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Identifying tax-setting responses from local fiscal policy programs*

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Abstract

This paper studies tax policy interaction 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 as well as in property tax rates. Our estimates imply response function gradients in the range of 0.3 to 0.7, depending on the type of tax and state. Policy spillovers from property tax rates remain very local, which is consistent with yardstick competition behavior.

Keywords: Local Public Finance, Tax Competition, Yardstick Competition, Spatial Interaction, Tax Setting, Marginal Cost of Public Funds

JEL classification: C21, H71, H73, R59

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1 Introduction

This paper contributes to a better understanding of local fiscal competition and local policy choices. Questions about the size and scope of policy interaction are fundamental to any debate on fiscal spillovers, both at the international but even more so at the national level.[1] 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.[2] Moreover, the precise mechanisms behind tax-setting interdependencies are often unclear and could be related to economic and/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 might be non-base related and thus driven by yardstick behavior (see Revelli and Tovmo, 2007), informational spillovers, and/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 spatial aspects of policy spillovers and the underlying mechanisms.

After the financial crisis in 2008, many German municipalities suffered from excessive debt and were running the risk of default.[3] As a result, several German states introduced debt reduction programs (DRPs) which offered debt relief to municipalities in return for consolidation efforts that involved substantial but non-uniform municipal property and cor-

[1]See also the recent global minimum (corporate) tax agreement to put a floor on tax competition (see Devereux, 2023).

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

[3]In Germany, states and municipalities held approximately 779 billion Euro in debt which amounts to 34% of the overall public debt.

porate tax increases.[4] We exploit quasi-exogenous assignment of municipalities to DRPs in the states of *Hesse* and *Northrhine-Westfalia* (NRW) to address two central research questions. First, how do local governments respond to their neighbors' tax policy choices on (im-)mobile bases? Second, how do tax policy shocks disseminate in space and over time? The quasi-exogeneity of the DRPs enables us to causally determine the size, scope, and nature of tax policy interaction among German municipalities.

In our analysis, we first show how corporate and property tax rates of municipalities subject to a DRP have changed. In a second step, we examine the average policy change of municipalities in the same state that are not directly targeted by these DRPs to learn about policy interaction. And third, we determine the spatial scope of these policy 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 DRP and non-DRP municipalities substantially increase business and property taxes after the respective program comes into effect. Property taxes exhibit a particularly pronounced increase of 11% to 58% in DRP and non-DRP municipalities in both states compared to pre-treatment levels. Lastly, we analyze the spatial scope of these tax policy spillover. The policy reaction decreases in the distance to the nearest DRP municipality, highlighting the significance of spatial aspects in policy spillovers. The response in property tax rates is particularly localized. Given the immobility of the property tax base, these findings provide evidence for non-base related policy spillovers among German municipalities like yardstick competition or learning.

Given the responses to the DRPs, we then calculate the slopes of the respective tax-response function. These vary between 0.62 and 0.77 for the business tax and 0.34 and 0.50 for the property tax rates. Looking at the efficiency implications of these tax hikes, we find marginal cost of public funds (MCPF) between 1.03 and 1.44 for the property taxes, while business tax hikes are associated with revenue losses implying that municipalities are on

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

the "wrong" (right-hand) side of the Laffer curve. Thus, German municipalities experience efficiency gains when relying more heavily on property taxation.

Studying spillovers in our setting is especially interesting and pertinent for three 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 policy spillovers to 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.

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 which 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 often addressed 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.[5] Surprisingly, there is only a small literature looking explicitly at the spatial dimension of tax policy spillovers.[6]

Our paper contributes to three strands of the literature.[7] It first adds to the literature studying local tax competition for mobile tax bases. Büttner (2001) examines determinants

[5]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).

[6]Notable exceptions are Agrawal (2015, 2016) and Eugster and Parchet (2019).

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

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, on the other hand, 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.

Our paper is most closely related to the recent contribution by Fremerey et al. (2022) who evaluate the effects of the NRW DRP. The authors employ a generalized DiD design using other financially distressed municipalities in NRW as a control group.[8] 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 DRP in NRW but exploit this quasi-exogenous intervention to identify the size and (spatial) scope of tax policy spillovers. Furthermore, our control group consists of (geographically distant) municipalities located in non-DRP states to avoid biased estimates of tax policy responses.[9]

The second strand of literature we contribute to investigates non-base related tax policy reactions on immobile tax bases. Baskaran (2014) studies tax mimicking of municipalities in NRW and Lower Saxony by exploiting an exogenous reform in local fiscal equalization schemes in NRW. 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

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

[9]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.

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. Yardstick competition appears to be particularly pronounced when a mayor's reelection bid is uncertain.

Lastly, we contribute to a small but growing strand of the literature that explicitly focuses on spatial aspects in tax policy setting. 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 income 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.

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 their spatial persistence.

The remainder of the paper is structured as follows. Section 2 outlines the institutional background of the DRPs in Hesse and NRW. The data used for the analysis is presented in Section 3. Section 4 outlines the identification strategy, while Section 5 presents the estimation results. Section 5.3 quantifies and discusses the slope of the tax reaction function. Section 5.4 focuses on spatial effects. Section 6 discusses our findings and provides additional robustness checks. In Section 7, we focus on revenue implications and calculate the MCPF for the different tax instruments. Section 8 finally concludes.

