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Identifying tax-setting responses from local fiscal policy programs *

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Abstract

This paper studies tax-policy interaction and competition among local governments for both mobile and immobile tax bases. We exploit exogenous changes in the local tax setting of German municipalities due to participation in state debt reduction programs to learn about the size, scope and nature of strategic interaction among local governments. Our results suggest strong and significant tax-policy responses both in corporate and property tax rates. Based on these results, we calculate tax-response function gradients in a range of 0.30 to 0.69. Spatial, political, demographic, and administrative municipality characteristics all influence the tax response qualitatively and quantitatively.

Keywords: Local Public Finance, Tax Competition, Yardstick Competition, Spatial Interaction, Tax-Response Functions

JEL classification: C21, H71, H73, R59

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1 Introduction

Questions about the size and scope of tax-policy interaction are fundamental to any debate on fiscal spillovers, both at the international but even more so at the national level. While the existence and consequences of strategic tax-setting behavior are well studied from a theoretical point of view, only few empirical papers provide consistent evidence on such interactions.[1] Moreover, the precise mechanisms behind tax-setting interdependencies are often unclear and could be related to economic or political motives. On the one hand, governments may engage in tax competition by strategically cutting taxes to attract mobile tax bases (see Wilson, 1986). On the other hand, interjurisdictional correlations in policy instruments may be non-base related and thus driven by yardstick behavior (see Shleifer, 1985; Revelli and Tovmo, 2007), informational spillovers, or learning. The intensity and nature of tax-policy spillovers is particularly relevant for federal states with significant internal mobility and local governments enjoying substantial fiscal autonomy with regard to spending and tax-policy setting – like the US, Canada, Switzerland, Italy, or Germany. This paper contributes to the literature by studying the size and scope of tax-policy interactions among German municipalities with a particular focus on various municipality characteristics and their impact on tax-setting responses.

After the financial crisis in 2008, many German municipalities suffered from excessive debt and were at the risk of default.[2] As a result, several German states introduced debt reduction programs (DRPs) offering debt relief to municipalities in return for consolidation efforts that involved substantial but non-uniform municipal property and corporate tax increases.[3] We exploit participation of some municipalities in DRPs to address two central research questions. First, how do local governments respond to their neighbors' tax-policy choices on

[1] See Fuest et al. (2005) and Keen and Konrad (2013) for a survey on the theoretical literature on strategic tax setting.

[2] In Germany, states and municipalities held approximately 779 billion Euro in debt, about 34% of total public debt.

[3] In the following, the terms local business taxation, business taxation, and corporate taxation will be used interchangeably.

(im-)mobile bases? Second, how do these tax-setting responses vary with spatial, political, demographic, and administrative proximity? The quasi-exogeneity of the DRPs enables us to causally determine the size, scope, and nature of tax-policy interaction among municipalities.

In our analysis, we first document that DRPs led to a significant increase in both corporate and property tax rates of participating municipalities. We then assess the average policy response of municipalities in the same state that were not directly targeted by DRPs to learn about strategic tax setting. And third, we analyze spatial, political, demographic, and administrative factors that potentially influence the magnitude of municipalities' tax-setting responses. For all three steps of the analysis, we sample a comparable control group from a pool of municipalities in states without a DRP using a matching approach.

Using a (generalized) Difference-in-Differences (DiD) model, we find that both treated (DRP) and nontreated (non-DRP) municipalities substantially increase business and property taxes after the respective program comes into effect. While property taxes exhibit a particularly pronounced increase relative to pre-treatment levels, the tax response of non-DRP municipalities is stronger for the business tax. Furthermore, the heterogeneity analysis demonstrates that on average, the policy response decreases in the distance to the nearest DRP municipality. Small municipalities in terms of population size appear to drive most of our results by responding to other small municipalities' tax setting. When both non-DRP and nearest DRP municipalities are governed by a social democratic political majority, tax responses are particularly strong as well. We also find larger effects for those non-DRP municipalities that are located within the same county as the nearest DRP one. Our findings on heterogeneous tax-setting responses, which we interpret in view of the literature on tax and yardstick competition, help us to better understand local policy choices.

Based on the results from the first two steps of the analysis, we calculate the slopes of the respective tax-response functions. We argue that our empirical setting allows us to estimate slopes without bias. The estimated tax-response gradients vary between 0.54 and 0.69 for the business tax and 0.30 and 0.49 for the property tax rates.

Studying spillovers in our setting is especially interesting and pertinent for several reasons. First, all municipalities are subject to the same policy environment (e.g., state laws and fiscal transfer schemes) with the DRPs affecting only some of the municipalities in a given state. Second, quasi-exogenous tax changes in DRP municipalities enable us to causally identify the size, scope, and nature of tax-setting responses of non-DRP municipalities in the same state. Third, German municipalities can levy taxes both on mobile and immobile tax bases. The latter allows us to distinguish – to some extent – tax competition from non-base related sources of interjurisdictional spillovers like yardstick competition or learning. Fourth, the non-uniform tax-policy response of DRP and non-DRP units enables us to study the characteristics that influence the tax-setting responses of these municipalities. Testing the relevance of different margins of heterogeneity in our setting yields novel insights on the underlying determinants of strategic tax interaction among jurisdictions.

While several studies have investigated tax-policy interaction among local governments, their findings have been contradictory and are often subject to severe endogeneity concerns due to two problems. First, tax-policy changes are generally non-random and depend on economic and political factors that also affect outcomes. Second, in counterfactual settings, outcomes of the control group may also be affected by treatment due to policy spillovers. While the first problem is widely acknowledged in the literature and sometimes addressed by exploiting quasi-exogenous policy interventions, the second problem is frequently neglected. In fact, neighboring jurisdictions are often purposefully chosen to ensure comparability and common trends in outcomes prior to the policy intervention. However, if spatial spillovers are present, neighboring jurisdictions are *by definition* a poor control group. Accounting for the size and scope of these spillovers is essential to ensure an unbiased identification of the true effects of any policy intervention.[4]

Our paper contributes to three strands of the literature.[5] It first adds to the literature on

[4]The response of neighboring jurisdictions likely depends on a number of factors including distance to the policy shock and the size of the affected municipality (see, e.g., Janeba and Osterloh, 2013).

[5]Agrawal et al. (2022) provide an excellent overview on the literature investigating local policy choices.

local tax competition for mobile tax bases. Büttner (2001) examines determinants of local business tax rates and their interdependence for a large panel of jurisdictions in Germany. Feld and Kirchgässner (2001) analyze personal income tax competition among Swiss cantons and larger cities. Their findings are in line with the theoretical model developed by Janeba and Osterloh (2013), where urban centers are in competition with their rural hinterland as well as with other urban centers for mobile tax bases. Rural areas, in contrast, compete only with the rural and urban areas in their immediate vicinity. Parchet (2019) analyzes the policy response of Swiss jurisdictions in personal income tax rates across cantonal borders using state-level policy changes as instruments. The author finds that personal income tax rates are strategic substitutes. Boning et al. (2023) investigate the introduction of a minimum local business tax rate in Germany and find no tax-setting response of municipalities in close proximity to former tax haven municipalities.

The second strand of literature we contribute to investigates non-base related tax-policy interaction. Baskaran (2014) studies tax mimicking of German municipalities exploiting an exogenous reform in local fiscal equalization schemes. Lyytikäinen (2012) exploits the exogenous variation in the lower limits of property taxation in Finland to study policy interaction among local governments. Both papers reject the hypothesis of local tax competition. Allers and Elhorst (2005) examine property tax rate interactions among Dutch municipalities. Their results imply that property tax rates are complements to neighbors' tax-policy choices. Similarly, Bordignon et al. (2003) find evidence for yardstick competition in property tax rates among Italian municipalities. Their findings suggest that yardstick competition is particularly pronounced when a mayor's reelection bid is uncertain.

And third, we contribute to a small but growing strand of research that explicitly focuses on heterogeneity in tax setting, stemming from municipality characteristics. So far, this literature has predominantly focused on spatial aspects. Agrawal (2015) analyzes sales tax differentials created by state border discontinuities in the US. The results of that paper suggest that tax differentials between high- and low-tax states are significantly lower at the state border and increase with driving time from the border. Similarly, Agrawal (2016) investigates vertical and horizontal competition in sales taxes in the US using an IV approach, providing evidence for horizontal competition among towns and vertical competition among towns and the county. Furthermore, horizontal tax competition appears to be particularly relevant for towns located at the county border. Eugster and Parchet (2019) study local income tax differentials along cultural borders of municipalities in Switzerland. While they find no tax differential at the border, they provide evidence for a growing differential with increasing distance to the border that can be attributed to interjurisdictional tax competition.

Our paper is also related to Fremerey et al. (2022), who study the DRP in Northrhine-Westfalia (NRW). They focus on the evaluation of the DRP policy rather than tax-setting responses between DRP and non-DRP municipalities. The authors employ a generalized DiD design using other financially distressed municipalities in NRW as a control group.[6] They find that municipalities participating in the DRP consolidated their budgets. Additionally, small municipalities consolidated by cutting spending, while larger municipalities raised taxes. In contrast to Fremerey et al. (2022), we do not explicitly evaluate the DRPs but exploit this quasi-exogenous intervention to identify the size and heterogeneity in tax-setting responses. Furthermore, our control group consists of (geographically distant) municipalities located in non-DRP states to avoid biased estimates associated with policy interaction.[7]

In contrast to the previous literature, our paper exploits quasi-exogenous variation in both property and business taxes within the same institutional context, without relying on an IV approach or state border discontinuities for identification. Tax changes are neither related to marginal adjustments in fiscal policies of municipalities nor are they driven by uniform changes to state legislation, but by municipality-specific interventions of the state that do not directly apply to other municipalities in the same state. Our causal setting allows us to explicitly determine the size and scope of policy interaction as well as the

[6] To ensure pre-treatment comparability, the authors emphasize that treatment and control municipalities are in geographical proximity to one another and economically linked.

[7] In fact, our results indicate that municipalities that are located in NRW but not subject to the DRP exhibit substantial tax-policy responses due to spillovers.

underlying determinants of tax-setting responses. Our heterogeneity analysis, in particular, supports our conclusion that yardstick competition between similar municipalities (similarity in terms of political majorities, size, geographic location, and administrative organization) is an important driver of local policy choices.

The remainder of the paper is structured as follows. Section 2 outlines the institutional background. The data used for the analysis is presented in Section 3. Section 4 outlines the identification strategy, while Section 5 presents the estimation results and quantifies the slope of the tax-response functions. Section 6 analyzes the municipality characteristics driving the tax-setting response. Section 7 discusses our findings and provides additional robustness checks. Section 8 finally concludes.

2 Institutional Background

2.1 Local Tax Instruments and Fiscal Tansfers

Germany consists of approximately 11,000 municipalities that enjoy substantial fiscal autonomy.[8] Municipalities raise revenue from three different tax instruments: the local business tax (LBT) levied on profits of local businesses, and two property taxes. Property tax A (PTA) is levied on agrarian land including forestry, and property tax B (PTB) is levied on developed or constructible land including commercial and residential properties.

The LBT, PTA, and PTB rates are calculated by multiplying a federal basic rate with a municipal multiplier. The multipliers for the LBT, PTA, and PTB are set independently on a yearly basis at the municipal level. By law, municipalities must decide and announce multiplier changes until the 30th of June of a given year. For the analysis we will focus

[8] Approximately 15% of overall tax revenue in Germany is raised by municipalities. On average, municipal budgets consist to 52% of tax revenue from municipal tax instruments, to 46% of vertical transfers from the state and federal government, and to 2% of federal grants as well as fees and contributions paid by citizens. As part of the vertical transfer schemes, municipalities pass roughly one sixth of gross local business tax revenue on to the respective state and the federal government. In return, municipalities receive about 15% of the income tax revenue and 2.2% of the value-added-tax revenue that is generated in their jurisdiction.

on tax rates rather than multipliers as the basic rate remains unchanged throughout our observational period.[9] Any variation in the business and property tax rates stems from changes in the municipal multipliers.[10]

The tax base of the property tax is determined by the respective fiscal authority, which determines the standard value of a property.[11] The LBT is levied on profits of both partnerships and corporations. Under federal law, profits from partnerships are also subject to personal income taxation, while corporations are subject to corporate taxation on their profits.[12] Personal income and corporate tax rates (as well as other tax base determinants such as depreciation allowances) are set at the federal level and apply uniformly to all German municipalities. Hence, the variation of the effective profit tax rate across municipalities is brought about by the variability in local business tax rates alone (see Becker et al., 2012). Furthermore, all tax bases are defined by federal law and are thus beyond the influence of the municipalities.

The municipal tax-setting autonomy is restricted by a number of regulations and incentives to limit fiscal externalities and avoid a "race-to-the-bottom".[13] In 2004, the federal government introduced a legal minimum LBT multiplier of 200 (7%).[14] Municipal tax competition is further dampened by horizontal fiscal equalization schemes within each state, which discourage setting a multiplier below a state's reference rate.[15] Municipalities may also be subject to scrutiny from higher-level supervising institutions taking on an advisory role to prevent excessive deficits. However, they have a very limited influence on municipal tax setting.[16]

[9]For more details on the federal basic rates and municipal tax setting, see Appendix A.2.

[10]In the following, the terms "tax rate" and "multiplier" will be used interchangeably, as they are perfectly proportional to each other.

[11]Standard property values were last ascertained on 01.01.1964 in the West and 01.01.1935 in the East and have not changed since. These values will be reevaluated by 2025, following a property tax reform in 2019.

[12]Some commercial activities, including farmers and freelancers, are exempt from the LBT. Profits of partnerships of up to 24,500 Euros are exempt. Furthermore, to avoid excessive double taxation of partnerships, LBT payments are fully tax deductible for personal income tax purposes up to 13.3 percentage points.

[13]The moderating impact of fiscal externalities is well-established (see, e.g., Büttner and Holm-Hadulla, 2008; Egger et al., 2010; Köthenbuerger, 2002).

[14]This effectively put an end to tax haven municipalities setting excessively low tax LBT rates (see Büttner and von Schwerin, 2016a; Boning et al., 2023).

[15]For more details on horizontal equalization see Appendix A.2.

[16]See Appendix A.9 for a detailed discussion.

2.2 Municipal Debt Reduction Programs

In response to rising debt levels, nine German states launched municipal debt reduction programs between 2010 and 2013. Under these programs, financially distressed municipalities received state funds to reduce debt levels and ensure that social security and public service obligations were met. States (partially) bailed out participating municipalities and provided financial assistance with interest payments in exchange for municipal consolidation efforts. Each state designed its program independently, leading to considerable heterogeneity across states in terms of eligibility, program scope and size, and the level of effort demanded from municipalities. A common feature of all programs was that participating municipalities were required to sign a consolidation contract that included a clear plan for reducing public debt by raising additional revenue or cutting expenditures. Our empirical analysis exploits quasi-random assignment of municipalities to the DRPs in the states of Hesse and NRW.[17] In the following, we describe the main features of these two programs.

The state of Hesse first announced its DRP in 2010 and enacted it in May 2012 with a volume of 3.2 billion Euros, covering about 46% of total municipal debt (2.8 billion Euros) and part of interest payments (400 million Euros). Debt relief was provided over several years and was conditional on persistent consolidation efforts. To be eligible for the Hesse DRP, municipalities needed to meet one of three criteria: average debt over 1,000 Euros per capita in 2009-2010, average deficit over 200 Euros per capita in 2005-2009, or both a deficit in 2005-2009 and debt over 470 Euros per capita in 2009-2010.[18] Given these criteria and the announcement date, self-selection into the program was effectively prevented.[19] Eligibility for the program was not influenced by political affiliation, as evidenced by the balanced participation of municipalities across party lines. Ultimately, 92 municipalities were eligible;

[17] The nine states with a DRP are Bavaria, Hesse, Lower Saxony, Mecklenburg-Western Pomerania, Northrhine-Westphalia, Rhineland-Palatinate, Saarland, Saxony-Anhalt and Schleswig-Holstein. We focus on Hesse and NRW because DRPs in other states are either of limited size, and lack enforcement or criteria to prevent self-selection into the program. For details, see Arnold et al. (2015).

