax rate of the neighboring jurisdiction is sufficiently high. If we evaluate the interaction term with the average tax multiplier of the neighboring regions of about 300 (see Table 2), the point estimate of the tax-shock effect in specification (2) turns out be close to the findings of Table 4. Evaluated at a higher tax multiplier of say 350, the tax-shock effect involves a decline of the business tax multiplier by about 11 points. For a tax multiplier of 400, the tax-shock effect amounts to a decline of the business tax multiplier by about 21 points.

The specifications employing the interaction term include no explicit variable capturing the level of the tax rate in the base year, since this is nested in the municipality fixed effect. However, the specification is restrictive in the sense that it implicitly assumes that the local tax rates

Table 6: Results for Subsamples based on the Tax Rate Distribution

	Sample	Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	$200 < \tau_{i0} \leq 290$	-1.777	41.659***	7.888 **	6.315	0.720	9.831
		(2.028)	(4.065)	(4.012)	(4.167)		
(2)	$290 < \tau_{i0} \leq 350$	-0.699	13.948***	-2.141	2.435 **	0.747	47.820
		(0.682)	(1.540)	(1.461)	(1.336)		
(3)	$350 < \tau_{i0}$	-14.398***	-33.744***	-26.720 **	-0.192	0.692	7.735
		(5.344)	(8.344)	(11.093)	(4.572)		
(4)	$200 < \tau_{i0} \leq 270$	-2.614	42.769***	12.340 **	7.654	0.662	6.629
		(2.441)	(4.233)	(5.328)	(4.849)		
(5)	$364 < \tau_{i0}$	-13.595**	-34.281***	-29.572 **	1.105	0.660	6.685
		(6.193)	(8.492)	(11.697)	(5.255)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

follow the same trend across the entire tax-rate distribution, i.e. high-tax municipalities follow the same general trend in tax policy as municipalities with lower tax rates. To explore effects of the tax-policy shock when group-specific tax-policy trends are taken into account, we apply the specification separately to different parts of the tax rate distribution.

Table 6 shows the results of separate estimates of the base model for specific parts of the 2002 tax rate distribution. In each specification, a full set of municipal as well as year fixed effects are included. Specification (1) reports results including only observations of municipalities with business tax multiplier between 200 and 290. Specification (2) reports results for a medium range with tax multipliers between 290 and 350. The third specification focuses on municipalities with business tax multipliers above 350. This division of the sample reflects (1) municipalities below the 15th percentile, (2) a medium part of the distribution above the 15th and below the 85th percentile, as well as (3) municipalities above the 85th percentile of the tax-rate distribution. Note that the large medium segment includes the spike in the tax rate distribution at the level of a business-tax multiplier of exactly 300.[12]

The comparison of the regression results across the three subsamples supports the inverse relationship between the tax rate in the base year and the response to the tax-policy shock. Whereas jurisdictions with low or medium tax rates in the base year show little or no response to the tax-policy shock in their neighborhood, jurisdictions with a high initial tax rate tend to lower their tax rates. For the top 15% of the pre-reform tax-rate distribution the point estimate indicates that the business tax multiplier is reduced by 14.4 points. The point estimate is relatively precise and significantly different from zero. Evaluated at the mean business tax multiplier of about 383 in this segment of the distribution, the implied change of the tax rate amounts to about 0,5 percentage points.[13]

[12]In order to check whether the results are driven by municipalities that used to set the business tax multiplier at a common reference point, we also employ regressions where all municipalities are excluded, that charge a business tax multiplier identical to the state-specific reference rate in 2002. However, results are not much effected, see Table C.6 in the Appendix.

[13]Note that the standard errors are robust to the inclusion of spatial autocorrelation and are similar to standard

Table 6 also shows that the effects of the municipal mergers vary systematically across the tax-rate distribution. The effect of an incorporation in an existing municipality reported for the lower part of the distribution indicates a sizeable increase of the business tax multiplier, whereas the effect for the high-tax sample indicates a decrease. This is intuitive as it indicates that the tax adjustment depends on the initial tax rate. If the incorporated municipality used to charge a low (high) tax rate, the adjustment is positive (negative). Municipalities incorporated in new entities show a similar pattern, but effects are less pronounced.

Specifications (4) and (5) report results for subsamples reflecting the bottom and top 10% of municipalities in the initial tax-rate distribution. The effects are quite similar to specifications (1) and (3). This supports the above division of the sample and suggests, in particular, that the top 15%, i.e. a tax multiplier higher than 350, is a useful definition of high-tax municipalities.[14]

Though the estimation results for municipalities with similar initial tax rates rely on more homogeneous subsamples of jurisdictions than the estimates obtained for the total sample, the difference-in-differences specifications still rely on a common-trend assumption within these samples. Figure 5 provides insights into whether, in fact, the pre-treatment period shows a similar time trend between municipalities with tax-haven municipalities in their neighborhood and the other municipalities that serve as a control group. It provides separate event study plots reporting the differential of the annual effects for these three groups. Plots (a)-(c) correspond to specifications (1)-(3), (d) to specification (5) of Table 6.[15] None of the plots shows any significant deviation between treatment and control groups prior to treatment. With regard to municipalities with initial tax rates in the top 15th and 10th percentiles, we see significant negative effects in all post-treatment periods, whereas for the other subsamples mostly insignificant

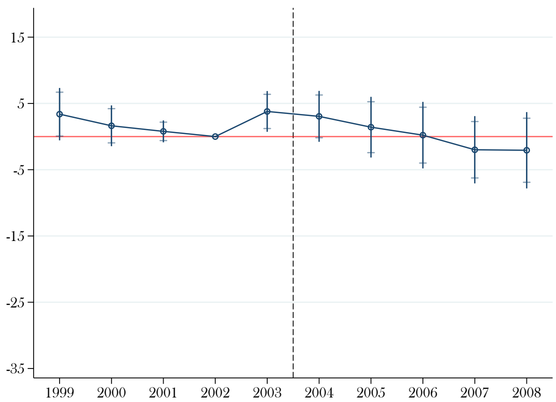
errors clustered on municipality level, see Table C.7 and C.8 in the Appendix.

[14]This view is confirmed by specification that use a broader definition of the lower and upper parts of the tax rate distribution. Table C.5 in the Appendix shows qualitatively similar results if the lower and upper parts represent the lowest and the top quintile. However, results for the top quintile, i.e. for a subsample that includes all municipalities with pre-reform business tax multiplier above 340, point at a smaller effect of the tax-shock.

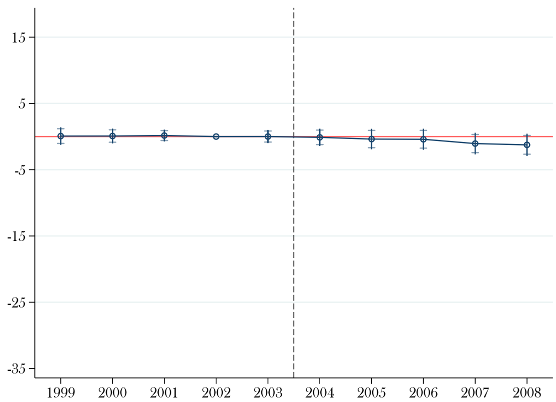
[15]The detailed estimation results are provided in the Appendix, see Table C.9.

Figure 5: Pre- and Post Reform Developments of sBusiness Tax Multiplier

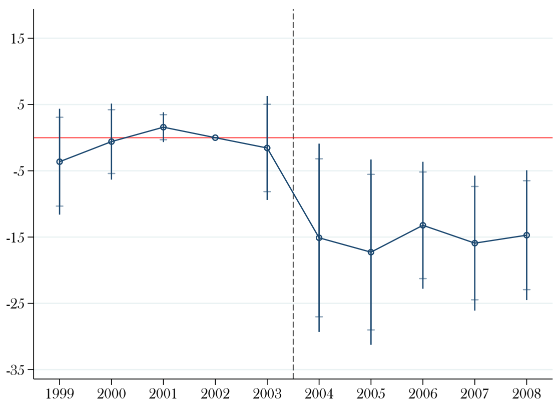
(a) Tax multiplier below 290 (lowest 15%)



(b) Tax multiplier from 290 to 350 (15–85%)



(c) Tax multiplier above 350 (top 15%)



(d) Tax multiplier above 364 (top 10%)

Notes: Plots of the coefficients along with confidence intervals of regressions of the business tax multiplier on year dummies interacted with the tax shock. The vertical lines indicate 95% confidence intervals, the horizontal markers indicate 90% confidence intervals. The plots refer to estimations for different samples based on the pre-reform tax rate distribution in 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. Coefficients of the interaction terms are depicted relative to the year 2002. For detailed estimates, see Table C.9 in the Appendix.

effects are found.

To address concerns that the results are affected by the municipal mergers, we checked results when all corresponding observations are excluded. However, the results for the different parts of the tax-rate distribution as well as the associated event-study plots are confirmed.[16]

Note that the plots point to a swift response of high-tax municipalities, as they tend to increase their tax rate already in the year when the minimum tax is introduced. However, this is not necessarily an indication of anticipation, as municipalities do not need to fix the tax rate at the beginning of the year. In fact, they can increase the business tax multiplier until June 30 of a year, and can lower it even until the end of the year.

Tax Policy Revisions

The results suggest that high-tax municipalities, in particular, have reacted to the tax-policy shock by revising their tax policy. In order to shed light on whether the decline in the tax rates relative to the control group can actually be attributed to an active revision of the municipalities' tax policy, we also examine the probability of tax rate changes by replacing the outcome variable with a binary indicator of these changes in each year relative to the previous period.

Table 7 provides the results for the same subsamples as above. In the specifications that refer to municipalities with low- or medium initial tax rates, no significant effects of the tax-shock are found. Specification (3) indicates that the tax-shock variable is associated with a significantly higher probability of tax policy revisions in high-tax municipalities, which increases by 7 percentage points. Specification (5) indicates an even stronger increase. Note that the higher probability of tax policy revisions is not driven by municipal mergers, which are captured by control variables and point to considerable tax revisions.

[16] The Appendix provides results obtained after excluding all municipalities that are associated with mergers. The results are, however, very similar. See Table C.10 and Figure B.2.