2 Institutional Background

2.1 Local tax instruments and fiscal tansfers

Germany is a federal republic governed by the principle of subsidiarity granting substantial autonomy to sub-national entities at the state and municipal level. The Federal Republic of Germany consists of sixteen states, which are further subdivided into 400 administrative districts, and approximately 11,000 municipalities. Under the German constitution, municipalities are granted financial sovereignty, allowing them to raise revenue and manage expenditures. German municipalities raise revenue from three different tax instruments. The local business tax (LBT, *Gewerbesteuer*) – levied on profits of local businesses –, a property tax on agrarian land including forestry (Prop A, *Grundsteuer A*), and a property tax levied on developed/constructible land including commercial and residential properties (Prop B, *Grundsteuer B*).[10] 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 goverment, and to 2% of federal grants as well as fees and contributions paid by citizens.[11]

The tax liabilities for the local business and property taxes are calculated by multiplying the tax base with a federal basic rate and a municipal multiplier. The basic rate is deter-

[10] Note that some commercial activities are exempt from the local business tax including farmers and freelancers.

[11] 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. The mentioned transfers are not horizontal ones equalizing across municipalities, but vertical ones, as they shift fiscal revenue between the respective municipality, state, and the federal government.

mined uniformly by the federal government. The federal basic rate for the LBT amounts to 3.5 percentage points 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).[12] For the Prop A, the basic rate is 0.6 percentage points across all municipalities. The basic rate of the Prop B 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).[13] The multipliers for the LBT, Prop A, and Prop B are set independently on a yearly basis at the municipal level. By law, municipalities must decide and announce multiplier increases until the 30th of June of a given year.

The tax base of the property tax is determined by the respective fiscal authority, which determines the standard value of a property.[14] 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.[15] 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).

The municipal tax setting autonomy is restricted by a number of regulations and incentives including fiscal equalization schemes to limit fiscal externalities and avoid a "race-to-

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

[13] 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.

[14] 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.

[15] Under 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 income tax purposes up to a municipal multiplier of 380. Several papers explore this particularity. von Schwerin (2015) finds considerable bunching of multipliers at the 380 threshold. Büttner et al. (2014) find that municipalities with a high ratio of partnerships have more frequently raised their LBT multiplier.

the-bottom".[16] In 2004, the federal government introduced a legal minimum LBT multiplier of 200. This effectively put an end to tax haven municipalities setting excessively low tax LBT rates.[17] Tax competition among municipalities is further disincentivized through horizontal fiscal equalization schemes within all German states, which discourage setting a multiplier below a state's reference rate.[18]

2.2 Municipal Debt Reduction Programs

In response to rising debt levels, nine German states launched municipal debt reduction programs between 2010 and 2013 (Arnold et al., 2015).[19] Under these programs financially distressed municipalities received state funding to reduce debt levels and to ensure that social security and public good obligations are met. States (partially) bailed out and provided financial assistance with interest payments to the respective municipalities in return for municipal consolidation efforts. Each of the nine states independently designed a respective program, leading to substantial heterogeneity across states regarding eligibility for participation, the scope and size of the program and/or the efforts demanded from municipalities. A common feature across all states was the obligation for participating municipalities to sign a consolidation contract, declaring a clear plan on how to reduce public debt. These contracts did not mandate tax increases or expenditure cuts, but left it to municipalities to

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

[17] Previously some small (<100 inhabitants) municipalities successfully attracted firms by setting LBT rates of zero (see Büttner and von Schwerin, 2016).

[18] Transfers within horizontal fiscal equalization schemes (*kommunaler Finanzausgleich*) 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.

[19] The nine states with a DRP are Bavaria, Hesse, Lower Saxony, Mecklenburg-Western Pomerania, Northrhine-Westphalia, Rhineland-Palatinate, Saarland, Saxony-Anhalt and Schleswig-Holstein.

outline feasible consolidation measures. In the following, we will focus on the DRPs in the states of Hesse and NRW in greater detail.[20]

The state of Hesse passed its debt reduction program (*Kommunaler Schutzschirm*) with a volume of 3.2 billion Euros into law in May 2012. Under this program, the state takes on 46% of the debt of participating municipalities (2.8 billion Euros) and part of their interest payments (400 million Euros). Debt relief is provided over several years and is conditional on persistent consolidation efforts. In order to be eligible to participate in the Hesse DRP, municipalities had to meet at least one of three criteria.[21] First, the average debt (*Kassenkredit*) amounted to more than 1,000 Euro per capita between 2009 and 2010. Second, an average deficit of more than 200 Euro per capita was reported between 2005 and 2009. Third, municipalities reported, on average, a deficit between 2005 and 2009 and an average debt of more than 470 Euro per capita between 2009 and 2010. For eligible municipalities, actual participation is voluntary and conditional on a contract between the municipality and the state. The program was first announced in 2010, a basic agreement between the state and the umbrella organizations of the municipalities in Hesse was reached in January 2012. The first contract was signed in November 2012 and the last contract was signed in February 2013. Given that all three eligibility criteria are based on budget figures in or prior to 2010, municipalities were unable to manipulate these figures preventing them from self-selecting into the program.[22] Program eligibility does not seem to be driven by party affiliation.[23] Furthermore, participation was not based on any of the outcome variables, as the multipliers were

[20] DRPs in other states are not analyzed due to their limited size, lack of enforcement and/or absence of criteria to prevent self-selection into these programs.