[18] See Hessisches Ministerium der Finanzen (2014), for more details.

[19] Anticipation effects are unlikely as the program's announcement in 2010 by Prime Minister Volker Bouffier followed an unexpected leadership change, not influenced by elections or coalition shifts.

86 participated, 6 declined. In our analysis we regard DRP eligibility ("intent to treat") as treatment and thus all 92 municipalities are considered as treated.[20] Final participation was voluntary and based on a contract between the municipality and the state. The first contract was signed in November 2012 and the last contract was signed in February 2013. The treatment year for the Hessian DRP is therefore 2013, in line with the 30 June deadline for the adjustment of the local tax multiplier. Conditional on (observed) municipality-specific heterogeneity, the status of eligibility can be regarded as quasi-exogenous, allowing for an unbiased estimation of the effects of the Hesse DRP.

The NRW debt reduction program was passed into law in December 2011 with a volume of 5.85 billion Euros and included both mandatory and voluntary participation. Specifically, 34 municipalities facing excessive debt within two years were forced to participate. An additional 27 municipalities that were expected to experience substantial debt burdens within five years were eligible to opt into the program. The risk of excessive debt was evaluated against a municipalities' 2010 budget figures. All 27 eligible municipalities opted into participation. Starting in 2012, all participants had to sign a consolidation contract with the state and received the same payments. These payments were conditional on persistent consolidation efforts and amounted to 350 million Euros per year. Thus, the treatment group comprises 61 municipalities and the treatment year for the NRW DRP is 2012.[21] Again, self-selection into the program can be credibly ruled out. The state government determined participation/eligibility independently from municipal interest groups (see Landtag Nordrhein-Westfalen, 2011). Concerns about the program favoring politically aligned municipalities are also unfounded, given the balanced political representation among participants and the unlikelihood of the DRP being passed by a minority coalition. Given the state mandate, complete second wave uptake, and the non-participation of municipal umbrella organizations in the program design, assignment of NRW municipalities to the DRP can be

[20]Including municipalities that did not actually participate in the Hesse DRP would, if anything, lead to a downward bias of our estimates.

[21]As a robustness test, we replicate all results considering only forced municipalities. Our results are robust and available upon request.

regarded as quasi-exogenous, conditional on municipality-specific heterogeneity.[22]

Participation in these two DRPs was conditional on a state-municipality-specific consolidation contract. This allowed municipalities to choose from various consolidation strategies, including but not mandating tax rate increases. The programs did, however, prevent LBT reductions. Municipalities had the autonomy to determine the extent of tax increases, conditional on their unique fiscal capacities and preferences for expenditure cuts over tax adjustments. The heterogeneity in municipalities' responses is precisely what we exploit in our empirical analysis to learn about policy interactions. Our main interest lies in the tax response of municipalities that were not targeted by their state's DRP because they were not financially distressed. Expenditure cuts by DRP-municipalities would, if anything, dampen the tax response of those same municipalities, but should have no effect on the (relative) response of non-DRP municipalities, which is what we are primarily interested in.

3 Data

Our analysis is based on municipality-level panel data containing annual information from 2008 to 2018 on local demographics, economic and geographic indicators, and local public finances, including detailed information on municipal tax rates, tax bases, and revenues of the three local tax instruments, the vertical transfers from consumption and personal income taxes, and the share of the local business taxes transferred to the state. The data is taken from the *Regionaldatenbank Deutschland* provided by the German Statistical Office (Statistisches Bundesamt (Destatis), 2008-2018).[23] The dataset includes all German munici-

[22]The NRW government introduced a horizontal transfer scheme in 2014 to finance the consolidation measures. However, Christofzik and Schneider (2019) study the introduction of this transfer scheme and document that it did not trigger tax increases.

[23]Unfortunately, information on debt levels is not comparable across states due to differing accounting standards during the time period under consideration. We begin our analysis in 2008 because a change in the federal basic rate in that year results in variation in the LBT that is not due to changes in the municipal multiplier.

palities.[24] For our analysis, we balance the panel by dropping all municipalities for which we have missing information on any of the three tax instruments for one or more years. Data on state DRPs were collected from public documents describing the participation criteria and the list of participants.

In our analysis, we distinguish between treated municipalities participating in the respective DRP (*DRP municipalities*), non-treated municipalities located in Hesse or NRW which were not directly targeted by the DRP (*non-DRP municipalities*) and control municipalities located in a state without a DRP (*controls*). The summary statistics of the final dataset used for the analysis are presented in Table 1. DRP and non-DRP municipalities in NRW and Hesse are described separately as well as all potential control municipalities located in states without a DRP. A general pattern that emerges is that DRP and non-DRP municipalities in Hesse and NRW are much more similar to each other than to the average control municipality. However, compared to Hesse, DRP municipalities in NRW are significantly larger than their non-DRP counterparts in terms of population density. For LBT rates, we find that NRW municipalities generally set a significantly higher tax rate than other German municipalities. Property tax rates are more similar across groups.[25]

Figure 1 depicts the cumulative change of LBT, PTA and PTB rates in the treatment year and the two years after the DRP came into effect. The borders of municipalities participating in the respective DRP are colored orange. In the case of NRW, treatment is very centralized in the *Ruhrgebiet* (the former industrial heart of Germany), where many municipalities with excessive debt and limited economic opportunities are located. In Hesse,

[24]Several German states have experienced waves of municipal mergers and other territorial reforms, particularly in East Germany. We account for this fact by fixing our data to the territorial boundaries of 2018 by aggregating the data of all municipalities that would eventually merge into one. The two states considered in the empirical analysis are hardly affected by mergers or similar reforms – there is only one reform in Hesse and none in NRW. Given the findings of Egger et al. (2022), we rerun our analysis excluding all municipalities that were involved in these reforms. The results are robust and are available upon request.

[25]Interestingly, our data on local tax rates suggest that there is an upward trend in LBT tax rates. This is the opposite pattern of what we see when looking at international data and countries' corporate income tax rates over time (see Mc Auliffe et al. (2024)). In Appendix A.1, we provide graphical illustrations on mean (Figure A.5) and median (Figure A.6) tax multipliers (for all three types of local taxes and all German municipalities). The figures illustrate that, on average, the increase in multipliers is most pronounced for the property tax B, starting from a relatively low level.

Table 1: Summary Statistics

	NRW		Hesse		
	DRP	**Non-DRP**	**DRP**	**Non-DRP**	**Controls**
Population Density (inhabitants/sqkm)					
mean	922.73	431.36	368.98	337.62	197.93
sd	741.84	449.91	500.37	377.62	285.58
min	107.78	43.23	20.51	37.88	5.79
max	3,246.92	2848.51	2,868.62	3,032.73	4,736.11
N	671	3,679	1,012	3,652	50,930
Area (in sqkm)					
mean	84.42	86.43	52.75	48.12	33.55
sd	51.46	49.76	31.17	32.28	33.14
min	20.49	22.36	4.4	4.05	1.33
max	232.83	405.17	165.61	248.31	379.57
N	671	3,685	1,012	3,652	50930
Total Population					
mean	84,030.96	37792.69	16,966.78	13,715.22	6,584.40
sd	109,224.27	81,907.11	29,949.58	41,916.58	29,342.95
min	6,508	4,116	615	1,066	35
max	583,393	1,085,664	201,585	753,056	1,471,508
N	671	3,679	1,012	3,652	50,930
Population share age 18 and younger					
mean	0.17	0.18	0.16	0.17	0.17
sd	0.01	0.02	0.02	0.02	0.03
min	0.14	0.14	0.1	0.12	0.02
max	0.21	0.26	0.21	0.23	0.38
N	671	3,679	1,012	3,652	50,852
Population share older than 65					
mean	0.21	0.20	0.22	0.21	0.20
sd	0.01	0.02	0.03	0.02	0.04
min	0.16	0.12	0.14	0.15	0.03
max	0.25	0.32	0.32	0.30	0.41
N	671	3,679	1,012	3,652	50,929
Local Business Tax Rate					
mean	16.15	14.96	12.79	12.22	11.99
sd	1.03	1.03	1.38	1.19	1.13
min	13.97	8.75	9.45	8.75	7
max	20.3	20.13	16.8	16.8	17.5
N	671	3,685	1,012	3,652	50,930
Property Tax A Rate					
mean	1.8	1.5	2.24	1.85	1.95
sd	0.58	0.35	0.67	0.48	0.49
min	1.02	0.78	1.2	0	0
max	4.26	4.95	4.71	4.32	11.4
N	671	3,685	1,012	3,652	50,930
Property Tax B Rate					
mean	1.94	1.54	1.40	1.13	1.76
sd	0.5	0.27	0.48	0.29	0.86
min	1.33	0.81	0.74	0.49	0
max	3.36	3.33	3.68	2.77	5.2
N	671	3,685	1,012	3,652	50,930

Summary Statistics Continued

	NRW		Hesse		
	DRP	**Non-DRP**	**DRP**	**Non-DRP**	**Controls**
Local Business Tax Base (in 1,000 Euro)					
mean	8,003.13	5,407.88	2,081.90	2,687.81	979.43
sd	12,258.99	17652.84	5,563	19,328.24	7,651.74
min	-82	-560	-2,146.76	-2,973.61	-6,448
max	97,227.25	274,382	44,903.27	418,565.8	551,921.3
N	671	3,685	1,012	3,652	50,885
Property Tax A Base (in 1,000 Euro)					
mean	30.16	44.8	14.58	14.59	10.44
sd	23.56	31.03	11.36	11.12	10.58
min	-29	-2.30	-7	-99	-31
max	138.98	328.75	57	104	170.02
N	671	3,685	1,012	3,649	50,858
Property Tax B Base (in 1,000 Euro)					
mean	2663.33	1,360.32	606.18	522.8	216.89
sd	3539.03	3,346.48	1186.3	2,276.12	1,148.43
min	165	30	13	21	-62.37
max	19,948.41	45,196.26	7,621.95	42,819	60,713.77
N	671	3,685	1,012	3,652	50,930
Personal Income Tax Transfer (in 1,000 Euro)					
mean	30,333.67	15,087.2	7,335.27	6,605.81	2,785.37
sd	39,060.7	35,096.65	12,710.09	21,555.87	16,262.06
min	2146	1058	215	254	4
max	271,348.5	581,567	94,670.14	453,685.9	1,210,197
N	671	3,685	1,012	3,652	50,930
Value-Added Tax Transfer (in 1,000 Euro)					
mean	4,717.44	2,340.34	999.26	941.4	355.78
sd	7,679.90	7,897.08	2,712.93	7,754.59	3,094.93
min	58	45	3.7	5	-343
max	67,356.36	158,841.8	27,287.57	191,859.5	283,237.2
N	671	3,685	1,012	3,652	50,872
Local Business Tax Transfer (in 1,000 Euro)					
mean	5,664.94	3,837.55	1,427.12	1,840.53	633.92
sd	8,673.62	12,589.14	3,817.16	13,213.12	5,310.74
min	-28	-386	-1,466.24	-2,036.92	-4,427
max	71,223.38	203,042.6	30,983.26	285,880.3	409,860.2
N	671	3,685	1,012	3,652	50,834
Total Tax Revenue (in 1,000 Euro)					
mean	82,844.24	43,685.32	18,196.91	18,421.59	7,063.3
sd	118,033.4	125,155.6	41,199.46	115,101.1	55,058.69
min	3,453	2257	0	-6,040.35	-10,619
max	848,240.9	2,042,051	304,150.3	2,492,956	4,113,045
N	671	3,685	1,012	3,636	50,845

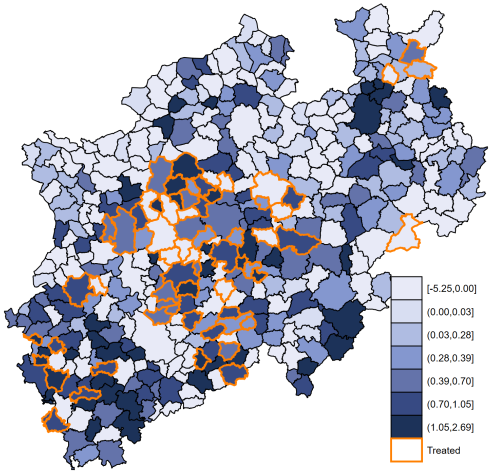
on the other hand, treatment is distributed across the entire state. Looking only at DRP municipalities, we observe that tax increases in those municipalities vary both in size and the choice of the tax instrument. It is striking, for example, that many DRP municipalities in NRW do not change the PTA rate. However, this pattern can be rationalized by the lack of agricultural land and thus an insufficient PTA tax base in the Ruhrgebiet. For both states, we observe substantial tax-setting responses by non-DRP municipalities located close to a DRP municipality, illustrating the importance of spatial aspects in the diffusion of tax shocks. This pattern appears to be particularly salient in Hesse.

4 Identification Approach

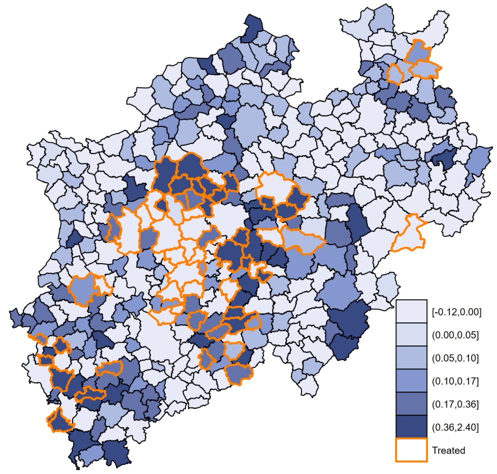
Our analysis involves three steps, with the primary goal of identifying the size and scope of tax-setting responses of non-DRP municipalities. First, we analyze the baseline effect of DRP participation on the DRP municipalities in Hesse and NRW. As argued in Section 2, we expect these municipalities to raise tax rates in their efforts to consolidate budgets. Second, we focus on the size of the tax-setting response of the non-DRP municipalities located in Hesse and NRW, respectively. These municipalities were not financially distressed and were not in need of tax rate increases. Any significant tax rate effect reflects a reaction to the tax rate adjustment of neighboring DRP municipalities. Lastly, in Section 6, we explore heterogeneity in tax-setting responses based on spatial, political, demographic, and administrative characteristics.