Table 7: Tax Policy Revisions by Subsample

	Sample	Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	$200 < \tau_{i0} \leq 290$	-0.010	0.182 ***	0.133 ***	0.094 ***	0.166	8.957
		(0.017)	(0.024)	(0.034)	(0.035)		
(2)	$290 < \tau_{i0} \leq 350$	0.006	0.263 ***	0.182 ***	0.135 ***	0.188	43.480
		(0.008)	(0.015)	(0.015)	(0.026)		
(3)	$350 < \tau_{i0}$	0.070 **	0.318 ***	0.437 ***	0.122 **	0.221	7.016
		(0.033)	(0.052)	(0.116)	(0.052)		
(4)	$200 < \tau_{i0} \leq 270$	-0.031	0.195 ***	0.134 ***	0.118 ***	0.168	6.046
		(0.019)	(0.025)	(0.040)	(0.041)		
(5)	$364 < \tau_{i0}$	0.088 **	0.316 ***	0.378 ***	0.173 ***	0.227	6.069
		(0.036)	(0.053)	(0.114)	(0.054)		

Notes: Dependent variable is an indicator for the change in the business tax rate relative to the previous year. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

As in the case of the analysis of the development of tax rates, the question arises as to whether the assumption of common trends is reliable. We have therefore also carried out more detailed analyses of the probability of tax-rate changes that consider pre- and post treatment developments. No anomalies are found before treatment. Closer inspection of the tax policy revisions of high-tax municipalities indicate that tax policy revisions are particularly frequent in the first year of the minimum tax where the probability increases to 15% or even 20%.[17]

Robustness Checks

The above specifications focus on the mere existence of one or more tax-haven municipalities in the neighborhood by using a binary indicator of the tax-policy shock. To see whether results vary, if further information is included, Table 8 provides results of specifications that employ alternative indicators of the tax-policy shock, focusing on the subsample of high-tax municipalities. For convenience, the first specification reports the basic result with the binary indicator. The specification (2) reports results of an indicator that includes the intensity of the induced tax rate change in the tax-haven municipality. Specification (3) and (4) use indicators that define the tax-shock in a way that is more standard in spatial econometrics by capturing the average of the binary indicator or of the required adjustment in all neighboring jurisdictions.

The negative tax-policy response is confirmed in all specifications. However, none of the alternative specifications shows a higher goodness of fit. This suggests that the tax-policy shock is well represented by a binary indicator for the presence of at least one tax-haven municipality.

A key assumption of the regression approach is that the effects of tax-rate increases in tax-havens weaken at greater distance to a tax-haven municipality: the basic specification rests on the assumption that the effect of the tax-policy shock is largely confined within a 15km distance.

[17] Plots of year-specific effects for neighboring municipalities tax policy revisions before and after the tax shock are provided in Figure B.3 in the Appendix. For detailed results see Table C.11 in the Appendix.

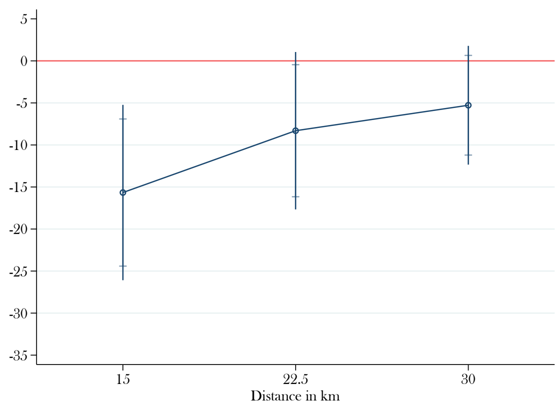
Table 8: Alternative Specification of Tax-Shock: High-Tax Municipalities

	(1)	(2)	(3)	(4)
Tax-shock	-14.398***			
	(5.344)			
Tax-shock: intensity		-29.932 **		
		(14.140)		
Tax-shock: spatial average 1			-335.744 ***	
			(113.284)	
Tax-shock: spatial average 2				-5.389 **
				(2.113)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.692	0.690	0.692	0.691
N	7,735	7,735	7,735	7,735

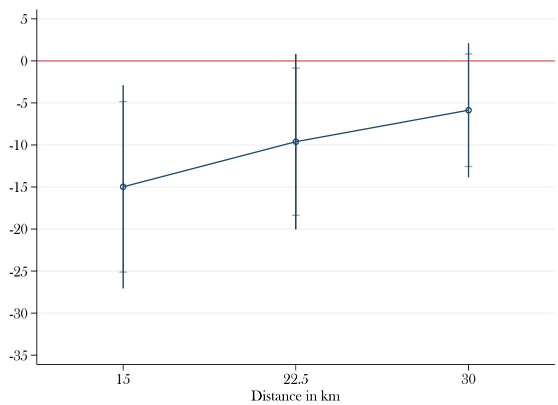
Notes: Dependent variable is the business tax multiplier. Regressions include municipalities in the top 15% of the pre-reform tax rate distribution. Tax-shock: intensity is an indicator that captures the intensity of the most relevant imposed tax rate change in the neighboring tax-haven municipalities, scaled between 0 and 1. Tax-shock: spatial average 1 is a spatial average of the number of tax havens in the neighborhood. Tax-shock: spatial average 2 is a treatment variable scaled by the actual imposed tax adjustment of close tax havens and the size of the neighborhood. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Figure 6: Tax-Shock Effects at Greater Distances: High-Tax Municipalities

(a) Tax multiplier above 350 (top 15%)



(b) Tax multiplier above 364 (top 10%)



Notes: Plots report coefficient estimates for neighboring municipalities within 15km of tax havens and for groups of municipalities with higher distance (i.e., between 15 and 22.5 and 22.5 and 30km) along with confidence intervals ordered by the maximum distance. The vertical lines indicate 95% confidence intervals, the horizontal markers indicate 90% confidence intervals. For detailed estimates see Table C.12 in the Appendix. Plot (a) refers to municipalities in the top 15% of the pre-reform tax rate distribution, plot (b) refers to municipalities in the top 10%.

To test whether the tax-policy shock exerts measurable effects also beyond this distance, we add indicators capturing the presence of tax-haven municipalities at greater distances.

While the detailed estimation results are provided in the Appendix, Figure 6 focuses on the effects found for the upper part of the tax-rate distribution by plotting point estimates of the coefficients together with confidence bands. In each plot three coefficients are reported: First, the tax-shock effect on neighbors defined as municipalities in a distance of up to 15km. Second, the tax-shock effect on municipalities with distance between 15 and 22.5km, and third, the tax-shock effect on municipalities with distance between 22.5km and 30km.

The plots show that the tax-shock effect clearly declines at greater distance to the tax-haven municipality. For the point estimates for the distances between 15 and 22.5km as well as 22.5 and 30km, the 95% confidence bounds include zero and we cannot reject the H0 hypothesis of no effect at this level of confidence. At the same time, the estimate for the tax-shock effect on neighbors with distance up to 15km proves robust even though broader groups of treated municipalities are included.

While the figure focuses on municipalities with relatively high tax rates, we also tested for tax-policy shock effects at greater distances for municipalities with lower initial tax rates. Though some small effects are found to be statistically significance at distances of 15 to 22.5km, for the wider range including distances of up to 30km no effects are found, supporting the view that the tax-shock effects are localized.[18]

The tax-policy of the neighbors of local tax havens may also be affected by other regional economic shocks. As a further robustness check, we employ GDP per capita at the state level as additional control variable. While the results consistently point to a positive effect, indicating

[18] The results are provided in Table C.12 in the Appendix. For the municipalities with relatively low tax rates, the point estimates indicate that business tax multipliers are reduced by up to 7 points, which is a tax rate decrease by about 0.28 percentage points. For the large group of municipalities with tax rates in a medium range, the above findings of small effects are confirmed.

that the business tax multiplier is set higher in years with relatively large GDP, the key finding of municipalities with high tax rates lowering their business tax multiplier in the response to the tax-policy shock proves robust.[19]

Potentially confounding effects on tax policy are also associated with political business cycles. Since the election dates in the seven federal states under consideration are synchronized, and since in four of the states the dates are almost identical, election cycles should already be partially represented by the year-specific fixed effects. As a robustness test, we estimated the specifications for the individual segments of the tax rate distribution including dummy variables. Following Foremny and Riedel (2014), we include binary indicators of whether the actual observation refers to an election year, to the last pre-election year, or to the first post-election year. While these indicators do have some predictive value, the estimates of the tax policy response to the tax-policy shock are hardly affected.[20] This suggests that the observed reaction to the minimum tax is not related to the political business cycle.

Alternative Dimensions of Heterogeneity

While most municipalities show no responses to the tax-policy shock, high-tax municipalities display a significant negative response. Since these municipalities tend to differ in terms of basic characteristics from the others, this raises the question of whether their tax-policy response reflects differences in those basic characteristics rather than their tax-policy strategy.

Table 9 provides variable means for the total sample as well as for low-, medium- and high-tax municipalities in the pre-reform period. The high-tax municipalities display much larger population and a much higher population density. To explore whether these characteristics are ultimately responsible for the heterogeneity of the effects of the tax-policy shock, we test

[19] See Table C.13 in the Appendix.

[20] The estimation results are provided in the Appendix, see Table C.16.

Table 9: Variable Means for the Years 1999 to 2002: Subsamples based on the Tax Rates

	All	0 – 15%	15 – 85%	85 – 100%
Population	3,550.93	1,087.28	2,458.62	13,669.97
Population density	116.46	61.62	108.61	237.83
Business tax multiplier	309.33	252.98	310.18	377.59
Business tax revenue per capita	149.49	133.85	157.67	118.37
Employees per capita[a]	0.19	0.17	0.19	0.25
Establishments per capita[a]	0.02	0.02	0.02	0.03
Incorporated in existing municipality[b]	0.10	0.15	0.10	0.05
Incorporated in new municipality[b]	0.05	0.05	0.05	0.02
Inclusion of a municipality[b]	0.04	0.05	0.03	0.04
No. Municipalities	6,721	1,022	4,917	782

Notes: Variable means for municipalities for the years 1999 to 2002, excluding tax havens. Subsamples are based on pre-reform tax rate distribution. [a] missing values encountered. [b] until 2008.

specifications that employ interactions with initial population size or density rather than with the initial tax rate.