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

[22] Additionally, anticipation effects from ex-ante diffusion of information can be credibly ruled out as the program was first announced in 2010 by the newly appointed prime minister, Volker Bouffier, following the unexpected resignation of Roland Koch. The change of the prime minister was not the result of an election nor of a change in the government coalition.

[23] At the time of implementation, the state was governed by a Christian democratic (CDU) and liberal (FDP) coalition, which received 37.2 % and 16.2% of the votes in the 2009 state election. The strongest opposition were the social democrats (SPD) with 23.7% of the votes. Based on the results of the municipal elections in Hesse in 2011, DRP and non-DRP municipalities exhibit only minor differences with a slightly higher (lower) vote share for the SPD (CDU). Out of the 92 eligible municipalities, 30 had a CDU majority and 59 a SPD one. Thus, the CDU government has not set eligibility criteria as to favor same party municipalities.

irrelevant for the selection process. Thus, 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. Moreover, the assignment of eligibility does not change over time, providing a stable treatment group.[24] Ultimately, 92 municipalities were eligible; 86 participated, 6 declined. Since municipal governments can only increase tax multipliers until the 30th of June, the treatment year for the Hesse DRP is 2013.

The NRW debt reduction program (*Stärkungspakt*) was passed into law in December 2011 with a volume of 5.85 billion Euros. The program was conducted in two waves. In the first wave, municipalities were forced to participate in the program and sign a consolidation contract with the state if they were expected to run into excessive debt between 2011 and 2013 based on their 2010 budget figures. 34 municipalities were obligated to participate in the first wave. In the second wave, municipalities that were expected to run into excessive debt in the years 2014 to 2016, based on their 2010 budget figures, could opt into the program. These municipalities had to decide by March 2012 whether they wanted to participate in DRP. Starting in 2012, second wave participants had to sign a consolidation contract with the state and received the same payments as first wave participants. All 27 eligible municipalities opted into participation.

The NRW government did not consider the opinions of municipal umbrella organizations in their decision on which municipalities were mandated/eligible to participate (see Landtag Nordrhein-Westfalen, 2011). Concerns about favoritism by predominantly allowing mostly politically aligned municipalities into the programs appear unjustified.[25] Municipalities participating in the DRP received a yearly aid of 25,89 Euros per inhabitant and additional aid based on the specific budget situation and interest payments. In total, these payments

[24]Note that treatment in this case is the "intent to treat". Including municipalities that did not actually participate in the Hesse DRP would, if anything, lead to a downward bias of our estimates.

[25]After the state election of 2010, the CDU received 34.6% of the votes and the SPD 34.5%. The SPD went on to form a minority coalition with the Green Party, which had reached 12.1% of the vote. Given the minority government, it appears unlikely that the DRP would have passed if it had predominantly favored government-aligned municipalities. Based on the 2009 municipal election results, the CDU was substantially stronger in non-DRP municipalities compared to the SPD. Consequently, out of the 61 DRP municipalities 34 exhibited a CDU majority, while the SPD only held the majority in 27 municipalities.

amount to about 350 million Euros per year conditional on persistent consolidation efforts. For the analysis, we consider both first and second wave municipalities participating in the DRP as treated.[26] 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 regarded as quasi-exogenous conditional on municipality-specific heterogeneity. Since municipal governments can only increase tax multipliers until the 30th of June, the treatment year for the NRW DRP is 2012.

In the following, we will primarily focus on the effects the DRPs in Hesse and NRW had on municipal multipliers. For the analysis, we will distinguish between the municipalities participating in the respective DRP (*Treated*), the municipalities located in Hesse or NRW which are not directly targeted by the DRP (*Nontreated*) and control municipalities located in a state without a DRP (*Controls*). While both state programs included individual contracts with treated municipalities, it is important to highlight that an adjustment of multipliers was one of many options to consolidate, yet no obligation. However, the programs prevented LBT reductions, as multipliers should be maintained. Nevertheless, the state governments did not prescribe standard increases in multipliers, but left the size of the increase to the municipalities. The heterogeneity in municipalities' responses is exactly what we exploit in our empirical analysis to learn about policy interaction. Given the differing abilities to reduce expenditures, the size and timing of multiplier changes across treated municipalities varies substantially. This is also in part due to the fact that treated municipalities could choose to cut expenditures rather than relying solely on tax increases. Expenditure cuts would, if anything, bias the tax response of the Treated downward, but should have no effect on the (relative) response of the Nontreated which we are primarily interested in.

[26] As a robustness test we replicate all results considering only first wave municipalities. Our results are robust and available upon request.