To identify the causal effect of the DRPs on the tax-rate setting of municipalities in each state, we sample a comparable control group from the pool of municipalities in states without a DRP and implement a (generalized) Difference-in-Differences (DiD) estimation strategy. An unbiased identification requires that DRP participation be independent of unobserved municipality characteristics. Given the institutional setup of the DRPs, the assignment of treatment is quasi-exogenous, conditional on observed municipality characteristics prevent-

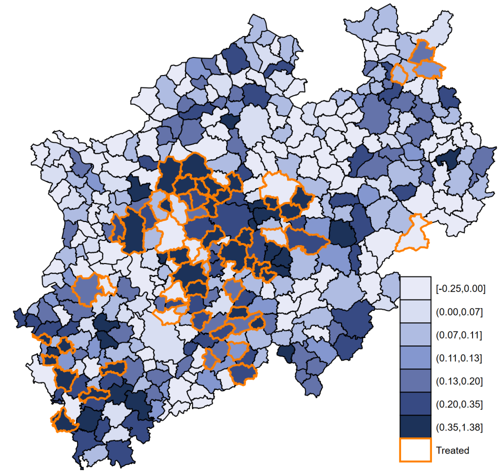
Figure 1: Tax Rate Changes of Municipalities in Hesse and NRW



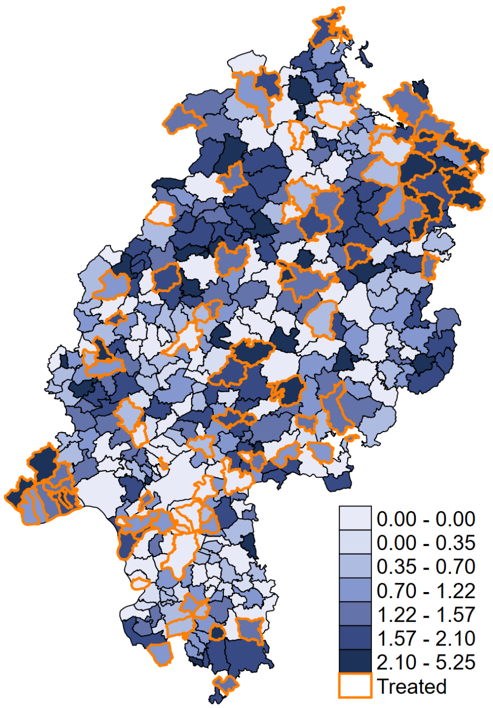
(a) LBT NRW



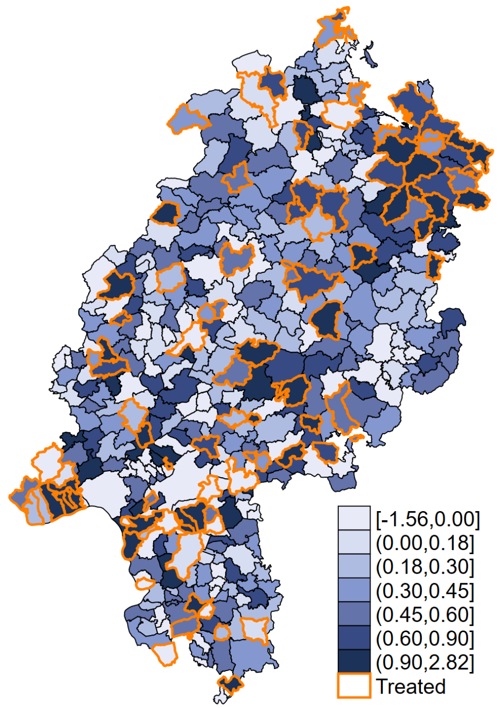
(b) PTA NRW



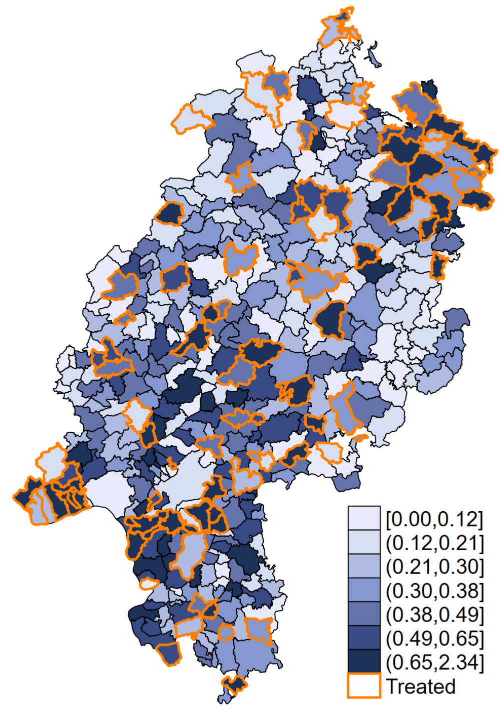
(c) PTB NRW



(d) LBT Hesse



(e) PTA Hesse



(f) PTB Hesse

ing self-selection into treatment.[26] In addition, two other assumptions must be met. First, the common trends assumption needs to hold, ensuring that the true effect of the DRP is not confounded by general time trends. In our setting it demands that municipalities in Hesse or NRW and control municipalities would have shown the same development of municipal tax rates in the absence of the DRPs. Second, control municipalities must not be affected by the treatment. Given the differences between DRP, non-DRP, and control municipalities depicted in Table 1, we employ Propensity Score Matching (PSM) to sample a more comparable control group for each subsample. The donor pool consists of all municipalities located in a state without a DRP.[27] The match is based on a number of municipality characteristics including demographics, tax bases, development of tax instruments, and fiscal transfers.[28]

To assess the direct effect of DRP participation on tax rates, we estimate:

$$TAX_{it} = \alpha + \beta(Post_t \times DRP_i) + \delta_i + \zeta_t + \epsilon_{it}, \qquad (1)$$

where TAX_{it} denotes the LBT, PTA or PTB tax rate of municipality i in year t; δ_i and ζ_t represent municipality and year fixed effects, respectively; ϵ_{it} captures the disturbance term. $Post_t$ is a dummy taking on the value one in the year of treatment and all post-treatment periods. DRP_i is a dummy indicating whether a municipality participated in a state DRP. The coefficient of interest is β. As state DRPs require municipalities to consolidate their public budgets, we expect β to be positive and statistically significant for all

[26]Self-selection concerns of NRW municipalities in the second wave are dismissed as eligibility does not depend on unobserved municipality characteristics and by the full take up of the program. All of our baseline results are robust to excluding these opt-in municipalities.

[27]These are the states of Baden-Württemberg, Bavaria, Brandenburg, Saxony, and Thuringia. Bavaria had a small DRP in 2012 aimed at the development of rural municipalities rather than fiscal consolidation. We replicate our analysis excluding Bavarian municipalities from the control group and find robust results that are available upon request. See Appendix A.5 for details.

[28]See Appendix A.5 for details on the matching procedure and pre-treatment summary statistics for the matched samples used in the analysis. Note that our identification approach is still based on the assumption of parallel or common trends. PSM helps, however, to make sure that this assumption holds. In Appendix A.7, we replicate the results of our analysis without matching and demonstrate that matching predominantly improves the precision of the estimates, but that it does not substantially change our findings.

three tax instruments.[29] In order to further explore the timing and persistence of the effect of DRP participation on municipal tax policy, we also estimate a dynamic generalized DiD specification:

$$TAX_{it} = \alpha_0 + \sum_{t=2008}^{2018} \alpha_t DRP_i \times year_t + \delta_i + \zeta_t + \epsilon_{it}. \tag{2}$$

From this, we obtain T coefficients of interest α_t, reflecting the effect in the respective year. For $t < t_{treatment}$, we expect the α_ts to be close to zero and statistically insignificant, while for $t \geq t_{treatment}$, all α_ts are expected to be positive and statistically significant. As municipalities participate over longer time periods in the state DRPs, we would expect the effect to be persistent over time. The goal of this first step of the analysis is to establish that participating municipalities indeed exhibit a strong tax-policy reaction to the respective states' DRP.

In the second step, we turn to municipalities located in the state implementing a DRP, but not participating in the respective DRP. To focus on these non-DRP municipalities, we estimate equations (1) and (2) replacing DRP_i with $non\text{-}DRP_i$. The indicator $non\text{-}DRP_i$ takes on the value one if a municipality is located in Hesse or NRW and not part of the respective DRP, and zero otherwise. Regarding the expected results for the LBT, PTA, and PTB, the intuition is less straightforward, given the mixed results of the previous literature. If German municipalities engage in corporate tax competition, we would expect that LBT rates are strategic complements ($\beta > 0$), implying that a rise in the LBT of one municipality should lead to an increase in the LBT of its neighboring municipalities. This response should be less than proportional compared to that of the DRP municipalities, otherwise we would observe a "race-to-the-top" in tax rates. As the property tax base is immobile, governments should have little to no strategic tax-base related incentive to react to changes in their

[29] Note that our identification approach crucially relies on the inclusion of δ_i, which removes level differences across municipalities.

neighbors' tax policy in the short term ($\beta = 0$).[30] However, if municipalities are learning from their neighbors or engage in yardstick competition, then property tax rates should also be complements ($\beta > 0$). In this case, spillovers in the property tax rates would be driven by non-base related motives.

Given the spatial pattern in Figure 1 and the heterogeneity analysis in Section 6, we allow for arbitrary spatial cluster correlation in the standard errors (see Colella et al., 2023). Distance cutoffs for the arbitrary spatial correlation between a non-DRP and the nearest DRP municipality are chosen based on the results presented in Table 4. Specifically, the distance cutoff is equal to the distance for which the average treatment effect is just zero rounded to the next full kilometer. If this distance exceeds the maximum distance to the nearest DRP municipality, the distance cutoff is set to this maximum value.[31] Distance cutoffs are calculated separately for each tax instrument and state, given the heterogeneous spatial response shown in Table 4.

5 Results

5.1 Baseline Results

We begin our analysis by establishing the baseline effects of the DRPs on the participating municipalities. Panel A of Table 2 displays the results for the baseline specification in equation (1). The results for NRW in columns (1)-(3) and Hesse in columns (4)-(6) show that the DRPs led to a substantial increase in the tax rates of all three tax instruments. The increase in NRW is most pronounced for the LBT at 0.82 percentage points. The increases in the PTA and PTB are also economically sizable and statistically significant at 0.46 and 0.56 percentage points. This is especially true when looking at the tax increases relative to pre-

[30] We might expect strategic interaction in property tax rates in the medium and long run due to subsequent rent and housing price changes (see Suárez Serrato and Zidar, 2016).

[31] For Hesse (NRW), the maximum distance between a non-DRP and a nearest DRP pair is 36 (76) kilometers.

treatment levels. Property tax rates increased by 31% and 35% compared to a 5% increase in the LBT. Turning to the results for Hesse, we observe both larger absolute and relative increases in the municipal tax instruments. LBT rates have increased by 1.31 percentage points, or about 11%, while the property tax rates A and B increased by 0.74 (40%) and 0.58 (54%), respectively.

Figure 2 plots the results of the dynamic DiD estimation of equation (2) for the DRP municipalities. Not surprisingly, we observe a substantial increase in all three tax instruments in both Hesse and NRW after treatment occurs, as already documented in Table 2. However, DRP municipalities in NRW respond with a one-year lag in their LBT tax setting, as the coefficients for 2012 are statistically insignificant at the 5% level. Looking at pre-treatment periods in both states, we find no coefficients that are statistically different from zero.[32] In fact, most of the pre-treatment coefficients are almost exactly zero and exhibit an almost entirely horizontal pattern. Thus, DRP and control municipalities exhibit almost identical tax rate trends prior to DRP implementation, implying that the parallel trends assumption holds. In both states, all three tax rates rise immediately after treatment and show a sustained response over time, resulting in a large and persistent increase. Overall, Table 2 and Figure 2 show that the DRPs in Hesse and NRW had a substantial impact on the LBT and property tax setting of DRP municipalities in both states. Note that the dynamic estimates explicitly allow for second-round effects in tax-setting, until the effects level off and new equilibrium tax levels materialize in 2017 and 2018.

5.2 Tax-Setting Response

We now turn to the tax-setting response of non-DRP municipalities in each state. Panel B of Table 2 shows that non-DRP municipalities in DRP states also exhibit substantial tax increases. In the case of NRW, LBT rates increase by about 0.44 percentage points, or 3%,

[32]For detailed estimation results presented in Figure 2 and Figure 3, see Table A.13 and Table A.14, respectively.

Table 2: Effect of DRPs on Tax Rates – Difference-in-Differences Results

Panel A: Baseline Effect on DRP Municipalities

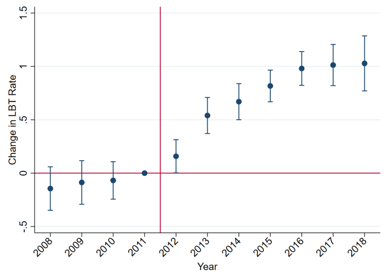
	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
Post × DRP	0.819***	0.461***	0.556***	1.315***	0.738***	0.586***
	(0.064)	(0.037)	(0.047)	(0.085)	(0.042)	(0.028)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,342	1,342	1,342	2,024	2,024	2,024
Average Tax Rate Pre-Treatment	15.661	1.504	1.597	12.113	1.847	1.093
Change in %	5.23	30.65	34.82	10.86	39.96	53.61

Panel B: Tax Response of Non-DRP Municipalities

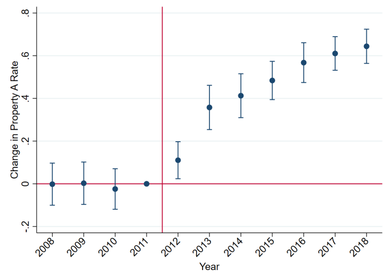
	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
Post × non-DRP	0.438***	0.140***	0.188***	0.905***	0.342***	0.284***
	(0.043)	(0.014)	(0.017)	(0.052)	(0.017)	(0.016)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,304	7,304	7,304	7,304	7,304	7,304
# Non-DRP Municipalities	332	332	332	332	332	332
# Control Municipalities	332	332	332	332	332	332
Average Tax Rate Pre-Treatment	14.675	1.397	1.428	11.792	1.667	0.985
Change in %	2.99	10.02	13.17	7.68	20.52	28.83

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

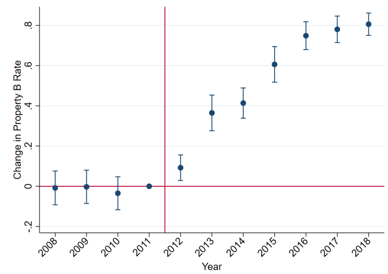
Figure 2: Dynamic Effect of DRPs on DRP Municipalities