Table 10 shows the results. Column (1) reports the effect of an interaction of the tax-shock variable with the population. No strong relationship with population size is found. Column (2) reports results from a specification in which the tax-shock variable is interacted with population density. The linear interaction term proves insignificant. We also explore the effects across subsamples. However, no differences are found regardless of whether the subdivision is based on population size or population density.[21] This suggests that the differential tax policy response of the high-tax municipalities is neither linked to population size nor to population density.

Tax Revenue Effects

The forced increase in tax rates in tax-haven municipalities could also have effects on the tax revenues of neighboring municipalities. This may be the result of direct effects, e.g., when the tax base is mobile and the former tax-haven municipality is losing locational attractiveness, or if profit shifting activities are reduced. Because tax policies of neighboring municipalities tend

[21] For the results, see Table C.14 in the Appendix.

Table 10: Results: Interaction with Initial Population and Density

	(1)	(2)
Tax-shock	-0.894	-1.165
	(0.990)	(1.078)
Tax-shock × population	0.079	
	(0.055)	
Tax-shock × pop. density		0.004
		(0.003)
Municipality FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.885	0.885
N	65,388	65,388

Notes: Dependent variable is the business tax multiplier. The indicator for population is the pre-reform municipality population in 1000. The indicator for population density is the pre-reform municipality population density per square kilometer. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust, as well as spatial autocorrelation consistent based on Conley (1999). The distance cut-off for spatial correlation is set to 30km and the lag cut-off for temporal correlation to 20 years. Sub-sample regressions are available in Table C.14. * denotes significance at 10%, ** at 5%, and *** at 1% level.

to change at least in high-tax municipalities, there might also be indirect effects. To explore the tax revenue effects, we employ an estimation approach similar to equation (1), where we replace the dependent variable with the tax revenues per-capita in municipality i in period t.

The results for the basic sample that includes municipalities irrespective of the initial tax rate are reported in Table 11. Specification (1) reports that a basic tax-shock variable relying on a 15km radius around tax-haven municipalities shows a positive revenue effect of about 34 euros per capita. The estimate is, however, very imprecise, and not significantly different from zero at a P-level of 10%. Specification (2) includes tax-shock indicators capturing the presence of tax-haven municipalities not only in the immediate neighborhood but also at greater distances. This specification indicates a positive tax revenue effects also at a distance of 15-22.5km, which is also estimated rather imprecisely, however.

We also explore whether revenue effects differ with the initial tax rate. The corresponding results

Table 11: Results: Business Tax Revenue

	(1)	(2)
Tax-shock 15km	33.823	48.264
	(63.848)	(64.429)
Tax-shock 15–22.5km		98.726
		(97.362)
Tax-shock 22.5–30km		-3.604
		(23.985)
Municipality FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.4836	0.4837
N	60,628	60,628

Notes: Dependent variable is the business tax revenue per capita. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. Municipalities are excluded after any type of merger took place. Standard errors are heteroscedasticity and autocorrelation robust, as well as spatial autocorrelation consistent based on Conley (1999). The distance cut-off is set to 30km and the lag cut-off for temporal correlation to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

do not point at significant tax revenue changes even we focus on the high-tax municipalities.[22] This is remarkable, as the tax rate is significantly reduced in these municipalities. In fact, if the tax base of high-tax municipalities were constant, based on the pre-treatment level of the tax rate, a revenue decline of about 4% should be found. The finding that tax revenues are unaffected hence suggests that the tax base in high-tax municipalities increases.

With regard to tax-haven municipalities, the above descriptive analysis indicates that per capita tax revenues are higher in tax-haven municipalities than in neighboring municipalities prior to the introduction of the minimum tax, even though the tax-havens charge low tax rates. After the introduction of the minimum tax, tax revenues of tax havens fell significantly relative to non-neighboring municipalities.[23] This suggests that the minimum tax-rate harms tax havens.

[22] See Table C.17 in the Appendix.

[23] See Table C.18 in the Appendix.

6 Summary and Conclusion

This paper provides an empirical analysis of the effects of a minimum tax rate on the tax policy of competing jurisdictions. The testing ground is the tax policy of German municipalities, which enjoy a constitutionally guaranteed right to determine the statutory tax rate of the local business tax – their main source of tax revenue. As some of the municipalities charged very low, in some cases even zero tax rates, a political debate about local tax havens commenced. In the year 2004, federal legislation introduced a minimum tax rate forcing municipalities to charge a business tax multiplier of at least 200 points, equivalent to a statutory tax rate of about 9.1% on firms' taxable profits. As a consequence, a number of tax-haven municipalities were forced to raise their tax rates. On average, the tax havens had to increase their tax rate by about 3.2 percentage points. We test whether and how competing municipalities in the region respond to this law-induced tax rate change. To this end, we employ a spatial econometric approach that enables us to distinguish treated and not-treated municipalities based on their distance to tax-haven municipalities, and provides us with estimates of an average indirect treatment effect.

The empirical results indicate that most municipalities do not change their tax policy in response to a law-induced tax increase by tax-havens in their local neighborhood. Apart from the tax havens, only municipalities that used to charge relatively high tax rates are found to change their tax policy: They tend to set lower tax rates in response, where the point estimates indicate a reduction of the statutory tax rate by about half a percentage point.

Our findings support theoretical concerns that an introduction of a minimum tax rate does not generally induce tax rate increases of competing jurisdictions and may even lead to lower tax rates. The theoretical literature has emphasized that the effects of imposing a minimum tax rate hinge on the tax-competition strategies followed by the jurisdictions. If jurisdictions choose their tax policy sequentially, the leader has an incentive to increase the tax rate in order to induce the follower to set a higher tax rate. The imposition of a minimum tax rate may then induce the leader to set a lower tax rate. However, whether the empirical distribution of business tax rates among German municipalities is actually driven by a leader-follower relationship cannot be proven within the scope of our analysis, but we note that the observed empirical reaction is consistent with this view. If the results are driven by leader-follower structures, an implication is that the benefits of the minimum tax rate policy are distributed unevenly across jurisdictions. In particular, leaders can utilize their strategic advantage to maximize their payoff. Our analysis provides some support for this view, since high-tax municipalities do not report significant tax-revenue losses despite lowering tax rates, while tax revenues of tax havens seem to decline.

Our analysis shows that the response of high-tax jurisdictions cannot be assigned to the fact that these jurisdictions tend to be relatively large and more densely populated than other jurisdictions. Another difference between high-tax and other jurisdictions is their treatment within the fiscal equalization system. As their tax rate is higher, they face a smaller incentive to increase their tax rate than other jurisdictions. The different treatment by the equalization scheme does not explain, however, why high-tax municipalities lower the tax rate rather than increasing it as tax havens charge higher tax rates.

Though our analysis is based on the experience of neighboring jurisdictions in a context of local tax competition, it is tempting to relate our findings to the issue of a global minimum tax in the context of corporate taxation. After all, the introduction of the minimum tax rate in Germany aims at preventing relocation and profit shifting into tax havens, issues that are intensively discussed in the international tax literature. Two related potential policy implications emerge. Apart from the tax havens, tax rates may not increase and countries may actually respond by lowering their tax rate. Moreover, effects for non-haven countries could differ systematically. In particular, tax rates imposed by high-tax countries might decrease. In light of our results, however, this would not necessarily lead to a decline in their tax revenues.

References

Agrawal, David R, William H Hoyt, and John Douglas Wilson (2022). "Local policy choice: theory and empirics". *Journal of Economic Literature* 60.4, pp. 1378–1455.

Altshuler, Rosanne and Timothy J Goodspeed (2015). "Follow the leader? Evidence on European and US tax competition". *Public Finance Review* 43.4, pp. 485–504.

Anselin, Luc (2002). "Under the hood issues in the specification and interpretation of spatial regression models". *Agricultural economics* 27.3, pp. 247–267.

Auerbach, Alan J (2018). "Measuring the effects of corporate tax cuts". *Journal of Economic Perspectives* 32.4, pp. 97–120.

Baskaran, Thushyanthan (2014). "Identifying local tax mimicking with administrative borders and a policy reform". *Journal of Public Economics* 118, pp. 41–51.

Besley, Timothy and Anne C Case (1995). "Does electoral accountability affect economic policy choices? Evidence from gubernatorial term limits". *The Quarterly Journal of Economics* 110.3, pp. 769–798.

Bordignon, Massimo, Floriana Cerniglia, and Federico Revelli (2004). "Yardstick competition in intergovernmental relationships: theory and empirical predictions". *Economics letters* 83.3, pp. 325–333.

Bosch, Núria and Albert Solé-Ollé (2007). "Yardstick competition and the political costs of raising taxes: An empirical analysis of Spanish municipalities". *International Tax and Public Finance* 14, pp. 71–92.

Brueckner, Jan K (2003). "Strategic interaction among governments: An overview of empirical studies". *International Regional Science Review* 26.2, pp. 175–188.

Bucovetsky, Sam and Michael Smart (2006). "The efficiency consequences of local revenue equalization: Tax competition and tax distortions". *Journal of Public Economic Theory* 8.1, pp. 119–144.

Buettner, Thiess (2003). "Tax base effects and fiscal externalities of local capital taxation: evidence from a panel of German jurisdictions". *Journal of Urban Economics* 54.1, pp. 110–128.

— (2006). "The incentive effect of fiscal equalization transfers on tax policy". *Journal of Public Economics* 90.3, pp. 477–497.

Buettner, Thiess, Nadine Riedel, and Marco Runkel (2011). "Strategic consolidation under formula apportionment". *National Tax Journal* 64.2, pp. 225–254.

Buettner, Thiess and Axel von Schwerin (2016). "Yardstick competition and partial coordination: Exploring the empirical distribution of local business tax rates". *Journal of Economic Behavior & Organization* 124, pp. 178–201.

Butts, Kyle (2023). "JUE Insight: Difference-in-differences with geocoded microdata". *Journal of Urban Economics* 133, p. 103493.

Case, Anne C (1991). "Spatial patterns in household demand". *Econometrica: Journal of the Econometric Society*, pp. 953–965.

Colella, Fabrizio et al. (2019). "Inference with arbitrary clustering". IZA Discussion Paper 12584.

Conley, Timothy G (1999). "GMM estimation with cross sectional dependence". *Journal of econometrics* 92.1, pp. 1–45.