3 Data

For the analysis, we use a panel of all German municipalities from 2004 to 2018, which is taken from the *Regionaldatenbank Deutschland* database provided by the German statistical office. The dataset contains information on local demographics, economic and geographic indicators, and local public finance, including detailed information on municipal multiplier levels, tax bases, and revenues of the three local tax instruments, the vertical transfers from consumption and personal income tax, as well as the share of the local business tax transfered to the state.[27] All variables are reported annually. For our analysis, we balance the panel by dropping all municipalities for which we have missing information of either of the three tax instruments for one or more years. Data on state DRPs was collected from public documents outlining the participation criteria as well as the list of participants.

The number of German municipalities has steadily decreased from 12,629 in 2004 to 11,012 in 2018. This drop is due to municipal mergers and other territorial reforms especially in the states of the former East Germany. We account for this fact by fixing our data to the territorial boundaries of 2018. This is done by aggregating the data of all municipalities that would eventually merge into one.[28] However, 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.

The summary statistics of the final dataset used for the analysis are presented in Table 1. The Treated and Nontreated in NRW and Hesse are depicted separately. Column (5) contains all potential control municipalities located in states without a DRP. A general pattern that emerges is that treated and nontreated municipalities in Hesse and NRW are much more similar to each other than to the average municipality in column (5). However, compared to Hesse, treated municipalities in NRW are significantly larger in terms of population density

[27] Unfortunately, information about debt levels is reported only at the county level.

[28] There is evidence that territorial reforms change economic outcomes (Egger et al., 2022). We therefore rerun our analysis excluding all municipalities that were involved in municipal mergers. The results are robust and available upon request.

compared to their nontreated counterparts. Looking at the LBT multipliers, we observe that NRW municipalities generally set a significantly higher multiplier than other German municipalities. Furthermore, LBT multipliers show a substantially smaller variation compared to either property tax rate.[29] The smaller variance of the LBT is likely driven by the fiscal equalization schemes and legal framework outlined in Section 2. All in all, the substantial differences between states indicate that a naive comparison of Treated, Nontreated, and all control municipalities would produce less accurate results.[30]

Figure 1 depicts the cumulative change of LBT, Prop A and Prop B multipliers 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 NRW), where many municipalities with excessive debt and limited economic opportunities are located. In Hesse, on the other hand, treatment is distributed across the entire state. Looking only at the Treated, we observe that tax increases in these municipalities vary both in size and the choice of the tax instrument. It is striking, for example, that many DRP municipalities in NRW are not changing the Prop A. However, this pattern can be rationalized by the lack of agricultural land and thus an insufficient Prop A tax base in the Ruhrgebiet. For both states, we observe substantial tax-setting responses by municipalities located close to a treated municipality, illustrating the importance of spatial aspects in the diffusion of tax shocks. This pattern appears to be particularly prominent in Hesse.

[29] Interestingly, our data on local tax multipliers suggest that there is an upward trend in these taxes. 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. (2022)). In Appendix A.1, we provide graphical illustrations on mean (Figure A.1) and median (Figure A.2) 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.

[30] For robustness, we replicate the analysis without PSM in Appendix A.3. The results remain robust but become more noisy.