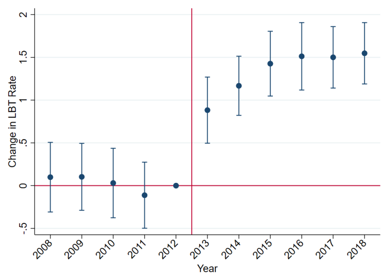
(a) LBT NRW



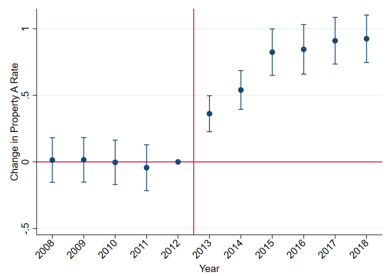
(b) PTA NRW



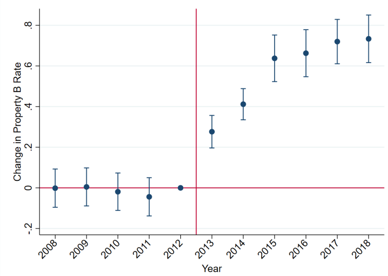
(c) PTB NRW



(d) LBT Hesse



(e) PTA Hesse

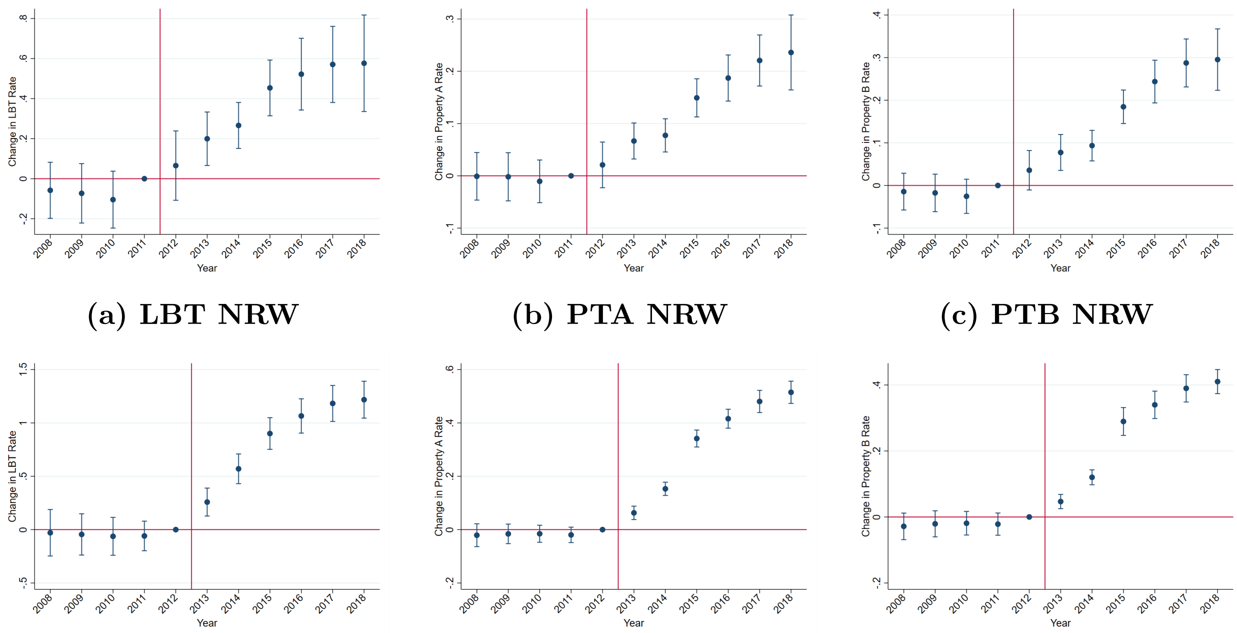


(f) PTB Hesse

which is more than half of the increase in DRP municipalities. Turning to column (4), we find that non-DRP municipalities in Hesse exhibit a larger LBT response of 0.90 percentage points or 8%. In both states, LBT rates increase substantially but less than proportionally. Looking at the results in columns (2) and (3), we find that non-DRP municipalities in NRW also significantly increase their property tax rates. PTA tax rates increase by about 0.14 percentage points, or 10% relative to the pre-treatment level. PTB tax rates increase by 0.18 percentage points, or 13%. The increase in property tax rates is again less than proportional compared to that of municipalities participating in the DRP, but it is economically and statistically significant. A similar picture emerges when looking at the results for Hesse in columns (5) and (6). However, the response in Hesse is larger both in absolute and relative terms, as property tax rates A and B increase by 0.34 (21%) and 0.28 (29%) percentage points, respectively.[33]

[33]Pre-treatment debt levels are not driving the tax-setting response of non-DRP municipalities. Furthermore, the municipality fixed effects control for the average debt level across the observational period, while the year fixed effects net out common shocks (like the global financial crisis) to debt levels in our sample. See Appendix A.3, for a detailed discussion.

Figure 3: Dynamic Effect of DRPs on Non-DRP Municipalities



(a) LBT NRW **(b) PTA NRW** **(c) PTB NRW**

(d) LBT Hesse **(e) PTA Hesse** **(f) PTB Hesse**

Looking at the dynamic DiD results shown in Figure 3, we find similar patterns as in Figure 2. We observe no statistically significant pre-trends for either state and all three policy instruments, again suggesting that the assumption of common trend holds. The tax-setting response of non-DRP municipalities in NRW materializes with a one-year lag, as the coefficients for 2012 are statistically insignificant at the 5% level. Similar to the DRP municipalities, tax rates increase gradually over time until 2016, when the effect appears to converge to a new equilibrium. Thus, non-DRP municipalities in both states exhibit substantial and persistent tax-setting responses.

5.3 Tax-Response Functions

Having established the baseline tax adjustment of DRP municipalities and the tax response of non-DRP municipalities, we can learn about the slope of the underlying tax-reaction functions. Our calculation of the slopes of the tax-response function differs from the approach commonly taken in the literature. Instead of estimating the slope directly, we compute it by combining our DiD coefficients. The slope of tax instrument k in state s is given by the ratio of the tax effects of DRPs in Panel A and B of Table 2:

$$Slope_k^s = \frac{\beta^s_{non-DRP,k}}{\beta^s_{DRP,k}}. \tag{3}$$

The calculation of the slope of the response function implicitly assumes that the tax response of non-DRP municipalities is only due to the tax increase of the same tax instrument in DRP municipalities.[34] Table 3 shows the slopes of the response functions for the two states and the different tax instruments.[35]

Table 3: Implied Slope of Tax-Reaction Function

	NRW			Hesse		
	LBT	PTA	PTB	LBT	PTA	PTB
Response:	0.54***	0.30***	0.34***	0.69***	0.46***	0.49***
	(0.07)	(0.04)	(0.04)	(0.06)	(0.04)	(0.04)

Standard errors are reported in parentheses and calculated using the Delta Method. *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

In both states, the tax response of non-DRP municipalities is strongest for the LBT. This is what we would expect since the local business tax base is presumably more mobile than the property tax base. The slope of (0.54-0.69) of the LBT response function is substantially larger than the 0.05 slope found in Büttner (2001). Based on country-level data, Egger and Raff (2015) estimate a coefficient of about 0.15, which is also substantially smaller than our slope coefficient. Devereux et al. (2008), however, estimate slope functions of similar magnitude when looking at international tax competition. Similarly, Thunecke (2022) finds a slope coefficient of 0.87 using the approach of Egger and Raff (2015). Thus, the slope

[34] Cross-tax effects are effectively assumed to be zero. Since the LBT, PTA, and PTB tax rates are chosen to consolidate public budgets, they are most likely substitutes. Thus, if anything, we would be underestimating the true magnitude of the slope function.

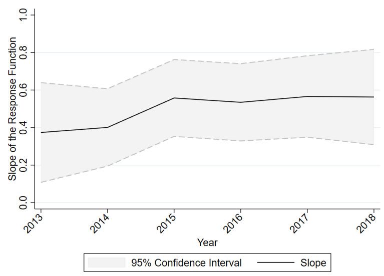
[35] Alternatively, we also estimate the slope of the response function directly in Appendix A.10 using an instrumental variable (IV) approach in the spirit of Lyytikäinen (2012). While the qualitative results are unchanged, the slopes derived from the baseline estimates are smaller than those from the IV estimation. See Appendix A.10 for details.

of the business tax-response functions appears to be symmetric for tax increases, as in this paper, and for tax decreases, as in the international tax competition literature. The slopes of the property tax response functions (0.30-0.49) are in a plausible range and in line with previous findings by Allers and Elhorst (2005), who suggest a slope coefficient of about 0.35. Previous literature has interpreted the responses to changes in local property tax setting as evidence for yardstick competition. This seems justified because the tax base is immobile in this context. While we believe that our findings can mainly be ascribed to mimicking behavior and hence yardstick competition in the short- and medium-run (see the discussion on the effect of distance and similarity below), there may be indirect effects through the mobility of people and Tiebout (1956) sorting. The latter may be reflected in prices and long-run outcomes.

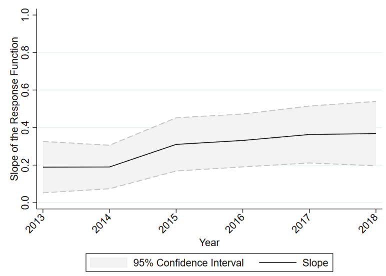
Beyond estimating one slope of tax-reaction functions for all post-treatment periods, it is worth visualizing its development over time. Figure 4 suggests that it takes some time until competing municipalities fully respond to the tax setting of the DRP municipalities – the slopes increase over time. Interestingly, they do so at a decreasing rate. This is also a plausible finding as tax rates converge to a new equilibrium and the reform effect stabilizes over time as depicted in Figures 2 and 3. In the case of Hesse, this produces a smooth concave function. The pattern is less clear for NRW, although its shape seems to be driven by the year 2015, where tax responses of non-DRP municipalities were somewhat less pronounced. Let us add, however, that these slope coefficients are obtained from flexible DiD regressions (for DRP and non-DRP municipalities) and the ratios from these estimates remain consistently positive and within a plausible range. As we cannot account for cross-tax effects, our slope coefficients may be to some degree context-specific.

Overall, in both states, all three tax instruments show substantial responses to the DRPs of non-DRP municipalities. These municipalities were not targeted by the DRPs because they were not financially distressed. Their tax rate adjustment is a response to the higher tax rates set by the DRP municipalities. Given the slopes of the response functions, LBT, PTA,

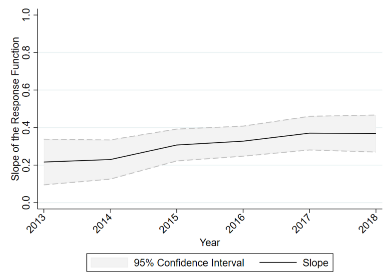
Figure 4: Slope of Tax-Reaction Function over Time



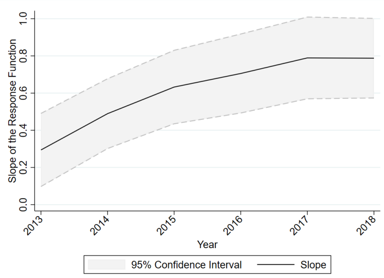
(a) LBT NRW



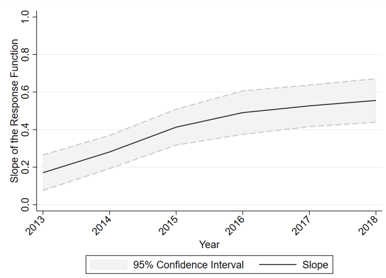
(b) PTA NRW



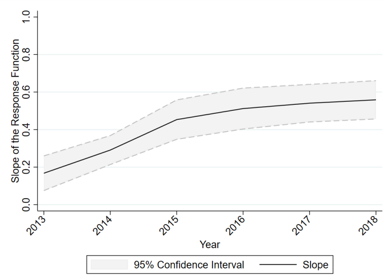
(c) PTB NRW



(d) LBT Hesse



(e) PTA Hesse



(f) PTB Hesse

and PTB tax rates appear to be strategic complements. While these results are informative about the magnitude of the tax-setting responses of non-DRP municipalities, they do not allow us to determine which type of fiscal interaction is driving the results (tax competition, interjurisdictional learning, tax mimicking, or yardstick competition). However, we expect that the LBT response is driven by tax competition for mobile capital, while the property tax responses are more related to mimicking behavior and yardstick competition. To shed light on this issue, we investigate the underlying heterogeneity of tax-setting responses in the following section.[36]

[36] While our paper does not explicitly evaluate local DRPs, our findings have some interesting policy implications. In particular, it appears that policymakers have – in response to the DRPs – shifted a relatively larger share of the tax burden to immobile tax bases. From an optimal tax perspective, this is efficient. To support our argument, we exploit our empirical framework to provide additional estimates of the marginal cost of public funds (MCPFs) in Appendix A.8. According to these results, a further increase in the LBT would be associated with substantial economic cost. However, the estimates of the MCPFs of the property tax rates are very close to one, implying that these tax instruments are almost lump-sum taxes. Blesse et al. (2019) argue in recent work that German municipalities generally choose too low property tax rates (from an efficiency perspective) due to imprecise expectations and political concerns. The exogenous state-mandated policy programs may thus be interpreted as a valuable policy tool to provide learning opportunities and correct myopic tax-setting behavior of municipalities. This should make local governments' fiscal policy more sustainable in the long-run.

6 Heterogeneity in Tax-Policy Responses

Our setting allows us to explore different dimensions of heterogeneity in the response of the non-DRP municipalities. Ultimately, we are interested not only in the size of the tax-policy response, but also in what drives fiscal responses. Do they depend on spatial proximity, political affiliation, municipality size, or being part of the same overarching administrative structure? We explore these dimensions of heterogeneity by analyzing differences in tax-setting responses between different pairs of DRP and non-DRP municipalities. For the analysis, we consider the characteristics of each non-DRP municipality and its geographically closest DRP municipality. We explore heterogeneity along the spatial dimension by testing how tax responses change with distance to the nearest DRP municipality, and whether spatial dynamics are symmetric across the different tax instruments. In order to investigate these questions, we specify:

$$TAX_{it} = \alpha + \beta(Post_t \times non\text{-}DRP_i) + \gamma(Post_t \times non\text{-}DRP_i \times Dist_{ij}) + \delta_i + \zeta_t + \epsilon_{it}, \quad (4)$$

where $Dist_{ij}$ denotes the distance between of a non-DRP municipality i and the nearest DRP municipality j.[37] We expect tax policy spillovers to be particularly relevant among geographic neighbors and γ to be negative. Here, γ is the differential effect of being located farther away from the nearest DRP municipality.

The spatial heterogeneity results are reported in Table 4. In line with the baseline specifications, we find statistically significant tax increases for all three tax instruments in both states. Looking at the results for NRW in columns (1)-(3), we find that the increase in the LBT and PTB is less pronounced the farther away a non-DRP municipality is from the nearest DRP municipality. More specifically, the LBT (PTB) response is on average 0.005 (0.003) percentage points smaller for every kilometer between the non-DRP and the next DRP municipality. This implies that the LBT (PTB) response of the non-DRP municipalities

[37] We compute the distance between the centroids of the municipalities.

in NRW vanishes, on average, for a municipality located about 112 (84) kilometers away from the nearest DRP municipality.[38] The results are less clear for PTA, as the distance coefficient is negative but insignificant. This is most likely due to the fact that the possibility of raising revenue from property tax A is tied to the existence of agricultural land in a given municipality. Thus, spatial proximity may not be the driving force behind tax-policy spillovers for the property tax rate A in NRW.[39]

Turning to the results for Hesse in columns (4)-(6), we find that the baseline effect remains statistically significant and positive. The spatial response for both property tax rates is negative, statistically significant, and stronger compared to NRW. Combining both coefficients implies that the property tax responses in Hesse vanish, on average, at around 77 kilometers (PTA) and 50 kilometers (PTB).[40] This very local pattern of property tax-setting responses indicates that geographical proximity matters for the size of tax-policy spillovers. Interestingly, the spatial interaction coefficient for the LBT is positive, implying that non-DRP municipalities, on average, show larger increases in their LBT the farther away they are located from the nearest DRP. This finding indicates that, for the LBT, not only spatial but also other factors might play a role. In fact, the results allow for an interesting interpretation in light of Janeba and Osterloh (2013).

While the standard tax-policy spillover literature emphasizes the importance of spatial proximity, it disregards the potential importance of political "proximity". Having the same or different political majorities could influence the size of policy spillovers due to competition for votes or knowledge spillovers along party lines. In order to investigate the relevance of

[38]Note that the maximum distance to the nearest DRP municipality in NRW is 76 kilometers.

[39]We do not generally believe that spatial spillovers stop at the state borders to the DRP states. We cannot test cross-border spillovers in NRW as it is entirely surrounded by states that also implemented DRPs. We test for spillovers to other states by using municipalities along the eastern border of Hesse and run DiD regressions as above. We do not find any effect on the tax-setting behavior of these municipalities, suggesting that our results are not biased by focusing on the non-DRP municipalities in a respective state (this is consistent with the findings in Baskaran (2014)).