Correia, Sergio (2019). "REGHDFE: Stata module to perform linear or instrumental-variable regression absorbing any number of high-dimensional fixed effects".

Delgado, Michael S and Raymond JGM Florax (2015). "Difference-in-differences techniques for spatial data: Local autocorrelation and spatial interaction". *Economics Letters* 137, pp. 123–126.

Desai, Mihir A, C Fritz Foley, and James R Jr Hines (2006). "The demand for tax haven operations". *Journal of Public economics* 90.3, pp. 513–531.
Devereux, Michael P (2023). "International tax competition and coordination with a global minimum tax". *National Tax Journal* 76.1, pp. 145–166.
Dharmapala, Dhammika and James R Jr Hines (2009). "Which countries become tax havens?" *Journal of Public Economics* 93.9-10, pp. 1058–1068.
Egger, Peter, Marko Koethenbuerger, and Gabriel Loumeau (2022). "Local border reforms and economic activity". *Journal of Economic Geography* 22.1, pp. 81–102.
Egger, Peter, Marko Koethenbuerger, and Michael Smart (2010). "Do fiscal transfers alleviate business tax competition? Evidence from Germany". *Journal of Public Economics* 94.3-4, pp. 235–246.
Englisch, Joachim and Johannes Becker (2019). "International effective minimum taxation–the GLOBE proposal". *World Tax Journal* 11.4, pp. 483–529.
Evers, Michiel, Herman RJ Vollebergh, and Ruud de Mooij (2004). *Tax Competition under Minimum Rates: The Case of European Diesel Excises*. CESifo Working Paper. Munich.
Fetzer, Thiemo (2021). "Can workfare programs moderate violence? Evidence from India". *Journal of the European Economics Association* forthcoming.
Foremny, Dirk and Nadine Riedel (2014). "Business taxes and the electoral cycle". *Journal of Public Economics* 115, pp. 48–61.
Fotheringham, A Stewart (1981). "Spatial structure and distance-decay parameters". *Annals of the association of American geographers* 71.3, pp. 425–436.
Freichel, Christoph et al. (2020). *German Profit Taxes*. UVK Verlag.
Gibbons, Stephen and Henry G Overman (2012). "Mostly pointless spatial econometrics?" *Journal of Regional Science* 52.2, pp. 172–191.
Government of Saxony (Freistaat Sachsen) (2016). *Praxisreport Freiwillige Gemeindezusammenschlüsse*. Tech. rep. Dresden.
Griffith, Daniel A (2012). *Advanced spatial statistics: special topics in the exploration of quantitative spatial data series*. Vol. 12. Springer Science & Business Media.
Hansen, Nico A and Anke S Kessler (2001). "The political geography of tax h (e) avens and tax hells". *American Economic Review* 91.4, pp. 1103–1115.
Hayashi, Masayoshi and Robin Boadway (2001). "An empirical analysis of intergovernmental tax interaction: the case of business income taxes in Canada". *Canadian Journal of Economics/Revue canadienne d'économique* 34.2, pp. 481–503.
Hebous, Shafik and Niels Johannesen (2021). "At your service! The role of tax havens in international trade with services". *European Economic Review* 135, p. 103737.
Heimberger, Philipp (2021). "Corporate tax competition: A meta-analysis". *European Journal of Political Economy* 69, p. 102002.
Hemmelgarn, Thomas and Gaëtan Nicodéme (2009). "Tax co-ordination in Europe: Assessing the first years of the EU-Savings Taxation Directive". *CESifo Working Paper*.
Hines, James R Jr (2005). "Do tax havens flourish?" *Tax policy and the economy* 19, pp. 65–99.
Hsiang, Solomon M (2010). "Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America". *Proceedings of the National Academy of sciences* 107.35, pp. 15367–15372.
Janeba, Eckhard and Steffen Osterloh (2013). "Tax and the city – A theory of local tax competition". *Journal of Public Economics* 106, pp. 89–100.
Janeba, Eckhard and Wolfgang Peters (1999). "Tax evasion, tax competition and the gains from nondiscrimination: The case of interest taxation in Europe". *The Economic Journal* 109.452, pp. 93–101.

Janeba, Eckhard and Guttorm Schjelderup (2023). "The global minimum tax raises more revenues than you think, or much less". *Journal of International Economics* 145, p. 103837.

Johannesen, Niels (2022). "The global minimum tax". *Journal of Public Economics* 212, p. 104709.

Kanbur, Ravi and Michael Keen (1993). "Jeux sans frontieres: Tax competition and tax coordination when countries differ in size". *American Economic Review*, pp. 877–892.

Keen, Michael and Kai A Konrad (2013). "The theory of international tax competition and coordination". *Handbook of Public Economics*. Vol. 5, pp. 257–328.

Konrad, Kai A (2009). "Non-binding minimum taxes may foster tax competition". *Economics Letters* 102.2, pp. 109–111.

Köthenbürger, Marko (2002). "Tax competition and fiscal equalization". *International Tax and Public Finance* 9, pp. 391–408.

Lenk, Thomas and Hans-Joachim Rudolph (2004). *Die kommunalen Finanzausgleichssysteme in der Bundesrepublik Deutschland: Die Ermittlung der Finanzkraft*. Tech. rep. University of Leipzig.

— (2004b). *Die kommunalen Finanzausgleichssysteme in der Bundesrepublik Deutschland: Der Ausgleich zwischen Finanzbedarf und Finanzkraft*. Tech. rep. University of Leipzig.

Lyytikäinen, Teemu (2012). "Tax competition among local governments: Evidence from a property tax reform in Finland". *Journal of Public Economics* 96.7-8, pp. 584–595.

— (2023). "Minimum tax rates and tax competition: Evidence from property tax limits in Finland". NBER Working Paper Series 31482.

Mansour, Mario and Grégoire Rota-Graziosi (2013). "Tax Coordination, Tax Competition, and Revenue Mobilization in the West African Economic and Monetary Union". *IMF Working Paper*.

Porto, Edoardo Di and Federico Revelli (2013). "Tax-limited reaction functions". *Journal of applied econometrics* 28.5, pp. 823–839.

Pütz, Thomas (2015). *Verkehrsbild Deutschland*. BBSR-Analysen Kompakt 15. Federal Office for Building and Regional Planning (Bundesinstitut für Bau-, Stadt- und Raumforschung).

Rauch, Anna and Caroline-Antonia Hummel (2016). "How to stop the race to the bottom: Empirical evidence from North Rhine-Westphalia". *International Tax and Public Finance* 23, pp. 911–933.

Revelli, Federico (2005). "On spatial public finance empirics". *International Tax and Public Finance* 12.4, pp. 475–492.

— (2013). "Tax mix corners and other kinks". *The Journal of Law and Economics* 56.3, pp. 741–776.

Smart, Michael (1998). "Taxation and deadweight loss in a system of intergovernmental transfers". *Canadian Journal of Economics*, pp. 189–206.

Swank, Duane (2016). "Taxing choices: international competition, domestic institutions and the transformation of corporate tax policy". *Journal of European Public Policy* 23.4, pp. 571–603.

Wang, You-Qiang (1999). "Commodity taxes under fiscal competition: Stackelberg equilibrium and optimality". *American Economic Review* 89.4, pp. 974–981.

Zodrow, George R and Peter Mieszkowski (1986). "Pigou, Tiebout, property taxation, and the underprovision of local public goods". *Journal of Urban Economics* 19.3, pp. 356–370.

Appendix

Tax Competition Effects of a Minimum Tax Rate: Empirical Evidence from German Municipalities

December 2023

Thiess Buettner, Maximilian Poehnlein

Contents

A Datasources and Definitions

The basic data is provided by the Statistical Offices of the German Federal States and the Federal Statistical Office of Germany. We add data on administrative boundary reforms, geographic information, and labor market variables from various sources.

Business tax data is provided by the statistical offices of seven German federal states (Schleswig-Holstein, Niedersachen (Lower Saxony), Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt (Saxony-Anhalt), and Thüringen (Thuringia)) in publications called "Realsteuervergleich der Städte und Gemeinden" comprising the years 1999 to 2008. The data reports unique municipal identifiers, local tax multipliers, tax revenues, area as well as population numbers for all municipalities in our sample.

Municipal identifiers are the official municipality keys. These keys are unique digit sequences identifying every independent jurisdiction in Germany. Moreover, the keys give information about all higher tiers of government to which a specific geographic entity belongs (e.g., the state).

Population numbers are defined as the absolute number of persons registered in a jurisdiction at the end of June in a specific year.

Local business tax multipliers are defined in percentage points and can be chosen by the respective municipality on a yearly basis. Tax autonomy of municipalities is restricted to setting the local tax multipliers, since the base rate is defined by federal law and tax administration is done by state governments. The statutory business tax rate of every jurisdiction is thereby defined as the product of the tax multiplier chosen by the municipalities and the federal base rate of 5%. Taking into account, that the tax payments are deductible in the time period under consideration, a tax multiplier of e.g. 300 of municipality i results into a statutory business tax rate of $\tau_i = \frac{300\% \times 0.05}{1+300\% \times 0.05} = 13\%$. Figure B.1 provides separate tax multiplier distributions for all states in the sample. It indicates that federal states not only differ with respect to the state specific tax multiplier distribution, but also in regard to the most common state specific bunching points. While most states have a common bunching point at a multiplier of 300, Sachsen (Saxony) and Schleswig-Holstein diverge and show bunching points at levels of 380 and 310, respectively.

Tax revenue data reflects the actual revenue collection within a specific year at municipal level. Annual tax payments include advance payments for the year in question based on assessments in the last year as well as considerable out-of-period payments, which are determined by business tax multipliers for different tax years.[24] Hence, the annual information is not synchronized with the tax rates.

Municipalities: Geographically we use data on 6,751 municipalities located in seven federal states located in Germany. We focus on federal states that include all municipalities which are directly or indirectly affected by the policy change in 2004. The former refers to municipalities that had to increase their business tax multiplier to the minimum requirement of 200 due to the new policy. The latter refers to municipalities that are in close proximity to a directly affected geographical entity, but not necessarily in the same state. We discuss different neighborhood structures in the main text. States that include directly affected municipalities are Schleswig-Holstein, Mecklenburg-Vorpommern, Brandenburg, Sachsen-Anhalt (Saxony-Anhalt) and Thüringen (Thuringia). The latter four states are located in eastern Germany and have entered the German federation in 1990. As some of the tax-haven municipalities are situated at the borders to the states of Niedersachen (Lower Saxony) and Sachsen (Saxony), municipalities in these states are also included.