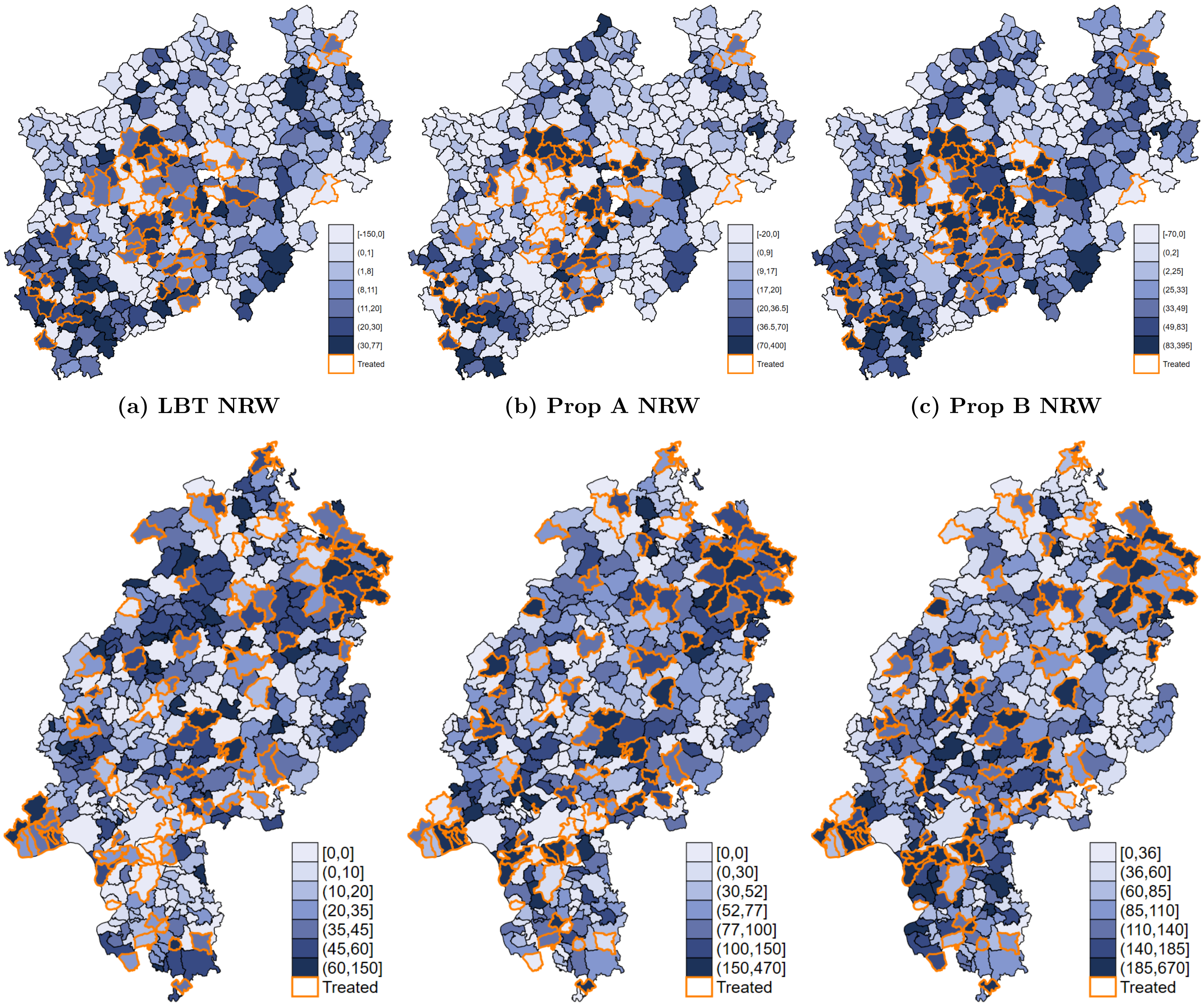
Table 1: Summary Statistics

	NRW		Hesse		
	Treated	**Nontreated**	**Treated**	**Nontreated**	**Controls**
Population Density (inhabitants/sqkm)					
mean	931.57	428.78	368.08	326.69	199.98
sd	748.45	444.43	496.11	354.50	283.50
min	107.78	43.23	20.51	37.88	5.12
max	3,342.37	2,848.51	2,868.63	3,032.73	4736.11
N	915	4,890	1,380	4,920	68,130
Area (in sqkm)					
mean	84.41	86.67	52.71	48.50	32.41
sd	51.44	50.10	31.12	32.28	30.64
min	20.49	22.36	4.4	4.05	1.33
max	232.83	405.17	165.61	248.31	328.48
N	915	4,890	1,380	4,920	68,130
Total Population					
mean	84,726.69	37,764.13	16,931.08	13,645.97	6,598.82
sd	109,765.7	81,954.86	29,677.4	41,434.45	29,149.81
min	6,508	4,116	615	1,066	35
max	588,084	1,085,664	201,585	753,056	1,471,508
N	915	4,890	1,380	4,920	68,130
Population share age 18 and younger					
mean	0.18	0.19	0.17	0.17	0.17
sd	0.016	0.02	0.02	0.02	0.03
min	0.14	0.14	0.1	0.12	0.02
max	0.23	0.28	0.21	0.25	0.38
N	915	4,890	1,380	4,920	68,046
Population share older than 65					
mean	0.21	0.20	0.22	0.21	0.20
sd	0.02	0.02	0.03	0.03	0.04
min	0.15	0.13	0.14	0.13	0.02
max	0.25	0.32	0.32	0.31	0.41
N	915	4,890	1,380	4,920	68,129
Local Business Tax Multiplier					
mean	454.55	422.74	356.70	342.27	339.23
sd	30.00	28.04	40.88	34.66	32.09
min	380	250	270	250	100
max	580	575	480	490	500
N	915	4,890	1,380	4,920	68,130
Property Tax A Multiplier					
mean	283.42	240.75	351.85	298.36	319.69
sd	89.29	55.39	104.96	70.48	80.56
min	170	130	200	0	0
max	710	825	785	720	1,900
N	915	4,890	1,380	4,920	68,130
Property Tax B Multiplier					
mean	520.19	424.70	369.08	304.87	343.93
sd	136.74	70.38	129.91	79.59	50.53
min	330	230	210	140	0
max	959	950	1,050	790	800
N	915	4,890	1,380	4,920	68,130