[40]Note that the maximum distance to the nearest DRP municipality in Hesse is 36 kilometers.

Table 4: Difference-in-Differences Results – Spatial Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.559***	0.162***	0.251***	0.788***	0.385***	0.349***
	(0.063)	(0.024)	(0.030)	(0.073)	(0.028)	(0.024)
non-DRP × Post × Dist	-0.005***	-0.001	-0.003***	0.012**	-0.005**	-0.007***
	(0.001)	(0.001)	(0.001)	(0.005)	(0.002)	(0.001)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,304	7,304	7,304	7,304	7,304	7,304

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

political proximity, we augment equation (1) as follows:

$$TAX_{it} = \alpha + \beta \times Post_t \times non\text{-}DRP_i \quad + \\ \sum_{g=2}^{3} \gamma_g \times Post_t \times non\text{-}DRP_i \times \mathbb{1}[Political\ Proximity = g] + \delta_i + \zeta_t + \epsilon_{it}. \quad (5)$$

Political Proximity is a categorical variable that reflects the political majorities in both the non-DRP and the nearest DRP municipality, and $\mathbb{1}[Political\ Proximity = g]$ is a dummy variable indicating each category. Political majority in this context means which party had the largest share of votes in the municipal election prior to the introduction of the DRP. The two most prominent parties in Hesse and NRW are the Social Democratic Party (SPD) and the conservative Christian Democratic Union (CDU). The key question is whether non-DRP municipalities that are governed by the same party as the nearest DRP municipality respond differently and if so, whether this response depends on the political ideology of the party. Thus, both DRP and non-DRP municipalities are categorized according to their majority party resulting in three combinations shown in Table 5. We take the different majority

Table 5: Categorization for Heterogeneity Analysis

	Political Proximity		*Size*	
Group	Non-DRP	DRP	Non-DRP	DRP
1	Different Majority		Different Size	
2	CDU	CDU	Small	Small
3	SPD	SPD	Large	Large

combinations as the baseline category of our analysis. Similar to the baseline specification, β returns the base effect on the non-DRP municipalities, while γ_g is the differential effect of having the same political majority as the nearest DRP municipality relative to having different majorities.

The political proximity results are presented in Table 6. Again, we observe positive and statistically significant baseline responses across all three tax instruments and in both states. Focusing on columns 1 to 3, we find that having the same political majority as the nearest DRP municipality results in larger tax-setting responses relative to municipality pairs with different majorities. These responses are significant for both property tax rates, while the LBT response is positive but statistically insignificant. This finding could be driven by greater information exchange or policy coordination among politically aligned municipalities.

In Hesse, we find that the LBT is differentially affected with SPD (CDU) municipalities setting higher (lower) LBTs if the nearest DRP municipality exhibits the same political majority. This response is absent for property taxes, except for the PTA and CDU municipalities (note, however, that the magnitude of the effect is small compared to the baseline effect). Thus, political majorities in non-DRP municipalities may be relevant for the overall size of the tax response.

Another source of heterogeneity is differences in the size of municipalities. Size may matter both for the subset of competitors, as in Janeba and Osterloh (2013), and for the size of the tax base for which municipalities compete. Municipality size also reflects location-specific agglomeration effects that may mitigate competitive pressures. To explore the heterogeneous

Table 6: Difference-in-Differences Results – Political Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.403***	0.112***	0.149***	0.843***	0.349***	0.285***
	(0.038)	(0.012)	(0.015)	(0.056)	(0.019)	(0.020)
CDU × CDU	0.053	0.039**	0.043***	-0.114**	-0.034**	-0.010
	(0.034)	(0.015)	(0.016)	(0.049)	(0.015)	(0.013)
SPD × SPD	0.015	0.028***	0.113***	0.206***	-0.001	0.001
	(0.037)	(0.004)	(0.034)	(0.048)	(0.018)	(0.014)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,304	7,304	7,304	7,304	7,304	7,304

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

tax-setting responses based on size, we take a similar approach as for the political proximity and estimate the following model:

$$TAX_{it} = \alpha + \beta \times Post_t \times non\text{-}DRP_i + \sum_{g=2}^{3} \gamma_g \times Post_t \times non\text{-}DRP_i \times \mathbb{1}[Size = g] + \delta_i + \zeta_t + \epsilon_{it}. \quad (6)$$

$Size$ categorizes the population size of the non-DRP municipality and its nearest DRP municipality, as shown in Table 5, and $\mathbb{1}[Size = g]$ indicates each category. Municipalities are categorized as large if their population is equal or greater than 100,000 or small otherwise.[41] We take municipalities of different sizes as the base category of our analysis. Here, γ_g is the differential effect of having the same large or small population size as the nearest DRP municipality relative to having a different size.

Table 7 presents the results for heterogeneity in size. Again, we find positive and statistically significant baseline effects across all three tax instruments in both states. Looking at the results for the LBT in NRW, we see that non-DRP municipalities with a similarly

[41] The population threshold is identical to the population threshold for a municipality to be considered a large city for administrative purposes.

sized nearest DRP municipality respond stronger than municipality pairs of different sizes. Focusing on the results in column (4), Hesse exhibits a partially different pattern with small municipalities responding stronger if the nearest DRP municipality is also small, while large municipalities even exhibit an overall reduction of their LBT if the nearest DRP municipality is large as well.[42] As for the results for the property tax rates in NRW, small municipalities respond particularly strongly to other small municipalities, while large ones with a large nearest DRP municipality exhibit a decrease, which is statistically significant for the PTA. In the case of Hesse, *small-small* municipalities do not respond differently. For large ones, however, the effect is negative, i.e., if the nearest DRP municipality is also large, the response becomes smaller.

Overall, our results suggest that municipality size is an important factor in explaining the size of the tax-setting response among municipalities. It seems that municipalities respond to similar municipalities of the same size by imitating the behavior of their DRP neighbors. This is consistent with yardstick competition, as mimicking behavior should predominately be observed among similarly-sized, small municipalities.

Finally, we explore the importance of being located in the same county as the nearest DRP municipality. Büttner and von Schwerin (2016b) find that municipalities sharing the same county affiliation are more likely to set similar local business tax rates. The county is the closest higher administrative level, but has no decision power when it comes to tax setting. To estimate the relevance of county affiliation for tax policy response functions, we estimate:

$$TAX_{i,t} = \alpha + \beta \times Post_t \times non\text{-}DRP_i + \gamma \times Post_t \times non\text{-}DRP_i \times County_{ij} + \delta_i + \zeta_t + \epsilon_{i,t}, \quad (7)$$

where $County_{ij}$ indicates whether the non-DRP municipality and its nearest DRP municipality are located in the same county. Based on the findings of Büttner and von Schwerin

[42] The results for large non-DRP and DRP municipalities are based on a small sample as only a few municipalities exceed the 100,000 population threshold. In NRW (Hesse), 15 (3) DRP and 13 (2) non-DRP municipalities are considered as large.

Table 7: Difference-in-Differences Results – Size Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.173***	0.066***	0.123***	0.518***	0.376***	0.311***
	(0.017)	(0.011)	(0.013)	(0.069)	(0.049)	(0.042)
Small × Small	0.333***	0.095***	0.084***	0.412***	-0.034	-0.028
	(0.068)	(0.018)	(0.016)	(0.056)	(0.047)	(0.035)
Large × Large	0.414***	-0.094***	-0.008	-0.849***	-0.455***	-0.233***
	(0.088)	(0.023)	(0.019)	(0.118)	(0.086)	(0.071)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,304	7,304	7,304	7,304	7,304	7,304

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

(2016b), we expect γ to be positive.

The county results are depicted in Table 8 and illustrate positive and statistically significant base effects for all three tax instruments in both states. We also observe positive and significant effects on the tax-setting response of non-DRP municipalities in NRW when these are located in the same county as the nearest DRP municipality. This is in line with Büttner and von Schwerin (2016b) and implies that municipalities respond stronger when sharing a county affiliation.

Looking at the results for Hesse in column (4), we find a similar effect for the LBT. This result is particularly interesting, given the positive spatial interaction coefficient in Table 4, suggesting that the positive effect cannot be attributed to spatial proximity due to county affiliation. By the same token, the insignificant interaction terms for the property tax rates in Hesse imply that the spatial results for Hesse in Table 4 are not driven by county affiliation. Hence, being located in the same county as the nearest DRP municipality leads, on average, to much stronger tax-setting responses among non-DRP municipalities.

Overall, we find that several margins of heterogeneity between non-DRP and the nearest

Table 8: **Difference-in-Differences Results – Administrative Heterogeneity**

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.380***	0.126***	0.167***	0.801***	0.329***	0.271***
	(0.036)	(0.013)	(0.014)	(0.052)	(0.018)	(0.018)
non-DRP × Post × Same County	0.183***	0.046***	0.067***	0.164***	0.022	0.021
	(0.034)	(0.013)	(0.017)	(0.043)	(0.020)	(0.013)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,304	7,304	7,304	7,304	7,304	7,304

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

DRP determine the size and the scope of the tax-setting responses. Spatial proximity, municipality size, political majorities, and common administrative structure significantly determine tax-policy responses. The fact that different dimensions of heterogeneity matter for the scope of the tax-setting responses also demonstrates that the observed effects on the non-DRP municipalities are not driven by state-specific time trends or general efforts of Hesse and NRW to consolidate municipal budgets.

7 Robustness Checks

In this section we present a number of robustness checks. First, we conduct permutation tests, focusing exclusively on potential control municipalities located in states without a DRP to validate the DiD results presented in Table 2, Panel B. This is done by randomly re-shuffling DRP status across control municipalities. We then run equation (1). We repeat this procedure 1,000 times for each tax-instrument-state combination. Treatment timing and the original size of the non-DRP and control groups in Hesse and NRW are maintained (664 municipalities in Hesse and 664 in NRW). Looking at Table 9, we observe that the placebo effects are not only significantly different from the actual effects, but they are also not statistically different from zero.[43] Consequently, the permutation test confirms that the increase in municipal tax instruments of the non-DRP municipalities is driven by the introduction of the DRP.

Table 9: Estimated Placebo Coefficients

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
Placebo effect	0.0002	-0.0007	-0.0006	0.0008	-0.0007	-0.0005
	(0.0620)	(0.0142)	(0.0166)	(0.0569)	(0.0138)	(0.0149)
Actual effect	0.438***	0.140***	0.188***	0.905***	0.342***	0.284***
	(0.043)	(0.014)	(0.017)	(0.052)	(0.017)	(0.016)

While the heterogeneity analysis in Section 6 focuses on the characteristics of the nearest DRP municipality, the tax setting response of the non-DRP municipalities should depend not only on the spatial proximity of the nearest DRP municipality, but also on the number of DRP units within a predefined radius.[44] We call this treatment intensity. We drop all control municipalities located within this radius. Finally, we divide the non-DRP municipalities into quartiles based on the number of DRP neighbors in their vicinity. We then run equation (1) again, replacing the treatment dummy with quartile dummies. The results are shown in Table 10. Looking at the results for the LBT in columns (1) and (4), we find that the tax-setting responses are broadly increasing in intensity. However, the increase across quartiles is non-monotonic. That is, tax-setting responses initially increase with more DRP municipalities in close proximity, but there appear to be some nonlinearities with respect to the highest intensity quartile. The results for the property tax rates are very similar, with an increasing effect in intensity.

[43]Figure A.8 in Appendix A.4 depicts the distribution of the placebo coefficients. Distributions for all three tax measures across both states are centered around zero. Furthermore, none of the placebo estimates compares to the estimated effects in Panel B of Table 2.

[44]The radius is 40 kilometers for Hesse and 80 kilometers for NRW. The radius is chosen in such a way that for each non-DRP municipality there is at least one DRP municipality within this radius.

Table 10: Treatment Intensity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
1.Quartile × Post	0.379***	0.137***	0.159***	0.991***	0.264***	0.205***
	(0.033)	(0.020)	(0.014)	(0.064)	(0.017)	(0.013)
2.Quartile × Post	0.572***	0.191***	0.173***	1.049***	0.336***	0.267***
	(0.093)	(0.030)	(0.022)	(0.062)	(0.023)	(0.016)
3.Quartile × Post	0.447***	0.106***	0.191***	0.862***	0.358***	0.301***
	(0.062)	(0.012)	(0.020)	(0.060)	(0.025)	(0.022)
4.Quartile × Post	0.352***	0.126***	0.230***	0.693***	0.422***	0.374***
	(0.024)	(0.011)	(0.030)	(0.071)	(0.025)	(0.025)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,304	7,304	7,304	7,304	7,304	7,304

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

8 Conclusions

In this paper we use local debt reduction programs (DRPs) and a Difference-in-Differences identification strategy to learn about tax competition and tax-setting responses. After the financial crisis of 2008, the German states of Northrhine-Westfalia and Hesse introduced DRPs, with municipal participation being mandated by the state governments. Participating municipalities had to prepare and execute feasible and binding consolidation measures that led to heterogeneous increases in local business and property tax rates.

Our empirical analysis shows that both local business and property tax rates of the municipalities participating in a DRP increased significantly by up to 54% compared to the pre-treatment period. We also show that municipalities located in Hesse or NRW that were not targeted by DRPs (because they were not financially distressed) responded strongly to the tax setting of the municipalities participating the DRP. The estimates for DRP and non-DRP municipalities allow us to calculate the slopes of the tax-response function. Our results indicate that these range from 0.54 to 0.69 for the local business tax and from 0.30 to 0.49 for the property tax rates.

In contrast to previous contributions to the literature, our empirical setting does not require the specification of a spatial lag model that relies on spatial instruments. Moreover, the importance of spatial proximity in tax-setting responses has been largely neglected in previous work. Our empirical approach specifically accounts for the fact that geographically close non-DRP municipalities should not serve as a benchmark and control group. The reason is that non-DRP municipalities respond significantly to the tax setting of nearby DRP municipalities. Neglecting this would severely bias the tax response estimates.

Given the unique institutional setting and the DRP reforms, our paper contributes to a better understanding of local policy choices. Besides the interaction in tax-setting behavior, we also provide estimates based on different measures of similarity and heterogeneity to find out whether our results are driven by tax competition for mobile capital or by yardstick competition. We find that spatial proximity, political majorities, municipality size, and a common administrative organization are important determinants of tax-setting responses, consistent with mimicking behavior and yardstick competition.