Geographic data is provided by the Federal Agency for Cartography and Geodesy. It reports precise information on boundaries of all relevant administrative levels in Germany. This enables us to produce customized maps of the relevant states and municipalities. Moreover, the Federal Agency for Cartography and Geodesy provides us with data on longitude and lati-

[24] See Federal Statistical Office (Destatis) (2023), Qualitätsbericht Realsteuervergleich.

tude of the administrative center of every municipality. We use this information to calculate all spatial variables based on kilometer distances in our estimations.

Labor market data is provided by the Federal Employment Agency. It reports information on employment subject to social security contributions and establishments/firms for all municipalities in our sample for the years 1999 to 2008.

Employment numbers are defined as the absolute number of registered employed individuals subject the social security contributions in a jurisdiction at the end of June in a specific year. Values are anonymized for municipalities with only one or two employed individuals in a year.

Number of establishments/firms is defined as the absolute number of establishments/firms in a municipality with any number of employed individuals subject the social security contributions at the end of June in a specific year. Values are anonymized for municipalities with only one or two establishments/firms in a year or if establishments/firms can be identified easily due too their size/relevance for the municipality.

State specific GDP and population data is provided by the Federal Statistical Office. It reports information on the nominal GDP and population number for the federal states of Germany for the years 1999 to 2008.

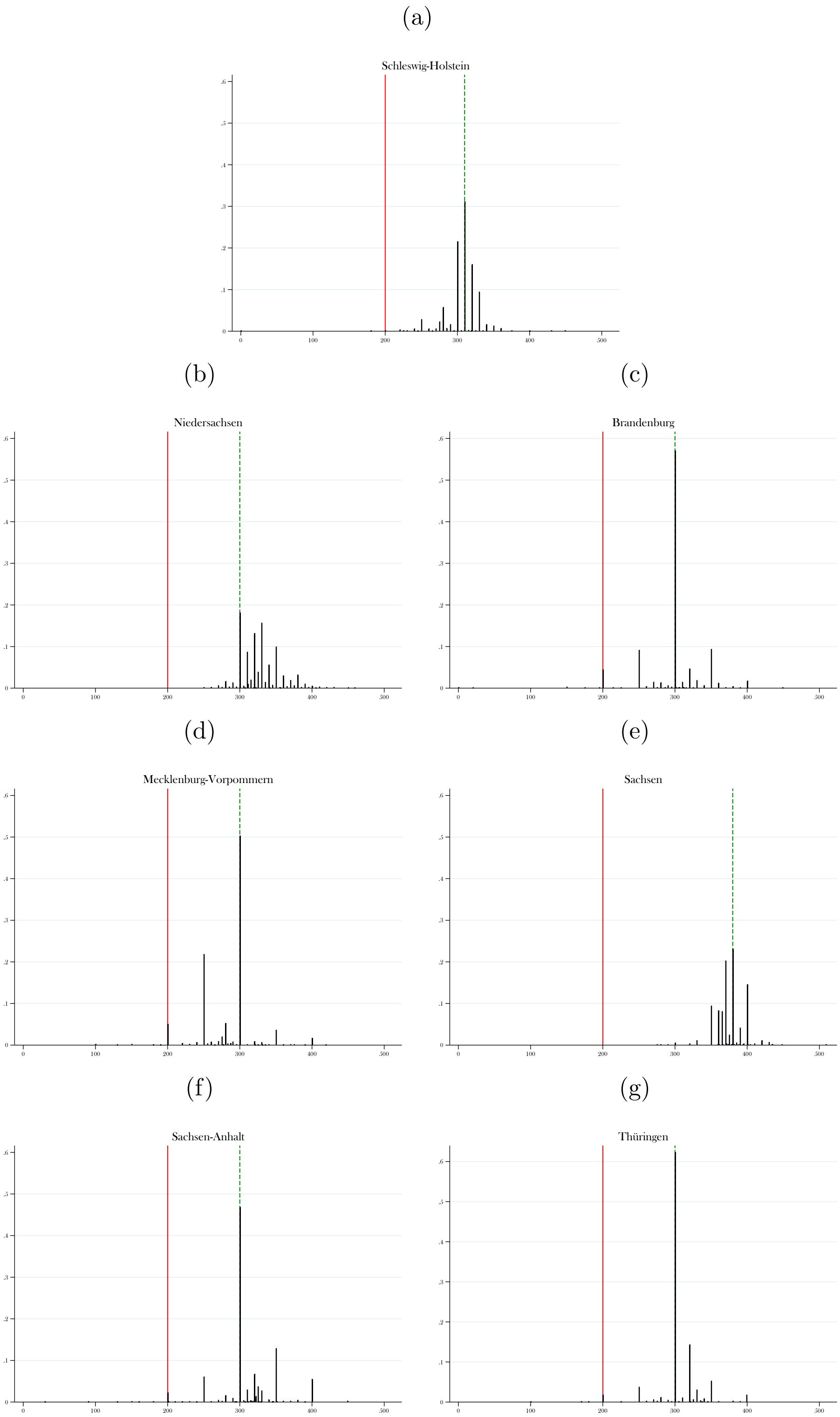
Administrative boundaries: In the time period under consideration, municipalities have partly been merged and reorganized. Data on these mergers and reorganizations ("Gebietsänderungen") is provided by the Federal Statistical Office of Germany. It documents the administrative changes of municipalities between different years in our sample as well as the reason for these changes. There are four documented reasons for changes in municipality indicators (dissolution, partial separation, administrative key changes, name changes). This data permits us to follow all municipalities over the whole sample period and to construct a yearly panel data set. We basically follow Buettner and von Schwerin (2016) and fix municipality boundaries to the year 2002.[25] If municipalities merge at a later point in time and do not report separate business tax multipliers anymore, we update the data of the respective municipality with the multiplier of the incorporating jurisdiction. Following this procedure, the estimation sample comprises 6,751 municipalities.

Specific information on the mergers has been collected using a variety of sources including municipal websites. The types of mergers we distinguish are inclusions of municipalities into an existing municipality and inclusions of jurisdictions into new municipalities.

[25] Buettner, T., von Schwerin, A. (2016), Constrained Tax Competition–Empirical Effects of the Minimum Tax Rate on the Tax Rate Distribution, paper presented at the VfS Annual Conference 2016, Augsburg.

B Figures

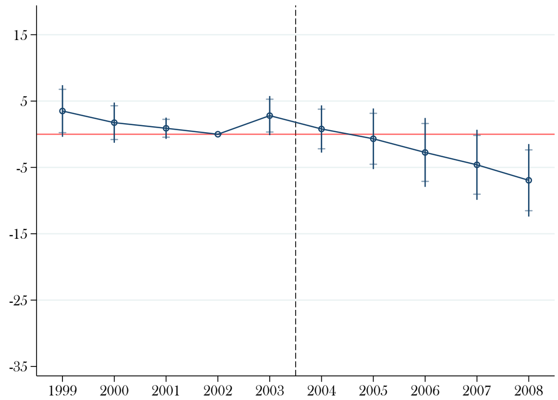
Figure B.1: Distribution of Pre-Reform Business Tax Multipliers: By State



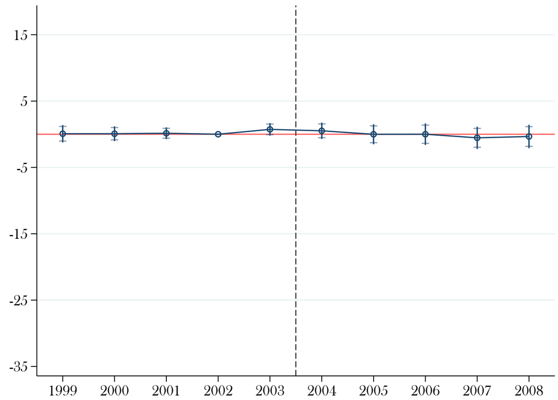
Notes: Histograms of business tax multipliers by state in the year 2002. The solid (red) vertical lines indicate the minimum tax multiplier of 200. The dashed (green) vertical lines indicate the modal value of the respective state's tax-rate distribution.

Figure B.2: Pre- and Post Reform Developments: Excluding Mergers

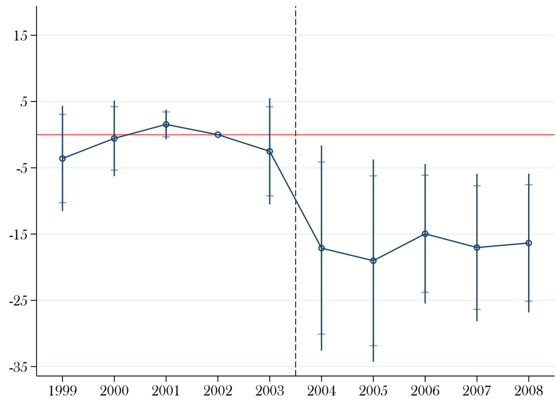
(a) Tax multiplier below 290 (lower 15%)



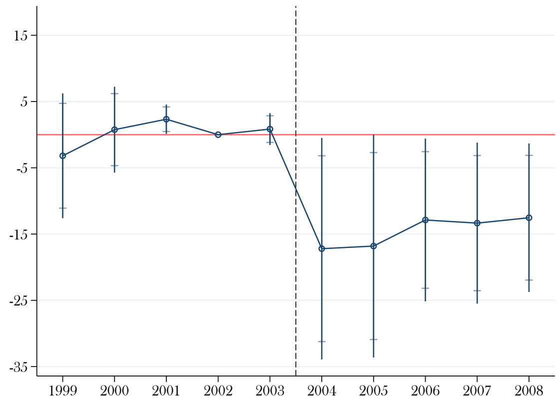
(b) Tax multiplier from 290 to 350 (15–85%)



(c) Tax multiplier above 350 (top 15%)