Summary Statistics Continued

	NRW		Hesse		
	Treated	**Nontreated**	**Treated**	**Nontreated**	**Controls**
Local Business Tax Base (in 1,000 Euro)					
mean	7,915.51	5,221.33	1,985.95	2,497.06	923.16
sd	12,369.13	17,666.69	5,298.15	18,595.76	7,249.96
min	-82	-560	-2,146.76	-2,973.61	-6,448
max	100,638	274,382	44,903.27	418,565.8	551,921.3
N	915	4,890	1,380	4,920	68,085
Property Tax A Base (in 1,000 Euro)					
mean	30.41	44.83	14.66	15.05	10.34
sd	23.78	31	11.39	15.12	10.45
min	-29	-2.30	-7	-99	-31
max	142	328.75	57	724	170.02
N	915	4,890	1,380	4,920	68,058
Property Tax B Base (in 1000 Euro)					
mean	2,622.31	1,329.99	592.46	505.44	213.24
sd	3,502.60	3,308.82	1,159.41	2,226.82	1137.35
min	149	30	13	19	-62.37
max	19,948.41	45,196.26	7,621.95	42,819	60713.77
N	915	4,890	1,380	4,920	68,130
Personal Income Tax Transfer (in 1000 Euro)					
mean	28,545.52	14,025.47	6,919.72	6,133.04	2,549.05
sd	37,081.03	33,044.86	11,994.28	20,182.85	15,106.97
min	1987	848	195	238	0
max	271,348.5	581,567	94,670.14	453,685.9	1,210,197
N	915	4,890	1,380	4,920	68,130
Value-Added Tax Transfer (in 1,000 Euro)					
mean	4,321.47	2,138.65	921.69	867.49	326.84
sd	7,145.33	7,394.91	2,507.17	7,388.83	2876.75
min	47	36	3.699	4	-343
max	67,356.36	158,841.8	27,287.57	191,859.5	283,237.2
N	915	4,890	1,380	4,920	68,072
Local Business Tax Transfer (in 1,000 Euro)					
mean	5,729	3,777.22	1,411.86	1,766.21	617.10
sd	8,938.05	12,808.44	3,742.19	13,045.12	5,112.96
min	-28	-386	-1,466.24	-2,036.92	-4,427
max	73,465	203,042.6	30,983.26	285,880.3	409,860.2
N	915	4,890	1,380	4,920	68,035
Total Tax Revenue (in 1,000 Euro)					
mean	79,067.32	41,320.88	17,057.96	17,219.61	6,573.78
sd	114,406	121,936.3	38,916.26	110,243.1	51,797.19
min	3,453	1,854.7	269	-6,040.348	-10,619
max	848,240.9	2,042,051	304,150.3	2,492,956	4,113,045
N	915	4,890	1,380	4,920	68,053

Figure 1: Tax Multiplier Changes of the Nontreated in Hesse and NRW



(a) LBT NRW **(b) Prop A NRW** **(c) Prop B NRW**

(d) LBT Hesse **(e) Prop A Hesse** **(f) Prop B Hesse**

4 Identification Approach

Our analysis involves three steps, with the main goal of identifying the size and scope of tax-setting responses of treated and nontreated municipalities. First, we analyze the baseline response of the Treated in Hesse and NRW with respect to the DRPs. Second, we focus on the size of the tax-setting response of the Nontreated located in Hesse and NRW, respectively. Lastly, we explore the spatial scope of these tax policy spillovers. In order to identify the baseline average causal effect of treatment on the Treated (ATT), we make use of a Difference-in-Differences (DiD) estimation strategy:

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

where TAX_{it} denotes the LBT, Prop A or Prop B multiplier 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. $Treat_i$ is a dummy indicating whether a municipality participated in a state DRP. The coefficient of interest β yields the ATT. As state DRPs require municipalities to consolidate their public budgets, we expect β to be positive and statistically significant for all three tax instruments. Note that our identification approach crucially relies on the inclusion of δ_i, which removes level differences across municipalities.

In order to further explore the timing and persistence of the effect of treatment on municipal tax policy, we also estimate dynamic ATTs using a generalized DiD following:

$$TAX_{it} = \alpha_0 + \sum_{t=2004}^{2018} \alpha_t Treat_i \times year_t + \delta_i + \zeta_t + \epsilon_{it}. \tag{2}$$

From this, we obtain T coefficients of interest α_t, reflecting the ATT in the respective year. For $t < t_{treat}$ we expect the α_ts to be close to zero and statistically insignificant, while for $t \geq t_{treat}$, 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 ATT to be persistent over time. The goal of this first step of the analysis is to establish that treated municipalities indeed exhibit a strong tax policy reaction to the respective states' DRP.

In the second step, we turn to the Nontreated located in the same state as the treated municipalities, but not directly participating in the respective DRP. To focus on these non-treated municipalities, we estimate equations (1) and (2) replacing $Treat_i$ with $Nontreat_i$. $Nontreat_i$ 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, Prop A, and Prop B, the intuition is less straightforward, especially given the mixed results of the previous literature. If German municipalities engage in corporate tax competition, we would expect that LBT multipliers 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 proportionate compared to the Treated as we should otherwise observe a "race-to-the-top". As the property tax base is immobile, governments should have little to no strategic tax-base related incentive to react to changes in their neighbors' tax policy in the short term ($\beta = 0$).[31] 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.