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Appendix For Online Publication

Identifying tax-setting responses from local fiscal policy programs

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A.1 Mean and median multipliers over time

Figure A.5

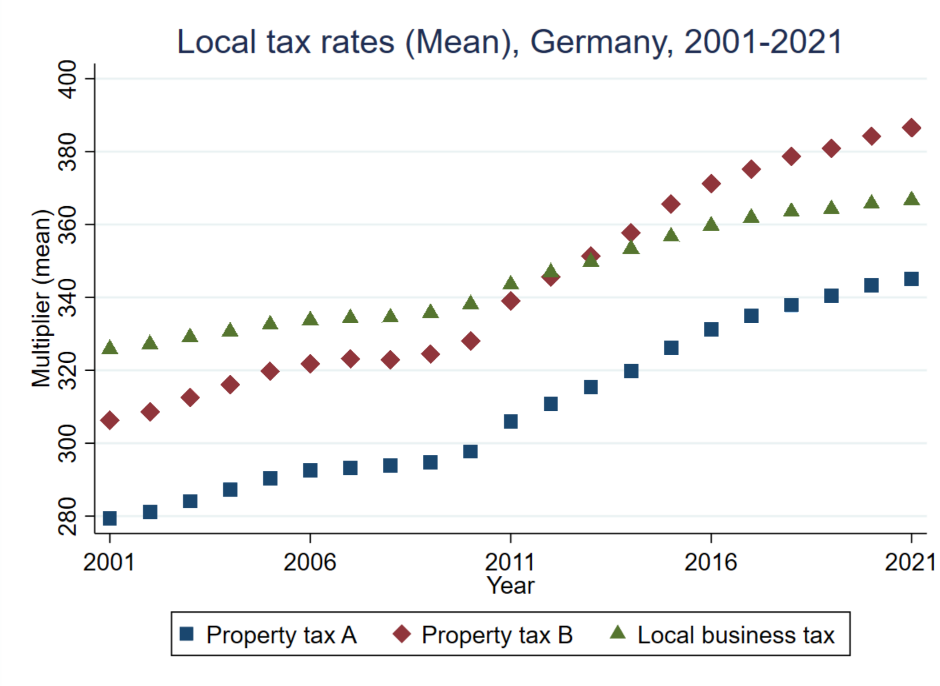
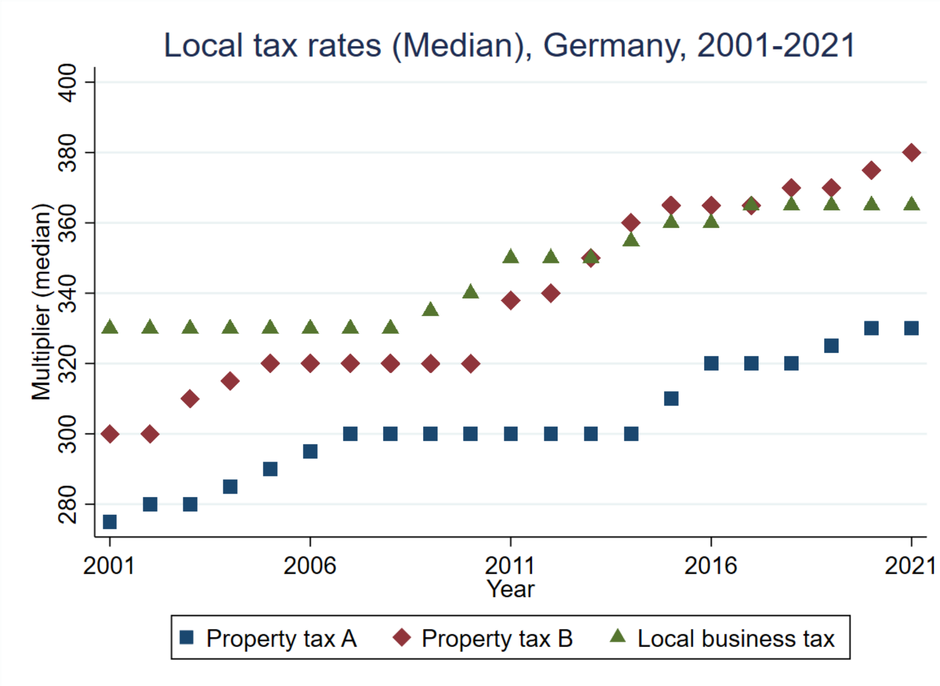


Figure A.6



A.2 Municipal tax setting

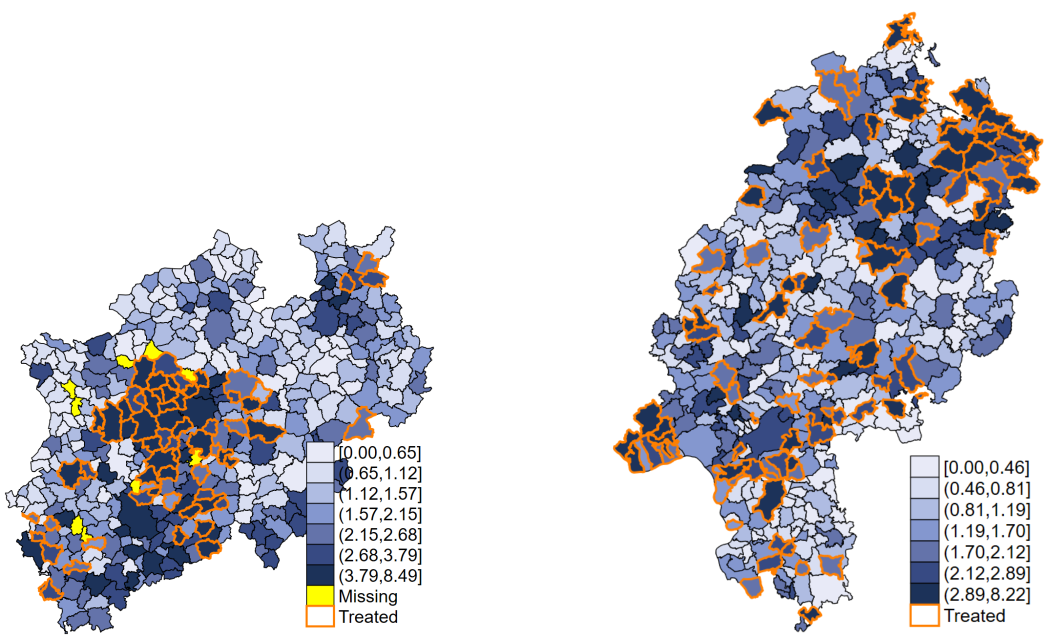
The basic rate is determined uniformly by the federal government. The federal basic rate for the LBT since 2008 amounts to 3.5% and is the same for all municipalities. Each municipality decides independently upon the municipal multiplier which determines the municipal tax rate. For example, a municipal LBT multiplier of 400 amounts to a statutory business tax rate of 14 percent (400 x 0.035). For the PTA, the basic rate is 0.6 percentage points across all municipalities. The basic rate of the PTB is on average 0.35 percentage points in the founding states of the Federal Republic of Germany (West Germany) and 0.8 percentage points in the states located in the former German Democratic Republic (East Germany). The basic federal rates for the property tax B differ across West and East Germany. In West Germany, a standard rate of 0.35% applies to all property types but there are some exceptions (0.31% for two-family houses and 0.26% for single-family houses up to about 38.000 Euro and 0.35% for the rest of the value). In East Germany the federal basic rate ranges between 0.5% and 1%, depending on the type of property and 3 municipality size-classes.

Transfers within horizontal fiscal equalization schemes are provided by the state and funded through tax revenues from the personal and corporate income tax, the VAT and the capital gains tax set at the federal level. The size of a transfer depends on a municipality's fiscal need and its fiscal capacity in terms of raising revenue. The calculation of fiscal needs varies by state, but generally large municipalities in terms of area and/or population are assigned disproportionately larger fiscal needs. The calculation of the fiscal capacity depends on the municipalities' tax policy decisions and a state-specific reference rate for all three tax instruments. These generally reflect the average multiplier level in the state. Municipalities that set a multiplier below the state's reference rate will have a fiscal capacity that exceeds their actual tax revenues and will generally receive zero transfers, and thus will be implicitly penalized for setting a "too low" tax rate. Baskaran (2014) finds that municipalities' tax setting strongly depends on the reference rate.

A.3 Pre-Treatment Debt Levels

One concern with respect to our results is the influence of pre-treatment debt levels. More specifically, whether the response of the non-DRP municipalities is driven by highly indebted municipalities that realize the need to consolidate their budgets in the wake of the DRP. Consequently, the tax-setting response of non-DRP municipalities would be determined by their debt levels rather than the tax hikes of the DRP municipalities. Unfortunately, changes in accounting principles across German states during our observational periods prevent us from directly including debt levels in the estimation. Thus, we can only test this possibility descriptively. Figure A.7 plots the pre-treatment debt per capita for NRW and Hesse. Unsurprisingly, DRP municipalities in both states exhibit high per capita debt levels. Looking at the non-DRP municipalities in NRW we observe high per capita debt levels in southern NRW. Comparing this to the tax rate changes depicted in Figure 1 we see that some of the highly indebted non-DRP municipalities have raised their tax rates while others have not. A similar picture emerges for Hesse. Generally, northern Hessian non-DRP municipalities exhibit higher debt per capita levels. Looking at the tax rate change sin Figure 1 we observe that tax increase partially coincide with higher debt levels. Thus, there seems to be no structural relationship between higher debt levels and tax hikes among the non-DRP municipalities in both states. Furthermore, the municipality fixed effects control for average debt level across the observational period, while the year fixed effects net out common shocks to debt levels in our sample like the global financial crisis. Thus, for municipal debt to contaminate our results, municipality-specific debt level changes would need to be prominent and strongly influence our results. Given the heterogeneity analysis, it appears highly unlikely that our results are driven by initial debt levels.

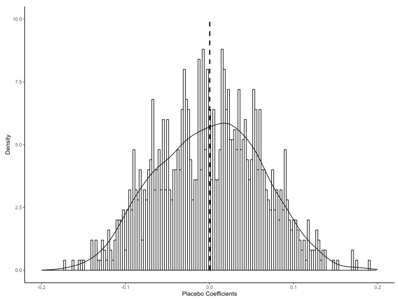
Figure A.7: Pre-treatment per capita debt levels in NRW and Hesse



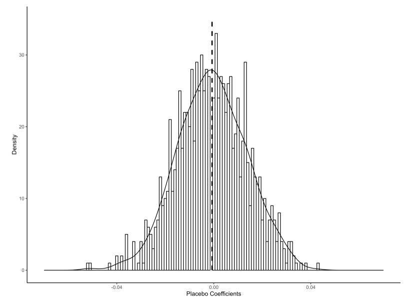
(a) NRW 2011 **(b) Hesse 2012**

A.4 Placebo Results

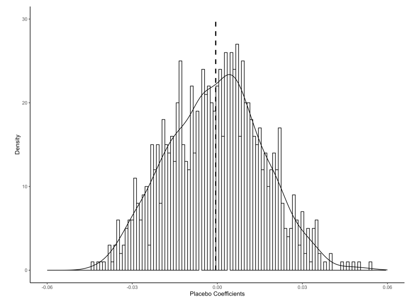
Figure A.8: Density of Placebo Test Coefficients for Non-DRP Response



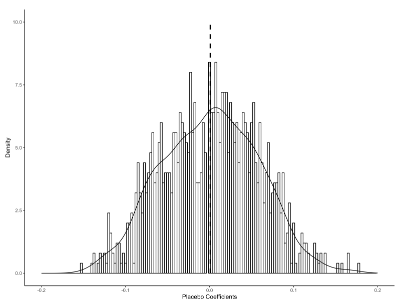
(a) LBT NRW



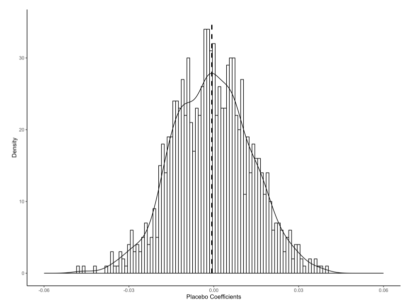
(b) PTA NRW



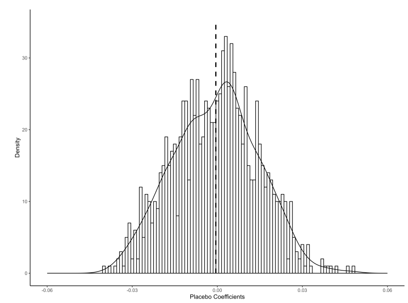
(c) PTB NRW



(d) LBT Hesse



(e) PTA Hesse



(f) PTB Hesse

A.5 Matching Procedure

For the construction of the control group, we use nearest-neighbor matching without replacement. The donor pool consists of all municipalities located in a state without a DRP. These are the states of Baden-Württemberg, Bavaria, Brandenburg, Saxony, and Thuringia. Bavaria had a small DRP in 2012 as part of the states' fiscal equalization scheme. The program only had a volume of 140 million Euros per year and was primarily aimed at the development of rural municipalities rather than fiscal consolidation. To ensure that the Bavarian DRP does not bias our results, we replicate our analysis excluding Bavarian municipalities from the control group. The results only change quantitatively and not qualitatively and are available upon request.

Matching is based on the unweighted mean of observable control variables for all pre-treatment periods. The match is based on a number of municipality characteristics including demographics, tax bases, development of tax instruments, and fiscal transfers. More specifically, we use the area of a municipality (*Area*), the population density (*Density*), as well as the population share of young (age <= 18; *Share_Young*) and old (age >= 65; *Share_Old*) inhabitants to adequately represent a municipalities' demographics. To capture the fiscal capacity of a municipality, we use the tax bases of the LBT, PTA, and PTB (*TAX_Base*). Additionally, we match on the average change in the LBT, PTA, and PTB rate to capture common pre-treatment trends in tax policy development (*Delta_TAX*). Lastly, the share of the VAT (*Share_VAT*) and personal income tax (*Share_IncTax*) a municipality receives, as well as the LBT transfer (*LBT_Transfer*) the municipality pays to the state and federal budget are included. Propensity scores are calculate by estimating the following probit model:

$$\begin{aligned}\Phi^{-1}(P((Non-)DRP=1|X)) = &\beta_0 + \beta_1 \times \text{Density} + \beta_2 \times \text{Area} + \beta_3 \times \text{PTA\_Base} \\ &+\beta_4 \times \text{PTB\_Base} + \beta_5 \times \text{Lbt\_Base} + \beta_6 \times \text{Share\_Old} \\ &+\beta_7 \times \text{Share\_Young} + \beta_8 \times \text{Share\_IncTax} + \beta_9 \times \text{Share\_VAT} \\ &+\beta_{10} \times \text{Delta\_LBT} + \beta_{11} \times \text{Delta\_PTA} + \beta_{12} \times \text{Delta\_PTB} \\ &+\beta_{13} \times \text{LBT\_Transfer},\end{aligned} \tag{A.8}$$

where Φ^{-1} is the inverse of the standard normal cumulative distribution function. Tables A.11 and A.12 display the pre-treatment summary statistics of the matched samples for Hesse and NRW, respectively.