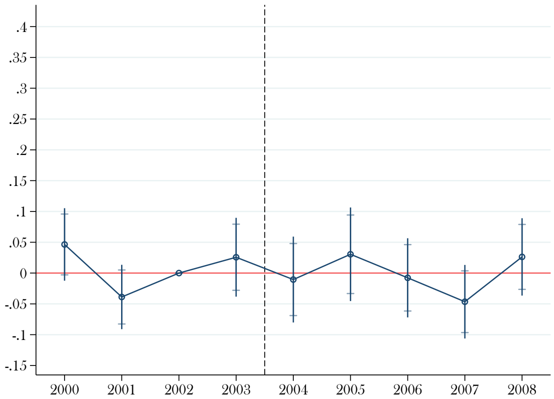
(d) Tax multiplier above 364 (top 10%)



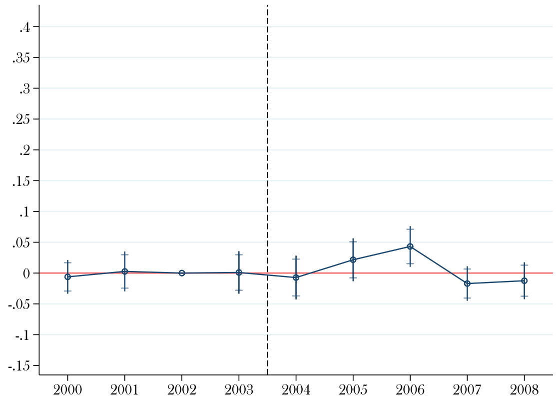
Notes: Plots of the coefficients along with confidence intervals of regressions of the business tax multiplier on year dummies interacted with the tax shock indicator. The vertical lines indicate 95% confidence intervals, the horizontal markers indicate 90% confidence intervals. The plots refer to estimations for different samples based on the pre-reform tax rate distribution in 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. Coefficients of the interaction terms are depicted relative to the year 2002. For detailed estimates see Table C.10 in the Appendix.

Figure B.3: Pre- and Post Reform Developments: Tax Policy Revisions

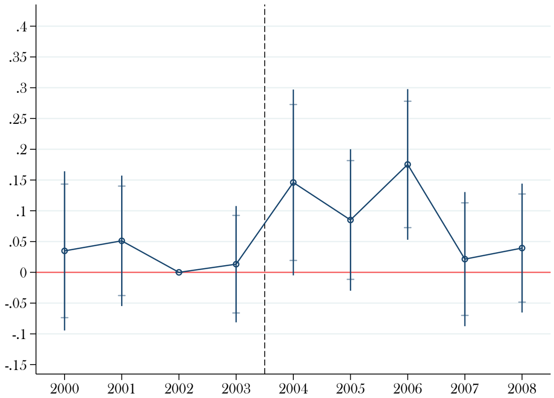
(a) Tax multiplier below 290 (lower 15%)



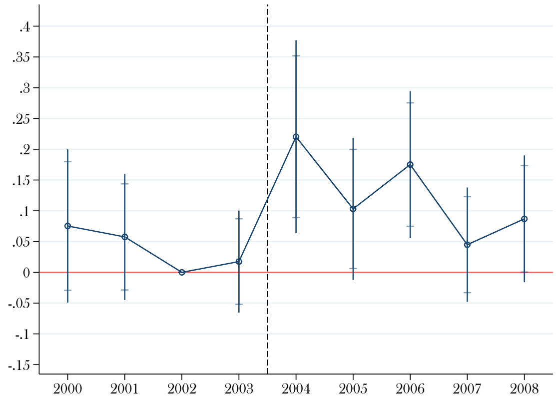
(b) Tax multiplier from 290 to 350 (15–85%)



(c) Tax multiplier above 350 (top 15%)

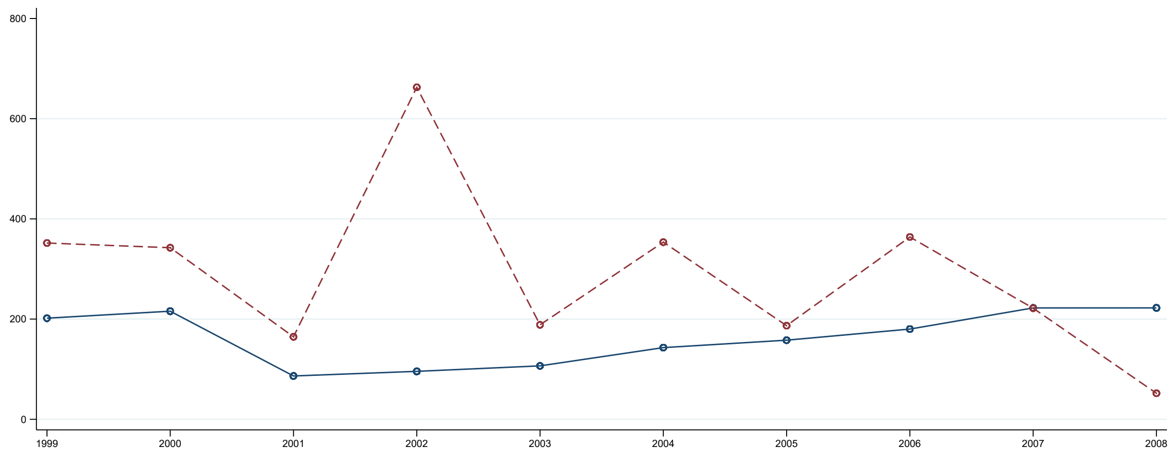


(d) Tax multiplier above 364 (top 10%)



Notes: Plots of the coefficients along with confidence intervals of regressions of a binary indicator of a change of the business tax multiplier relative to the previous year on year dummies interacted with a binary indicator of the spatial tax shock. The vertical lines indicate 95% confidence intervals, the horizontal markers indicate 90% confidence intervals. The sub-figures refer to estimations for different samples based on the pre-reform tax rate distribution in 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. Coefficients of the interaction terms are depicted relative to the year 2002. For detailed results see Table C.11 in the Appendix.

Figure B.4: Average Business Tax Revenues



Notes: Solid line depicts the mean business tax revenue per capita for all municipalities except tax-haven municipalities in the year 1999 to 2008. Dashed line depicts the mean business tax revenue per capita for municipalities charging a multiplier below 200 in 2002. Municipalities subject to mergers between the two groups are excluded. Due to data outliers, the municipality Norderfriedrichskoog (id 1054090) is excluded.

C Tables

Table C.1: Detailed Descriptive Statistics 1999–2008

	Mean	Median	Std.dev.	Min	Max	Obs
All						
Population	4,346.43	1,001.00	15,989.63	3.00	518,088.00	67,179
Population density	116.23	61.06	180.76	0.66	2,537.91	67,176
Business tax multiplier	314.52	300.00	39.92	0.00	510.00	66,696
Business tax revenue per capita	239.27	49.90	8,751.46	-7,584.58	1.26e+06	67,002
Employees per capita	0.19	0.15	0.19	0.00	8.56	57,337
Firms per capita	0.02	0.02	0.02	0.00	1.74	64,303
Tax Havens						
Population	2,098.99	668.50	4,836.18	34.00	46,948.00	296
Population density	49.93	33.37	63.48	4.09	589.72	296
Business tax multiplier	213.22	200.00	82.65	0.00	350.00	295
Business tax revenue per capita	16,932.22	33.44	129,335.64	-864.26	1.26e+06	296
Employees per capita	0.34	0.13	1.01	0.00	6.97	254
Firms per capita	0.07	0.02	0.24	0.00	1.74	290
Neighboring (Treated) Municipalities						
Population	2,999.50	648.00	11,042.66	31.00	237,952.00	7,348
Population density	107.01	50.03	168.93	3.07	1,905.22	7,346
Business tax multiplier	303.46	300.00	38.16	100.00	450.00	7,328
Business tax revenue per capita	228.76	35.72	1854.78	-7,584.58	58,460.93	7,328
Employees per capita	0.20	0.15	0.21	0.00	2.54	5,755
Firms per capita	0.02	0.02	0.01	0.00	0.13	6,832
Control Municipalities						
Population	4,371.79	1036.00	16,583.76	3.00	518,088.00	58,499
Population density	118.27	62.64	183.72	0.66	2,537.91	58,498
Business tax multiplier	316.46	310.00	38.69	0.00	510.00	58,060
Business tax revenue per capita	154.61	50.80	1,228.84	-6,745.10	111,947.98	58,342
Employees per capita	0.19	0.15	0.17	0.00	8.56	50,292
Firms per capita	0.02	0.02	0.01	0.00	0.23	56,145

Notes: Descriptive statistics based on different samples for municipalities in the years 1999 to 2008. Treated and control municipalities are excluded in the respective subsamples if they are part of a merger with a municipality of the opposite group.

Table C.2: Detailed Descriptive Statistics 1999–2002

	Mean	Median	Std.dev.	Min	Max	Obs
All						
Population	3,539.85	859.00	14,818.33	3.00	516,807.00	26,704
Population density	116.16	60.49	181.95	0.66	2532.37	26,704
Business tax multiplier	308.74	300.00	39.69	0.00	510.00	26,664
Business tax revenue per capita	150.45	35.28	1,076.30	-6,745.10	58,788.42	26,543
Employees per capita	0.19	0.15	0.18	0.00	4.52	22,486
Firms per capita	0.02	0.02	0.02	0.00	1.40	25,543
Tax Havens						
Population	999.63	516.50	1,491.34	35.00	7,394.00	116
Population density	46.67	31.16	48.68	4.09	244.14	116
Business tax multiplier	170.87	170.00	84.82	0.00	330.00	115
Business tax revenue per capita	368.49	12.51	1,543.57	-192.84	14,833.69	116
Employees per capita	0.26	0.13	0.53	0.00	3.69	94
Firms per capita	0.06	0.02	0.18	0.00	1.40	113
Treated Municipalities						
Population	2,520.77	604.50	10,598.34	31.00	237,952.00	3,170
Population density	105.95	48.93	174.50	3.07	1,905.22	3,170
Business tax multiplier	299.74	300.00	38.52	100.00	450.00	3,163
Business tax revenue per capita	278.70	25.24	1,874.02	-470.71	52,079.54	3,151
Employees per capita	0.21	0.15	0.22	0.00	2.54	2,473
Firms per capita	0.02	0.02	0.01	0.00	0.13	2,952
Control Municipalities						
Population	3,690.38	908.00	15,329.35	3.00	516,807.00	23,418
Population density	117.89	62.43	183.24	0.66	2,532.37	23,418
Business tax multiplier	310.63	300.00	38.11	0.00	510.00	23,386
Business tax revenue per capita	132.00	36.96	911.67	-6,745.10	58,788.42	23,276
Employees per capita	0.19	0.15	0.17	0.00	4.52	19,919
Firms per capita	0.02	0.02	0.01	0.00	0.22	22,478

Notes: Descriptive statistics based on different samples for municipalities in the years 1999 to 2002.