Lastly, not only the size of tax-setting responses but also the spatial scope of these spillovers is relevant. If the Nontreated respond to state DRPs even though they are not directly targeted, the question remains how this response changes with distance to treated units and, whether these spatial dynamics are symmetric across tax instruments. In order to investigate these questions, we specify

$$TAX_{it} = \alpha + \beta(Post_t \times Nontreat_i \times Dist_{ij}) + \delta_i + \zeta_t + \epsilon_{it}, \tag{3}$$

[31] 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).

where $Dist_{ij}$ denotes the minimum distance between the centroid of an untreated municipality i and the centroid of the nearest treated municipality j.[32] We would expect β to be negative implying that spillovers are local. In the case of the LBT this would either imply that tax competition is particularly fierce among geographical neighbors or that municipalities primarily mimic these neighbors. Standard errors are clustered on the state level throughout the analysis.

For an unbiased identification using the (generalized) DiD estimator, we require a control group that meets two assumptions. First, the common trends assumption which ensures that the true effect of treatment is not confounded by general time trends. Intuitively, it demands that the treatment and control municipalities are actually comparable, i.e., would have shown the same development of municipal multipliers in the absence of the DRPs. Second, the exogeneity of treatment assumption must be met. For this, treatment must be exogenously assigned, i.e. it must be independent of unobserved municipality characteristics. Moreover, control municipalities must not be affected by the treatment. Given the institutional setup of the DRPs, the assignment of treatment is quasi-exogenous and thus unaffected by unobserved municipality characteristics preventing self-selection into treatment.[33] Regarding the choice of the control group, we need to ensure that both assumptions are met to identify the impact of state DRP both on the treated and nontreated municipalities in Hesse and NRW. Given the differences between Treated, Nontreated, and control municipalities depicted in Table 1, we employ Propensity Score Matching (PSM) to sample a more comparable control group. Note that our identification approach in (1) and (2) is still based on the assumption of parallel or common trend. PSM helps, however, to make sure that this assumption holds.

For the construction of the control group, we use k-nearest neighbor matching without replacement. Matching is based on the unweighted mean of observable control variables for the periods $t_{Treat-3}$ to $t_{Treat-7}$. The donor pool consists of all municipalities located in a

[32]In Section 6 we provide additional robustness checks using driving distance and travel times.

[33]Some NRW municipalities could choose to opt into treatment, self-selection concerns are resolved by the quasi-exogenous assignment of eligibility and full take up of the program. All of our results are robust to excluding these opt-in municipalities.

state without a DRP, these are the states of Baden-Württemberg, Bavaria, Brandenburg, Saxony, and Thuringia.[34] 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, the population density, as well as the population share of young (age <= 18) and old (age >= 65) inhabitants to adequately represent a municipalities' demographics. To capture the fiscal capacity of a municipality, we use the tax bases of the LBT, Prop A, and Prop B. Additionally, we match on the average change in the LBT, Prop A, and Prop B rate to capture common pre-treatment trends in tax policy development. Lastly, the share of the VAT and personal income tax a municipality receives, as well as the LBT transfer the municipality pays to the state and federal budget are included. In Appendix A.3 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.

5 Results

5.1 Baseline Results

We begin our analysis by establishing the baseline effects of the DRPs on the Treated. Panel A of Table 2 depicts the results for the baseline specification in equation (1). Looking at the results for NRW in columns (1)-(3) and Hesse in columns (4)-(6), we observe that the DRPs led to a substantial increase in the municipal multipliers of all three tax instruments. The rise in multipliers in NRW is most pronounced for the property tax rate B with 162 basis points (0.57 percentage points), which amounts to an increase of 37% compared to the average pre-treatment level. The LBT increase by 22 basis points (0.77 percentage points) is also

[34]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.

economically sizable and statistically significant and constitutes a 5% increase. Property tax B multipliers in Hessian DRP municipalities rose by 170 basis points (0.60 percentage points) or 58% compared to pre-treatment levels. LBT multipliers even rose by 1.26 percentage points or 11%. Property tax A multipliers rose more in Hesse compared to NRW but are overall less pronounced than the rise in the Prop B.

Figure 2 plots the dynamic DiD estimation results of equation (2) for the Treated. Unsurprisingly, we observe a substantial increase in all three tax instruments in both Hesse and NRW after treatment occurs, as already documented in Table 2. Looking at pre-treatment coefficients, we only find statistically significant differences between the Treated in NRW and control municipalities for the Prop B in 2006 and the Prop A in 2005, 2006, and 2010. However, these differences are economically close to zero and clearly exhibit no time trend.[35] Pre-trends are entirely absent in Hesse. Consequently, the common trends assumptions holds for both DRPs and we do not observe any anticipation effects. Multipliers across both states and all three tax instruments rise immediately after treatment and exhibit a staggered but continuous response leading to a large and persistent increase. Due to this dynamic adjustment to treatment, the ATTs reported in Table 2 to some extent underestimate the true and persistent increase in municipal multipliers. Lastly, we observe variation around the point estimates, implying that treated municipalities exhibit heterogeneous responses to their participation in the state DRP. All in all, Table 2 and Figure 2 illustrate that the DRPs in Hesse and NRW can be regarded as quasi-exogenous and that they had a substantial impact on the LBT and property tax-setting of treated municipalities in both states. Note that the dynamic estimates specifically allow for second round effects in tax setting until the effect levels out and a new equilibrium tax levels materialize in the years 2017 and 2018.