Table A.11: **Summary Statistics for the Matched Samples and Pre-Treatment Periods – Hesse**

	DRP		Non-DRP		
	DRP	**Control**	**Non-DRP**	**Control**	**All Controls**
Population Density (inhabitants/sqkm)					
mean	363.26	346.54	334.36	369.12	197.93
sd	487.12	507.20	302.23	360.42	285.58
N	460	460	1,660	1,660	50,930
Area (in sqkm)					
mean	52.61	50.72	48.12	46.13	33.55
sd	31.0	46.98	32.28	38.18	33.14
N	460	460	1,660	1,660	50930
Total Population					
mean	16,697.57	8653.75	13,570.19	10,990.22	6,584.40
sd	29,169.66	7517.08	40,353.08	22,766.28	29,342.95
N	460	460	1,660	1,660	50,930
Population share age 18 and younger					
mean	0.17	0.16	0.17	0.18	0.17
sd	0.01	0.02	0.02	0.03	0.03
N	460	460	1,660	1,660	50,852
Population share older than 65					
mean	0.22	0.23	0.21	0.21	0.20
sd	0.03	0.03	0.02	0.03	0.04
N	460	460	1,660	1,660	50,929
Local Business Tax Rate					
mean	11.87	11.98	11.54	11.91	11.99
sd	1.17	0.97	1.02	1.11	1.13
N	460	460	1,660	1,660	50,930
Property Tax A Rate					
mean	1.8	1.99	1.62	1.95	1.95
sd	0.25	0.60	0.32	0.35	0.49
N	460	460	1,660	1,660	50,930
Property Tax B Rate					
mean	1.04	1.60	0.94	1.47	1.76
sd	0.15	0.78	0.14	0.68	0.86
N	460	460	1,660	1,660	50,930

Summary Statistics Matched Samples Hesse continued

	DRP		Non-DRP		
	DRP	**Control**	**Non-DRP**	**Control**	**All Controls**
Local Business Tax Base (in 1,000 Euro)					
mean	1,934.85	713.43	2407.51	1578.0	979.43
sd	5,311.89	883.45	16,691.88	5,150.75	7,651.74
N	460	460	1,660	1,660	50,885
Property Tax A Base (in 1,000 Euro)					
mean	14.79	12.42	14.76	14.69	10.44
sd	11.65	11.92	11.63	13.37	10.58
N	460	460	1,660	1,660	50,858
Property Tax B Base (in 1000 Euro)					
mean	585.81	277.62	503.67	378.88	216.89
sd	1,153.93	266.68	2,196.13	973.81	1,148.43
N	460	460	1,660	1,660	50,930
Personal Income Tax Transfer (in 1,000 Euro)					
mean	6,412.65	3,289.17	5,725.49	4,021.03	2,785.37
sd	10,786.96	3,555.5	17,867.77	8,537.75	16,262.06
N	460	460	1,660	1,660	50,930
Value-Added Tax Transfer (in 1,000 Euro)					
mean	839.0	274.35	804.95	533.68	355.78
sd	2,160.9	320.26	6,881.96	1,839.47	3,094.93
N	460	460	1,660	1,660	50,872
Local Business Tax Transfer (in 1,000 Euro)					
mean	1,320.08	457.77	1,642.68	1,037.51	633.92
sd	3,631.71	600.11	11,354.06	3,497.86	5,310.74
N	460	460	1,660	1,660	50,834
Total Tax Revenue (in 1,000 Euro)					
mean	15,903.17	6,664.99	16,114.24	10,754.59	7,063.3
sd	37,107.48	7,150.88	99,333.13	31,579.85	55,058.69
N	460	460	1,660	1,660	50,845

Table A.12: Summary Statistics for the Matched Samples and Pre-Treatment Periods – NRW

	DRP		Non-DRP		
	DRP	**Control**	**Non-DRP**	**Control**	**All Controls**
Population Density (inhabitants/sqkm)					
mean	931.52	766.21	426.11	452.83	197.93
sd	747.43	803.66	440.53	618.36	285.58
N	244	244	1,328	1,328	50,930
Area (in sqkm)					
mean	84.41	73.86	86.70	75.93	33.55
sd	51.52	52.61	49.81	53.92	33.14
N	244	244	1,328	1,328	50,930
Total Population					
mean	84,571.84	47,005.64	37,410.74	80,218.61	6,584.40
sd	109,160	76,559.99	24,406.79	52,546.87	29,342.95
N	244	244	1,328	1,328	50,930
Population share age 18 and younger					
mean	0.18	0.17	0.19	0.18	0.17
sd	0.01	0.02	0.02	0.03	0.03
N	244	244	1,328	1,328	50,930
Population share older than 65					
mean	0.21	0.21	0.20	0.20	0.20
sd	0.01	0.04	0.02	0.03	0.04
N	244	244	1,328	1,328	50,930
Local Business Tax Rate					
mean	15.48	12.33	14.51	11.98	11.99
sd	0.81	1.19	0.75	1.0	1.13
N	244	244	1,328	1,328	50,930
Property Tax A Rate					
mean	1.47	1.99	1.36	1.96	1.95
sd	0.22	0.34	0.24	0.45	0.49
N	244	244	1,328	1,328	50,930
Property Tax B Rate					
mean	1.54	1.29	1.38	1.33	1.76
sd	0.18	0.29	0.12	0.46	0.86
N	244	244	1,328	1,328	50,930

Summary Statistics Matched Samples NRW continued

	DRP		Non-DRP		
	DRP	**Control**	**Non-DRP**	**Control**	**All Controls**
Local Business Tax Base (in 1,000 Euro)					
mean	7,544.72	5,761.14	4,854.84	3,718.25	979.43
sd	11,812.7	11,197.52	16,213.56	10,913.24	7,651.74
N	244	244	1,328	1,328	50,930
Property Tax A Base (in 1,000 Euro)					
mean	29.92	29.0	44.81	30.37	10.44
sd	23.61	21.67	30.39	18.69	10.58
N	244	244	1,328	1,328	50,930
Property Tax B Base (in 1000 Euro)					
mean	2,609.25	1785.8	1,300.95	926.67	216.89
sd	3,457.26	3017.79	3,243.38	2,270.02	1,148.43
N	244	244	1,328	1,328	50,930
Personal Income Tax Transfer (in 1000 Euro)					
mean	26,412.68	18,571.19	12,670.79	9,316.22	2,785.37
sd	33,749.08	28,815.6	28,629.41	20,661.31	16,262.06
N	244	244	1,328	1,328	50,930
Value-Added Tax Transfer (in 1,000 Euro)					
mean	3,839.14	2,603.52	1,861.06	1,316.25	355.78
sd	6,167.59	5,942.49	6,310.80	4,391.08	3,094.93
N	244	244	1,328	1,328	50,930
Local Business Tax Transfer (in 1,000 Euro)					
mean	5,119.44	3,907.02	3,306.23	2,517.32	633.92
sd	7,886.47	7,590.35	11,051.31	7,421.61	5,310.74
N	244	244	1,328	1,328	50,930
Total Tax Revenue (in 1,000 Euro)					
mean	72,480.53	48,193.96	37,713.05	26,058.22	7,063.3
sd	105,009.4	90,854.34	110,940.4	73,180.1	55,058.69
N	244	244	1,328	1,328	50,930

A.6 Generalized DiD Tables

Table A.13: Generalized Difference-in-Differences – DRP Municipalities

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
DRP × 2008	-0.145	-0.002	-0.008	0.099	0.014	-0.001
	(0.104)	(0.050)	(0.043)	(0.208)	(0.085)	(0.048)
DRP × 2009	-0.087	0.003	-0.003	0.103	0.016	0.005
	(0.104)	(0.051)	(0.042)	(0.200)	(0.085)	(0.048)
DRP × 2010	-0.068	-0.024	-0.035	0.030	-0.003	-0.019
	(0.090)	(0.048)	(0.042)	(0.207)	(0.085)	(0.047)
DRP × 2011				-0.112	-0.044	-0.044
				(0.197)	(0.088)	(0.048)
DRP × 2012	0.158**	0.111**	0.092***			
	(0.079)	(0.044)	(0.032)			
DRP × 2013	0.540***	0.358***	0.365***	0.883***	0.362***	0.276***
	(0.086)	(0.053)	(0.045)	(0.197)	(0.069)	(0.041)
DRP × 2014	0.670***	0.413***	0.414***	1.167***	0.540***	0.412***
	(0.086)	(0.052)	(0.038)	(0.177)	(0.074)	(0.039)
DRP × 2015	0.817***	0.484***	0.606***	1.426***	0.824***	0.637***
	(0.076)	(0.046)	(0.045)	(0.193)	(0.089)	(0.058)
DRP × 2016	0.981***	0.568***	0.749***	1.512***	0.845***	0.663***
	(0.081)	(0.048)	(0.035)	(0.201)	(0.095)	(0.059)
DRP × 2017	1.013***	0.611***	0.780***	1.500***	0.910***	0.720***
	(0.098)	(0.040)	(0.034)	(0.183)	(0.089)	(0.056)
DRP × 2018	1.028***	0.644***	0.806***	1.548***	0.925***	0.733***
	(0.131)	(0.041)	(0.028)	(0.183)	(0.091)	(0.060)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1342	1342	1342	2024	2024	2024

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

Table A.14: Generalized Difference-in-Differences – Nontreated

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × 2008	-0.058	-0.001	-0.014	-0.029	-0.021	-0.028
	(0.071)	(0.023)	(0.022)	(0.111)	(0.022)	(0.021)
non-DRP × 2009	-0.073	-0.002	-0.017	-0.045	-0.016	-0.021
	(0.076)	(0.024)	(0.022)	(0.099)	(0.019)	(0.020)
non-DRP × 2010	-0.105	-0.011	-0.025	-0.063	-0.015	-0.019
	(0.072)	(0.021)	(0.020)	(0.091)	(0.016)	(0.018)
non-DRP × 2011				-0.059	-0.020	-0.022
				(0.071)	(0.015)	(0.017)
non-DRP × 2012	0.065	0.021	0.036			
	(0.088)	(0.022)	(0.024)			
non-DRP × 2013	0.200***	0.067***	0.077***	0.258***	0.063***	0.047***
	(0.068)	(0.018)	(0.022)	(0.067)	(0.013)	(0.011)
non-DRP × 2014	0.266***	0.077***	0.094***	0.570***	0.153***	0.120***
	(0.059)	(0.016)	(0.018)	(0.071)	(0.013)	(0.012)
non-DRP × 2015	0.453***	0.149***	0.185***	0.901***	0.341***	0.289***
	(0.071)	(0.019)	(0.020)	(0.076)	(0.016)	(0.022)
non-DRP × 2016	0.522***	0.187***	0.244***	1.065***	0.416***	0.340***
	(0.091)	(0.023)	(0.026)	(0.082)	(0.018)	(0.021)
non-DRP × 2017	0.571***	0.221***	0.288***	1.183***	0.480***	0.390***
	(0.097)	(0.025)	(0.029)	(0.086)	(0.021)	(0.021)
non-DRP × 2018	0.577***	0.236***	0.295***	1.218***	0.515***	0.410***
	(0.123)	(0.037)	(0.037)	(0.088)	(0.021)	(0.019)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7304	7304	7304	7304	7304	7304

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

A.7 Unmatched Results

This subsection replicates the estimation results of Section 5 and 6 for the DRP and non-DRP municipalities in NRW and Hesse when we use all municipalities in non-DRP states as the control group instead of creating a balanced panel of similar municipalities through matching. Comparing the baseline results for the DRP municipalities in NRW in Panel A of Tables 2 and A.15, we find that the coefficient for the LBT is smaller but still economically and statistically significant. For the property taxes, we find quantitatively similar coefficients. Overall, standard errors are substantially larger for all three tax instruments. Looking at the results for the DRP municipalities in Hesse, the coefficients are quantitatively almost identical with slightly larger standard errors.

Regarding the baseline results for the non-DRP municipalities in Panel B of Tables 2 and A.15, we observe more pronounced differences. In the case of NRW, coefficients are smaller for the unmatched sample which is most notable for the LBT. At the same time, standard errors are substantially larger implying that the coefficients are again less precisely estimated. Turning to Hesse, coefficients are consistently smaller while standard errors are consistently larger compared to the baseline results. Concerning the spatial results, a similar picture emerges for Hesse.

The generalized DiD results depicted in Figures A.9 and A.10 provide a more in-depth view on the findings for the unmatched sample. Looking at the results for NRW in Figure A.9, we again observe flat and insignificant pre-treatment differences and a clear increase in the average of the different tax measures after the DRP introduction. However, the confidence intervals around the post-treatment coefficients are larger compared to the results in Figure 2. The generalized DiD results for the DRP municipalities in Hesse are almost identical to the ones for the matched sample in Figure 2. As for the results of the non-DRP in Figure A.10, we again observe flat and statistically insignificant pre-trends and a clear upward trend post treatment for both states and all three tax instruments. Compared to the matched sample, the results differ most for the LBT of the non-DRP municipalities in NRW, where the upward trend only becomes statistically significant with a lag of three periods. It is evident that the confidence intervals around the post-treatment coefficients are substantially larger, implying that these coefficients are less precisely estimated.

Lastly, we not only replicate the baseline results but also the heterogeneity results. Table A.16 contains the spatial proximity estimates. Looking at the results for NRW in columns (1)-(3), we find no substantial differences compared to the matched sample. The ATT remains positive and significant as well as the distance interaction for the LBT and PTB. The results for Hesse are more robust. ATTs are positive and statistically significant, but smaller than the matched sample results. The distance interaction yields similar results compared to the matched sample except for the LBT and PTA coefficient that are now statistically less significant. Turning to the municipality-size results in Table A.17, the findings for Hesse are robust compared to Table 7 for the matched sample. For NRW, the baseline response remains positive but less significant for both property tax rates and turns negative and insignificant for the LBT. The size coefficients, however, remain unchanged. Comparing the results for political heterogeneity for the unmatched sample in Table A.18 and the matched sample in Table 6, ATTs are again positive and statistically significant but smaller compared to the matched sample. The political heterogeneity coefficients are almost identical and only differ for the PTB in NRW and PTA in Hesse for the CDU × CDU combination. We finally replicate the results for administrative heterogeneity in Table A.19. ATTs are again smaller for the unmatched sample and for the LBR in NRW and the coefficient turns insignificant compared to Table 8. The same county interaction delivers the same results for the matched and unmatched sample.

Given these findings for the unmatched sample, it seems that the matching approach is not driving the baseline results except for the spatial response in NRW. Rather, matching leads us to compare more similar municipalities with each other, which substantially decreases noise and thus increases the precision of our estimates. Matching appears to be particularly beneficial in the case of NRW. The average NRW municipality is significantly different from the average control municipality, as illustrated by Table 1. Comparing these municipalities without matching would therefore produce misleading results.

Table A.15: Difference-in-Differences Results

Panel A: DRP Municipalities

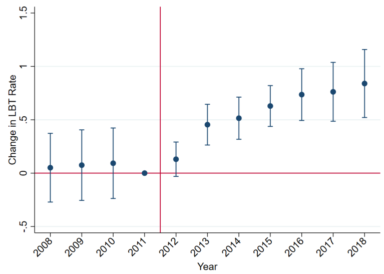
	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
DRP × Post	0.526***	0.412***	0.481***	1.200***	0.718***	0.532***
	(0.099)	(0.054)	(0.076)	(0.089)	(0.050)	(0.037)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,601	51,601	51,601	51,942	51,942	51,942
Average Tax Rate Pre-Treatment	15.661	1.504	1.597	12.113	1.847	1.093
Change in %	3.36	27.39	30.12	9.91	38.87	48.67

Panel B: Non-DRP municipalities

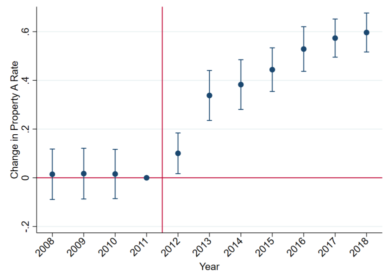
	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.179**	0.109***	0.113***	0.758***	0.318***	0.217***
	(0.082)	(0.020)	(0.030)	(0.069)	(0.027)	(0.026)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,582	54,582	54,582	54,582	54,582	54582
Average Tax Rate Pre-Treatment	14.675	1.397	1.428	11.792	1.667	0.985
Change in %	1.22	7.8	7.9	6.43	19.08	22.03

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

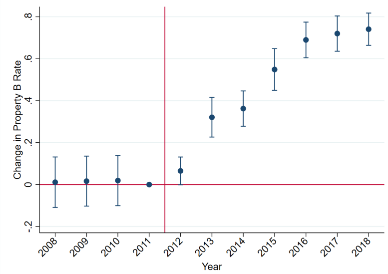
Figure A.9: Effect of Debt Reduction Programs on DRP Municipalities