Table C.3: Variable Means in the Years 1999 to 2002: Subsamples by Tax Rate – Neighbors

	All	0 – 15%	15 – 85%	85 – 100%
Population	2,520.77	772.12	2,075.72	15,017.20
Population density	105.95	54.32	107.67	278.35
Business tax multiplier	299.74	246.21	308.84	381.26
Business tax revenue per capita	278.70	202.76	313.04	108.85
Employees per capita[a]	0.21	0.20	0.20	0.26
Establishments per capita[a]	0.02	0.02	0.02	0.02
Incorporated in existing municipality[b]	0.18	0.22	0.18	0.07
Incorporated in new municipality[b]	0.06	0.02	0.07	0.07
Inclusion of a municipality[b]	0.05	0.04	0.06	0.09
No. Municipalities	796	168	584	44

Notes: Average characteristics based on different samples for municipalities in the years 1999 to 2002. Municipalities are excluded in the respective subsamples if they are part of a merger with a control municipality. There are 796 municipalities neighboring at least one tax-haven municipality (within 15km radius). Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. [a] missing values encountered. [b] until 2008.

Table C.4: Share of Municipalities Affected by Mergers

Year	Incorporated in new	Incorporated in existing	Inclusion of other
2002	0.000	0.000	0.000
2003	0.029	0.057	0.015
2004	0.040	0.079	0.026
2005	0.043	0.088	0.030
2006	0.044	0.091	0.031
2007	0.048	0.095	0.034
2008	0.049	0.103	0.035

Notes: Share of municipalities involved in a merger since the year 2002. The two types of mergers are incorporations in a new or existing municipality. Inclusion of other captures if a municipality incorporates another jurisdiction, but remains present.

Table C.5: Results for Subsamples: Alternative Percentiles

	Sample	Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	0–20%	-0.047	22.362***	2.377	4.255**	0.759	35.098
		(0.976)	(1.836)	(1.641)	(2.056)		
(3)	20–80%	0.181	11.317**	-1.654	3.892	0.653	17.606
		(1.064)	(4.486)	(3.656)	(2.661)		
(4)	80–100%	-7.357**	-11.297*	-22.184***	1.349	0.737	12.684
		(3.026)	(6.132)	(5.151)	(2.751)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 20th percentile: 300, between the 20th and 80th percentile: 300 to 340, 80th percentile: 340. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are clustered on municipality level. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.6: Results for Subsamples: Excluding Reference Points

	Sample	Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	0–15%	-1.777	41.659***	7.888**	6.315	0.720	9.832
		(2.028)	(4.065)	(4.012)	(4.167)		
(2)	15–85%	-0.509	12.881***	-9.000***	3.909**	0.720	21.633
		(1.058)	(3.732)	(3.383)	(1.881)		
(3)	85–100%	-15.363***	-38.289***	-29.326**	-0.515	0.702	6.519
		(5.890)	(8.869)	(12.070)	(6.175)		
(4)	0–10%	-2.614	42.769***	12.340**	7.654	0.662	6.630
		(2.441)	(4.233)	(5.328)	(4.849)		
(5)	90–100%	-14.656**	-38.971***	-32.776**	1.285	0.671	5.469
		(7.007)	(9.033)	(12.805)	(7.614)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002, excluding municipalities on pre-Reform state specific bunching points. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364.. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.7: Results for Subsamples: Spatial Std. Errors

	Sample	Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	0–15%	-1.777	41.659 ***	7.888 *	6.315	0.720	9.831
		(2.312)	(5.025)	(4.418)	(4.142)		
(2)	15–85%	-0.699	13.948 ***	-2.141	2.435 *	0.747	47.820
		(0.773)	(1.882)	(1.803)	(1.341)		
(3)	85–100%	-14.398***	-33.744***	-26.720 **	-0.192	0.692	7.735
		(5.401)	(8.569)	(11.295)	(4.601)		
(4)	0–10%	-2.614	42.769 ***	12.340 **	7.654	0.662	6.629
		(2.692)	(4.996)	(5.772)	(4.873)		
(5)	90–100%	-13.595**	-34.281***	-29.572 **	1.105	0.660	6.685
		(6.254)	(8.724)	(11.937)	(5.326)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust, as well as spatial autocorrelation consistent based on Conley (1999). The distance cut-off is set to 30km and the lag cut-off for temporal correlation to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.8: Results for Subsamples: Clustered Std. Errors

	Sample	Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	0–15%	-1.777	41.659 ***	7.888 *	6.315	0.720	9.831
		(2.208)	(4.386)	(4.365)	(4.556)		
(2)	15–85%	-0.699	13.948 ***	-2.141	2.435 *	0.747	47.820
		(0.745)	(1.666)	(1.578)	(1.455)		
(3)	85–100%	-14.398**	-33.744***	-26.720 **	-0.192	0.692	7.735
		(5.795)	(9.033)	(12.013)	(4.989)		
(4)	0–10%	-2.614	42.769 ***	12.340 **	7.654	0.662	6.629
		(2.663)	(4.565)	(5.794)	(5.300)		
(5)	90–100%	-13.595**	-34.281***	-29.572 **	1.105	0.660	6.685
		(6.721)	(9.196)	(12.684)	(5.737)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are clustered at municipality level. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.9: Pre- and Post-Reform Developments: Detailed Results

	Top 10%	Top 15%	15–85%	Lowest 15%	Lowest 10%
Tax-shock × Year 1999	-3.224	-3.626	0.075	3.383 *	3.763
	(4.829)	(4.076)	(0.677)	(2.016)	(2.295)
Tax-shock × Year 2000	0.719	-0.592	0.083	1.629	1.282
	(3.324)	(2.928)	(0.571)	(1.571)	(1.794)
Tax-shock × Year 2001	2.331 **	1.583	0.155	0.787	0.824
	(1.135)	(1.150)	(0.456)	(0.845)	(0.948)
Tax-shock × Year 2003	1.894	-1.554	0.007	3.793 **	4.606 **
	(1.598)	(4.004)	(0.508)	(1.568)	(1.900)
Tax-shock × Year 2004	-15.481 **	-15.109**	-0.115	3.050	3.897 *
	(7.845)	(7.249)	(0.664)	(1.960)	(2.359)
Tax-shock × Year 2005	-15.667 **	-17.277**	-0.376	1.416	0.636
	(7.872)	(7.136)	(0.791)	(2.337)	(2.821)
Tax-shock × Year 2006	-11.592 **	-13.221***	-0.410	0.216	-0.995
	(5.669)	(4.889)	(0.813)	(2.561)	(3.104)
Tax-shock × Year 2007	-12.552 **	-15.916***	-1.056	-1.990	-3.646
	(5.593)	(5.198)	(0.833)	(2.589)	(3.126)
Tax-shock × Year 2008	-11.114 **	-14.712***	-1.251	-2.065	-2.490
	(5.300)	(4.997)	(0.859)	(2.938)	(3.506)
Incorp. in existing munic.	-34.281 ***	-33.743***	13.945 ***	41.750 ***	42.919 ***
	(8.492)	(8.347)	(1.540)	(4.063)	(4.227)
Incorp. in new munic.	-29.722 **	-26.736**	-2.143	7.970 **	12.463 **
	(11.757)	11.110)	(1.461)	(4.024)	(5.350)
Inclusion of another munic.	1.082	-0.219	2.437 *	6.297	7.624
	(5.255)	(4.572)	(1.336)	(4.168)	(4.849)
Municipality FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R^2	0.661	0.692	0.747	0.720	0.663
N	6,685	7,735	47,821	9,832	6,630

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.10: Pre- and Post-Reform Developments: Excluding Mergers

	Top 10%	Top 15%	15–85%	Lowest 15%	Lowest 10%
Tax-shock × Year 1999	-3.186	-3.593	0.076	3.503 *	3.942 *
	(4.807)	(4.054)	(0.669)	(1.986)	(2.256)
Tax-shock × Year 2000	0.757	-0.559	0.077	1.747	1.458
	(3.306)	(2.911)	(0.566)	(1.547)	(1.765)
Tax-shock × Year 2001	2.331 **	1.546	0.149	0.902	0.994
	(1.128)	(1.145)	(0.453)	(0.819)	(0.914)
Tax-shock × Year 2003	0.845	-2.506	0.735	2.806 *	2.960
	(1.225)	(4.089)	(0.481)	(1.505)	(1.839)
Tax-shock × Year 2004	-17.206**	-17.123**	0.520	0.794	0.895
	(8.527)	(7.901)	(0.633)	(1.815)	(2.222)
Tax-shock × Year 2005	-16.809*	-19.016**	-0.005	-0.683	-2.114
	(8.577)	(7.787)	(0.773)	(2.332)	(2.870)
Tax-shock × Year 2006	-12.874**	-14.955***	0.003	-2.742	-4.411
	(6.267)	(5.373)	(0.833)	(2.650)	(3.294)
Tax-shock × Year 2007	-13.345**	-17.032***	-0.539	-4.606 *	-6.751 **
	(6.198)	(5.676)	(0.863)	(2.694)	(3.341)
Tax-shock × Year 2008	-12.537**	-16.350***	-0.340	-6.943 **	-8.139 **
	(5.719)	(5.340)	(0.904)	(2.787)	(3.376)
Municipality FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R^2	0.703	0.732	0.769	0.735	0.653
N	6,403	7,422	44,477	8,868	5,890

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. Municipalities are excluded after any type of merger took place. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.11: Pre- and Post-Reform Developments: Tax Revisions