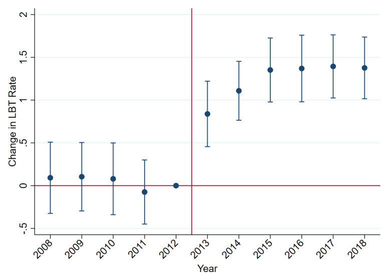
(a) LBT NRW



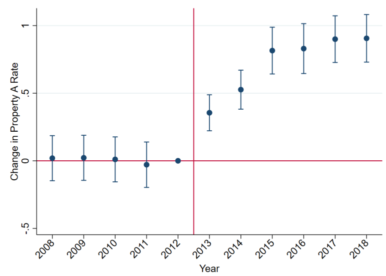
(b) PTA NRW



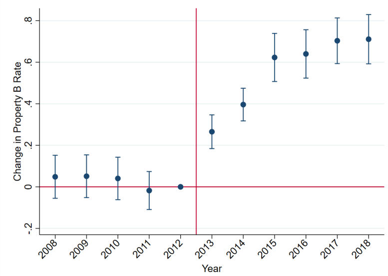
(c) PTB NRW



(d) LBT Hesse

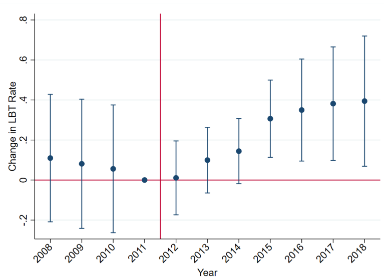


(e) PTA Hesse

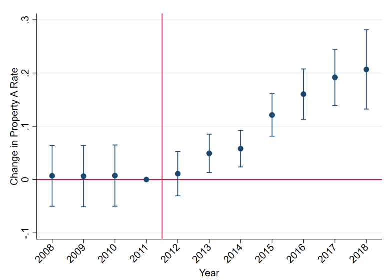


(f) PTB Hesse

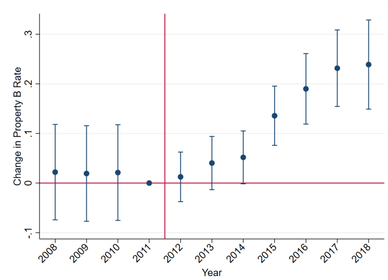
Figure A.10: Effect of Debt Reduction Programs on Non-DRP Municipalities



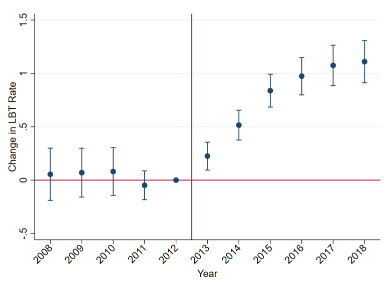
(a) LBT NRW



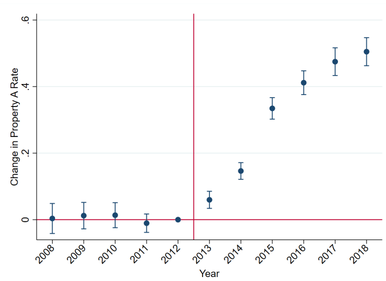
(b) PTA NRW



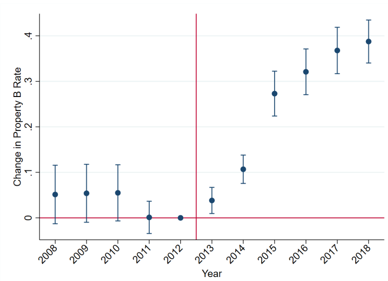
(c) PTB NRW



(d) LBT Hesse



(e) PTA Hesse



(f) PTB Hesse

Table A.16: Difference-in-Differences Results - Spatial Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.300***	0.130***	0.175***	0.641***	0.361***	0.282***
	(0.100)	(0.031)	(0.044)	(0.096)	(0.043)	(0.037)
non-DRP × Post × Dist	-0.005***	-0.001	-0.003***	0.012*	-0.005*	-0.007***
	(0.002)	(0.001)	(0.001)	(0.007)	(0.003)	(0.002)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,582	54,582	54,582	54,582	54,582	54582

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

Table A.17: Difference-in-Differences Results - Size Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	-0.085	0.035**	0.048*	0.371***	0.352***	0.244***
	(0.071)	(0.016)	(0.027)	(0.082)	(0.063)	(0.052)
Small × Small	0.333***	0.095***	0.084***	0.412***	-0.034	-0.028
	(0.070)	(0.018)	(0.018)	(0.064)	(0.057)	(0.043)
Large × Large	0.414***	-0.094***	-0.008	-0.849***	-0.455***	-0.233***
	(0.085)	(0.021)	(0.018)	(0.113)	(0.078)	(0.065)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,582	54,582	54,582	54,582	54,582	54582

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

Table A.18: Difference-in-Differences Results - Political Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	0.144*	0.081***	0.074***	0.696***	0.325***	0.218***
	(0.078)	(0.016)	(0.026)	(0.073)	(0.029)	(0.029)
CDU × CDU	0.053	0.039**	0.043**	-0.114**	-0.034*	-0.010
	(0.038)	(0.018)	(0.019)	(0.055)	(0.019)	(0.014)
SPD × SPD	0.015	0.028***	0.113***	0.206***	-0.001	0.001
	(0.042)	(0.007)	(0.034)	(0.059)	(0.025)	(0.019)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,582	54,582	54,582	54,582	54,582	54,582

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

Table A.19: Difference-in-Differences Results - Administrative Heterogeneity

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(1) LBT	(2) PTA	(3) PTB
Nonreat × Post	0.121	0.094***	0.092***	0.654***	0.305***	0.203***
	(0.077)	(0.018)	(0.026)	(0.069)	(0.029)	(0.028)
non-DRP × Post × Same County	0.183***	0.046***	0.067***	0.164***	0.022	0.021
	(0.035)	(0.015)	(0.020)	(0.049)	(0.024)	(0.016)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	54,582	54,582	54,582	54,582	54,582	54,582

Standard errors are reported in parentheses and corrected for arbitrary spatial cluster correlation (see Colella et al., 2023). *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

A.8 Marginal Cost of Public Funds

Let us briefly discuss the efficiency implications of the DRPs across the different tax measures. For this, we exploit our setting to better understand the revenue consequences of the programs and interpret the findings in light of the Laffer curve – the inverse U-shaped relationship between statutory tax rate and tax revenue. Our goal is to calculate the marginal cost of public funds (MCPF) as a summary measure of the loss associated with raising additional revenue to finance public spending.

As suggested in Dahlby (2008), focusing on a particular tax, the MCPF may be interpreted as the inverse of the elasticity of tax revenue with respect to the tax rate. The steeper the (positive) slope of the Laffer curve, the more effectively governments can raise tax revenue as a tax increase reflects to a large extent in additional tax revenue. The Laffer relationship suggests that with higher taxes, the slope becomes flatter because more avoidance activity takes place until additional tax increases may even reduce tax revenue. We are then to the right of the maximum (revenue-maximizing) point in the inverse U-shaped Laffer curve.

Let us exploit the property of the Laffer curve and follow the formal notation in Dahlby (2008), showing that a simple representation of the MCPF is given by $MCPF = \frac{R/\tau}{dR/d\tau} = \frac{1}{\rho}$, where R denotes revenue and τ the statutory tax; $dR/d\tau$ thus denotes the change in tax revenue with respect to a change in τ. The parameter ρ corresponds to the elasticity of tax revenue with respect to the tax rate. In the absence of behavioral changes, revenue will be proportional to the tax rate, so that ρ and $MCPF$ both equal 1.[45]

Our setting allows us to estimate ρ. To do so, we first estimate equation (1) with the respective log tax revenue as the dependent variable. Table A.20 summarizes the results for the DRP (Panel A) and non-DRP municipalities (Panel B). We then calculate the average change in revenue per multiplier point by dividing the coefficients in Table A.20 by the results depicted in Panel A and B of Table 2. This allows us to determine the elasticity of revenue as $\rho = \frac{d\widehat{R}/R}{d\widehat{\tau}/\tau}$.[46] The advantage of this approach is that the corresponding MCPF ($1/\rho$) is obtained from exogenous variation in tax rates.

Looking at the last line of Panel A and B of Table A.20, we observe that the MCPF for the property tax rates lies in a range between 0.96 and 1.30. This finding is consistent for both property taxes PTA and PTB, both states NRW and Hesse, and for both DRP and non-DRP municipalities. Interestingly, the MCPF of the property tax rates is very close to one in several cases implying that they are almost lump-sum taxes.

The effects on tax revenue in case of LBT revenue are negative and statistically significant in the case of NRW and for non-DRP municipalities in Hesse.[47] This suggests that municipalities are on the right-hand side of the Laffer curve and raising the LBT is no longer associated with higher tax revenue. Given the relatively low MCPF on property taxes, it seems clearly optimal for municipalities to shift tax burden to less responsive tax bases by making use of higher PTA and PTB tax rates. In particular, our findings suggest that for the DRP and non-DRP municipalities in Hesse, it is efficient to rely more on PTB. For both

[45] A MCPF equal to 1 would correspond to a lump-sum tax.

[46] For τ we take the mean tax rate for the respective subgroup (see Table A.20). The notation in $d\widehat{\tau}$ and $d\widehat{R}$ indicates that the change in the respective tax and revenue are taken from the estimations above.

[47] The statistical insignificance in the case of the DRP municipalities in Hesse implies that municipalities are to the right of, but close to the Laffer-curve maximum.

DRP as well as non-DRP municipalities in NRW, we find that the use of PTA is associated with the lowest efficiency cost.

Table A.20: Difference-in-Differences Results: Revenue

Panel A: DRP Municipalities

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
DRP × Post	-0.159***	0.241***	0.243***	-0.033	0.278***	0.435***
	(0.031)	(0.020)	(0.019)	(0.037)	(0.018)	(0.016)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1340	1341	1342	2017	2022	2024
Mean Tax	16.15	1.80	1.94	12.79	2.24	1.40
ϵ	-3.13	0.94	0.85	-0.32	0.85	1.04
$MCPF$	-0.32	1.06	1.18	-3.14	1.18	0.96

Panel B: Non-DRP Municipalities

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
non-DRP × Post	-0.085***	0.097***	0.104***	-0.052***	0.143***	0.252***
	(0.018)	(0.011)	(0.008)	(0.020)	(0.010)	(0.013)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7290	7283	7285	7245	7304	9840
Mean Tax	14.95	1.49	1.54	12.22	1.85	1.13
ϵ	-2.92	1.03	0.85	-0.7	0.77	1.00
$MCPF$	-0.34	0.97	1.17	-1.43	1.30	1.00

The table depicts the results of the DiD estimation. Standard errors are reported in parentheses and are clustered on the state level. * denotes significance at the 10% level; ** denotes significance at the 5% level; *** denotes significance at the 1% level.

A.9 Fiscal Supervision on Higher Levels

One potential threat to our identification is the role of fiscal supervision of German municipalities through higher level institutions. Municipalities have come under increased scrutiny from supervising institutions *(Kommunalaufsicht)*, which ensure that the municipality meets its legal obligations.[48] Scientific evidence on the role of the *Kommunale Finanzaufsicht* in general and in NRW and Hesse in particular is scarce. Christofzik and Kessing (2018) analyze the lack of fiscal supervision on municipal budgets in NRW between 2003 and 2009. They illustrate that unsupervised municipalities increase their debt per capita but do not provide any evidence on their tax setting. Rösel (2017) analyzes the political economy of fiscal supervision and finds no evidence that party alignment between the state government and the fiscal supervision authority affects municipal deficits. However, partisanship of governments and supervisors seem to affect public budgets. In a survey among mayors, 26% referred to the pressure of supervising institutions as a relevant factor for rises in multipliers (Wagschal et al., 2016). However, supervising institutions cannot legally coerce municipalities to raise their multipliers. In 2010, the highest German administrative court (*Bundesverwaltungsgericht*) ruled that supervising institutions have the right to complain about multipliers, in case the respective municipality faces a budget crisis and does not have a plan how to overcome it.[49] Lowering the multiplier or setting one that is relatively low compared to the belonging county or state can be forbidden. The court states that the latter does not restrict municipal autonomy excessively. However, a consistent legal framework is missing. Stiftung (2017) provide a descriptive overview on the role of the *Kommunale Finanzaufsicht*. The authors highlight that supervisors perceive themselves as partners rather than supervisor and as politically independent. They also take a more in-depth look at the interaction between fiscal supervision and the debt reduction programs in Hesse and NRW. According to Stiftung (2017), both NRW and Hesse, unsurprisingly, increased fiscal supervision of DRP municipalities after the introduction of the DRP. In the case of NRW, they document that non-DRP municipalities do not perceive fiscal supervision to tighten after the introduction of the DRP. For Hesse, non-DRP municipalities seem to experience stricter fiscal supervision which stem from more reporting, consulting, and guidelines. However, given the heterogeneity results in Section 6, an overall stricter fiscal supervision cannot explain our findings, especially since municipalities cannot be coerced to raise their taxes. Additionally, Holtkamp and Bathge (2014) and Wagschal (2016) describe the heterogeneity of supervising institutions across states in terms of their degree of interfering.

All in all, there is no common practice of fiscal supervision both across and within states, and assessments depends on margins of discretion. Ultimately, municipalities retain full control over the decision of tax increases. Thus, higher level fiscal supervision may influence individual municipalities tax-setting but does not affect the overall tax level in any given state. Consequently, our results are not driven by higher scrutiny of fiscal supervisory boards.

[48] Municipalities that belong to a county are supervised by institutions of the respective county. Independent cities are supervised by state-wide institutions. The legal foundation is provided in §§118-129 Gemeinde Ordnung (GemO).

[49] BVerwG, Urteil v. 27.10.2010 - 8 C 43.09.

A.10 IV Estimation of the Slope of the Tax-Setting Response

Based on our data we can also estimate the slope of the tax-response functions directly. Following Lyytikäinen (2012), we regress the tax-policy choice of the non-DRP on the spatially weighted tax rates of DRP municipalities:

$$Tax_{i,t} = \beta \sum_{j \neq i} w_{ij} Tax_{jt} + \delta_i + \zeta_t + \epsilon_{i,t}. \tag{A.9}$$

w_{ij} denotes the weight the tax-policy choice of any DRP municipality j receives based on the inverse distance between j and the non-DRP municipality i. Thus, the tax-policy choices of geographically close municipalities receive a higher weight compared to the ones located further away. Estimating equation (A.9) using OLS will most likely produce biased results of β as we are unable to differentiate between tax-policy responses stemming from the introduction of the DRP and "normal" tax rate changes; $Tax_{i,t}$ and Tax_{jt} are simultaneously determined. In order to resolve the endogeneity problems we estimate equation (A.9) using two-stage least squares (2SLS) employing $DRP \times Post$ as an instrument for $\sum_{j \neq i} w_{ij} Tax_{jt}$. The results are depicted in Table A.21. Looking at the results we observe positive, statistically significant slope coefficients of the tax-setting responses that are smaller than one and thus within a plausible range. Compared to the results in Table 3 the slope coefficients are also larger for the LBT responses compared to the property tax rates. However, the 2SLS estimation yields larger slope coefficients across all tax instruments and both states implying that our approach yields more conservative results with respect to the size of tax-setting responses.

Table A.21: IV Slope Estimation

	NRW			Hesse		
	(1) LBT	(2) PTA	(3) PTB	(4) LBT	(5) PTA	(6) PTB
$\sum_{j \neq i} w_{ij} Tax_{jt}$	0.684***	0.423***	0.412***	0.780***	0.527***	0.526***
	(0.015)	(0.011)	(0.008)	(0.011)	(0.010)	(0.007)
F-Stat	10666	8870	6729	31838	17131	17622
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3685	3685	3685	3652	3652	3652

Standard errors are reported in parentheses. *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

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