	Top 10%	Top 15%	15–85%	Lowest 15%	Lowest 10%
Tax-shock × Year 2000	0.075	0.035	-0.006	0.046	0.052
	(0.064)	(0.066)	(0.014)	(0.030)	(0.033)
Tax-shock × Year 2001	0.058	0.051	0.003	-0.039	-0.024
	(0.052)	(0.054)	(0.017)	(0.027)	(0.028)
Tax-shock × Year 2003	0.018	0.013	0.001	0.026	0.024
	(0.042)	(0.048)	(0.018)	(0.033)	(0.036)
Tax-shock × Year 2004	0.220 ***	0.146 *	-0.007	-0.011	-0.008
	(0.080)	(0.077)	(0.018)	(0.036)	(0.037)
Tax-shock × Year 2005	0.103 *	0.085	0.022	0.031	-0.017
	(0.059)	(0.059)	(0.018)	(0.039)	(0.040)
Tax-shock × Year 2006	0.175 ***	0.175 ***	0.043 **	-0.008	-0.013
	(0.061)	(0.062)	(0.017)	(0.033)	(0.037)
Tax-shock × Year 2007	0.045	0.021	-0.017	-0.046	-0.055 *
	(0.047)	(0.056)	(0.014)	(0.030)	(0.033)
Tax-shock × Year 2008	0.087 *	0.039	-0.012	0.026	0.004
	(0.053)	(0.053)	(0.015)	(0.032)	(0.033)
Incorp. in existing munic.	0.315 ***	0.318 ***	0.263 ***	0.182 ***	0.196 ***
	(0.053)	(0.052)	(0.015)	(0.024)	(0.025)
Incorp. in new munic.	0.377 ***	0.436 ***	0.181 ***	0.134 ***	0.135 ***
	(0.114)	(0.116)	(0.015)	(0.034)	(0.040)
Inclusion of another munic.	0.173 ***	0.121 **	0.135 ***	0.095 ***	0.118 ***
	(0.054)	(0.052)	(0.026)	(0.035)	(0.041)
Municipality FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
R^2	0.228	0.222	0.188	0.167	0.169
N	6,069	7,016	43,480	8,957	6,046

Notes: Dependent variable is a binary indicator of the change in the business tax rate relative to the previous year. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.12: Results for Subsamples: Testing for Greater Distances

		Tax-shock				
	Sample	0–15km	15–22.5km	22.5–30km	R^2	N
(1)	0–15%	-3.521 *	-7.271 ***	-2.641	0.721	9.832
		(2.133)	(2.208)	(2.635)		
(2)	15–85%	-0.155	2.228 ***	1.042	0.721	47.821
		(0.697)	(0.785)	(0.666)		
(3)	85–100%	-15.660***	-8.306 *	-5.278	0.694	7.735
		(5.320)	(4.775)	(3.603)		
(4)	0–10%	-4.453 *	-7.345 ***	-2.281	0.664	6.630
		(2.618)	(2.760)	(3.402)		
(5)	90–100%	-14.979**	-9.613 *	-5.867	0.664	6.685
		(6.168)	(5.321)	(4.071)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.13: Results for Subsamples: Including State GDP per Capita

	Sample	Tax-shock	State GDP per capita	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
(1)	$200 < \tau_{i0} \leq 290$	-1.548	0.006 ***	41.740 ***	8.687 **	7.215 *	0.722	9.831
		(1.998)	(0.001)	(4.016)	(3.983)	(4.143)		
(2)	$290 < \tau_{i0} \leq 350$	-0.429	0.005 ***	14.490 ***	-1.410	3.267 **	0.750	47.820
		(0.674)	(0.000)	(1.522)	(1.450)	(1.301)		
(3)	$350 < \tau_{i0}$	-12.071**	0.010 ***	-32.105***	-23.673 **	1.257	0.697	7.735
		(5.104)	(0.003)	(7.812)	(11.280)	(4.302)		
(4)	$200 < \tau_{i0} \leq 270$	-2.466	0.008 ***	43.003 ***	13.381 **	9.179 *	0.665	6.629
		(2.394)	(0.002)	(4.168)	(5.270)	(4.873)		
(5)	$364 < \tau_{i0}$	-10.471*	0.012 ***	-32.275***	-25.530 **	1.898	0.668	6.685
		(5.940)	(0.003)	(7.841)	(12.093)	(4.945)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Moreover, all regressions include a state-specific GDP per capita control variable. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.14: Results for Subsamples: Population and Population-Density

Sample		Tax-shock	Incorp. in exist. munic.	Incorp. in new munic.	Incl. of munic.	R^2	N
Population							
(1)	0–15%	-0.463	11.381 ***	3.272	5.047	0.821	9.628
		(1.770)	(2.961)	(3.022)	(6.427)		
(2)	15–85%	-0.572	20.562 ***	-2.243	2.649	0.871	45.908
		(0.969)	(2.164)	(1.840)	(2.268)		
(3)	85–100%	-1.463	9.195	4.518	2.526	0.934	9.852
		(1.920)	(9.121)	(6.064)	(1.707)		
Population Density							
(4)	0–15%	1.949	11.145 ***	1.142	5.057	0.832	9.495
		(1.814)	(2.887)	(2.476)	(4.232)		
(5)	15–85%	-1.596	19.285 ***	-1.537	0.820	0.874	45.960
		(1.026)	(2.034)	(2.152)	(2.125)		
(6)	85–100%	-1.089	36.329 ***	-0.140	4.781 **	0.914	9.933
		(1.558)	12.440)	(3.810)	(2.108)		

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform population and population density distribution in the year 2002. The threshold levels to distinguish the population percentiles are: 15th percentile: 297, between the 15th and 85th percentile: 297 to 4267, 85th percentile: 4267. The threshold levels to distinguish the population density percentiles are: 15th percentile: 24.68, between the 15th and 85th percentile: 24.68 to 176.86, 85th percentile: 176.86. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.15: Elections at the Local Level

Federal State	Years	
Schleswig Holstein	2003	2008
Lower Saxony (Niedersachsen)	2001	2006
Brandenburg	2003	2008
Mecklenburg-Vorpommern	1999	2004
Saxony (Sachsen)	1999	2004
Saxony-Anhalt (Sachsen-Anhalt)	1999	2004
Thuringia (Thüringen)	1999	2004

Notes: Election years for local council elections in our sample.

Table C.16: Results for Subsamples: Accounting for Election Years

	$\tau_{i0} < 290$ (1)	$290 < \tau_{i0} < 350$ (2)	$350 < \tau_{i0}$ (3)	$\tau_{i0} < 270$ (4)	$364 < \tau_{i0}$ (5)
Tax-shock	-1.724	-0.685	-14.372***	-2.538	-13.584 **
	(2.027)	(0.682)	(5.334)	(2.442)	(6.185)
Election_{t-1}	2.330 ***	0.223	-0.848	2.735 **	-3.148
	(0.760)	(0.194)	(1.685)	(1.092)	(1.962)
Election_{t}	0.304	-0.742 ***	-3.562 *	0.428	-3.614
	(0.932)	(0.193)	(1.863)	(1.305)	(2.573)
Election_{t+1}	0.481	-0.391 **	-2.890 *	0.075	-2.059
	(0.773)	(0.181)	(1.536)	(1.090)	(2.140)
Incorp. in exist. munic.	41.942 ***	14.193 ***	-33.454***	43.144 ***	-34.103 ***
	(4.074)	(1.545)	(8.294)	(4.264)	(8.447)
Incorp. in new munic.	8.076 **	-1.914	-26.493**	12.622 **	-29.364 **
	(4.063)	(1.475)	11.039)	(5.422)	(11.661)
Inclusion of munic.	6.517	2.579 *	0.219	7.950	1.182
	(4.184)	(1.338)	(4.590)	(4.889)	(5.267)
R^2	0.720	0.747	0.692	0.663	0.661
N	9,832	47,821	7,735	6,630	6,685

Notes: Dependent variable is the business tax multiplier. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Moreover, all specifications include binary indicators indicating whether the an election is forthcoming, currently held, or has been held in the previous period (Election_{t-1}, Election_{t-1}, Election_{t-1}). Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.17: Results for Subsamples: Business Tax Revenue

	Sample	Tax-shock	R^2	N
(1)	0–15%	12.57	0.455	8,839
		(221.7)		
(2)	15–85%	32.89	0.514	44,378
		(64.02)		
(3)	85–100%	15.80	0.330	7,398
		(29.29)		
(4)	0–10%	-206.9	0.484	5,876
		(181.9)		
(5)	90–100%	1.257	0.323	6,380
		(29.39)		

Notes: Dependent variable is the business tax revenue per capita. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. Observations associated with any merger are excluded. Samples are based on the pre-reform tax rate distribution in the year 2002. The threshold levels to distinguish the percentiles are: 10th percentile: 270, 15th percentile: 290, between the 15th and 85th percentile: 290 to 350, 85th percentile: 350, 90th percentile: 364. Standard errors are heteroscedasticity and autocorrelation robust. The lag cut-off for temporal correlation is set to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.

Table C.18: Regression Results for Tax-Haven Municipalities

	(1)	(2)
Minimum-Tax	66.442 ***	-219.398 *
	(12.013)	(124.816)
Incorp. in existing munic.	14.663 ***	-290.559 **
	(2.383)	(117.083)
Incorp. in new munic.	0.826	-49.490
	(1.911)	(63.036)
Inclusion of another munic.	2.869 *	3.603
	(1.587)	(28.983)
Municipality FE	Yes	Yes
Year FE	Yes	Yes
R^2	0.883	0.399
N	58,297	58,580

Notes: Dependent variable in specification (1) is the business tax multiplier, inspecification (2) is business tax revenue per capita. The coefficient for the minimum tax is a binary indicator for tax-havens interacted with the period under the minimum tax. Observations include the tax havens and other municipalities. Municipalities in a 15km radius to a tax-haven are excluded. In specification (2) we also exclude data for the municipality Norderfriedrichskoog (id 1054090) because of outliers in the revenue data. All specifications include a full set of fixed effects for municipality and year as well as separate year fixed effects for the east German states. In addition, the specifications include binary controls for mergers, i.e. incorporation in a new or existing municipality as well as inclusion of another municipality. Standard errors are heteroscedasticity and autocorrelation robust, as well as spatial autocorrelation consistent based on Conley (1999). The distance cut-off for spatial correlation is set to 30km and the lag cut-off for temporal correlation to 20 years. * denotes significance at 10%, ** at 5%, and *** at 1% level.