[35] The results confirm that there is hardly any difference in tax setting between treated and controls before the reforms. The matching approach but also the fixed effect approach helps to make sure that this is the case. For detailed estimation results depicted in Figure 2 and Figure 3, see Table A.1 and Table A.2 respectively.

Table 2: Difference-in-Differences Results

Panel A: Treated

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Treat × Post	22.185***	76.745***	162.299***	35.753***	118.704***	169.981***
	(1.011)	(0.768)	(3.608)	(6.417)	(8.188)	(9.975)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	1830	1830	1830	2760	2760	2760
Change in p.p.	0.77	0.46	0.57	1.26	0.71	0.60
Change in %	5.05	31.84	37.40	10.64	40.10	58.41

Panel B: Nontreated

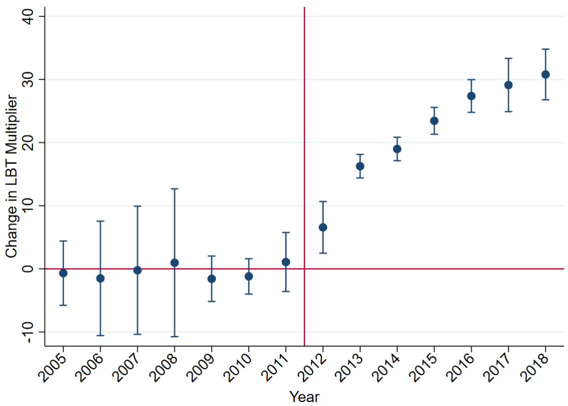
	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Nontreat × Post	13.768***	25.777***	59.634***	27.496***	57.998***	84.221***
	(1.104)	(2.910)	(4.023)	(3.019)	(3.007)	(4.540)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9780	9780	9780	9840	9840	9840
Change in p.p.	0.49	0.156	0.21	0.98	0.35	0.29
Change in %	3.33	11.61	15.33	8.41	21.64	32.02

Panel C: Spatial

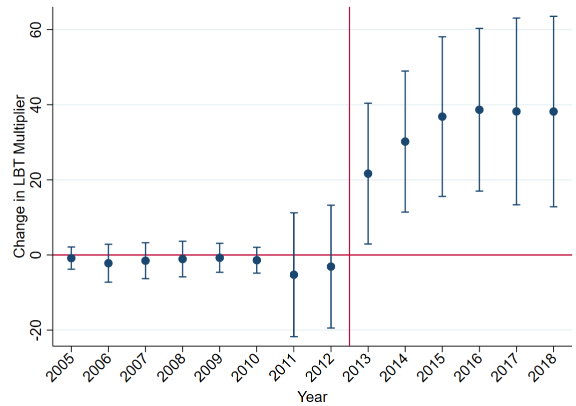
	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Post × Dist	-0.025*	-0.061**	-0.070**	-0.021	-0.027	-0.044
	(0.011)	(0.023)	(0.021)	(0.027)	(0.024)	(0.030)
Nontreat × Post	8.884*	9.121	54.081***	19.924**	62.471***	97.556***
	(3.950)	(8.582)	(8.784)	(7.576)	(5.551)	(7.328)
Nontreat × Post × Dist	-0.111***	-0.052*	-0.670***	0.467***	-0.929***	-2.178***
	(0.011)	(0.023)	(0.021)	(0.027)	(0.024)	(0.030)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9780	9780	9780	9840	9840	9840

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.

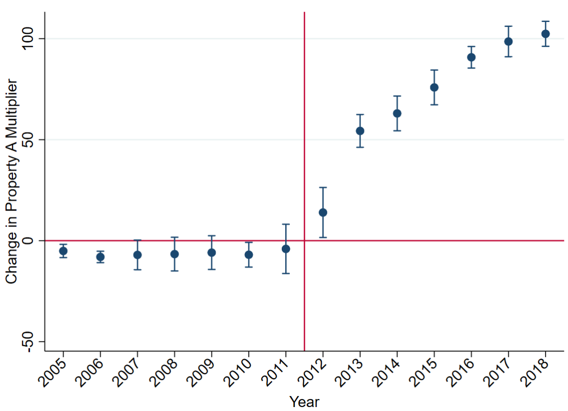
Figure 2: Effect of Debt Reduction Programs on the Treated



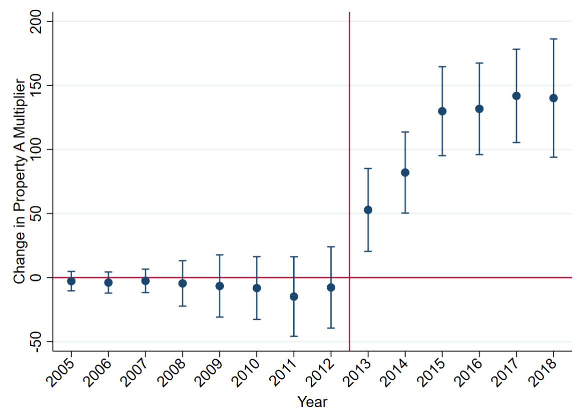
(a) LBT NRW



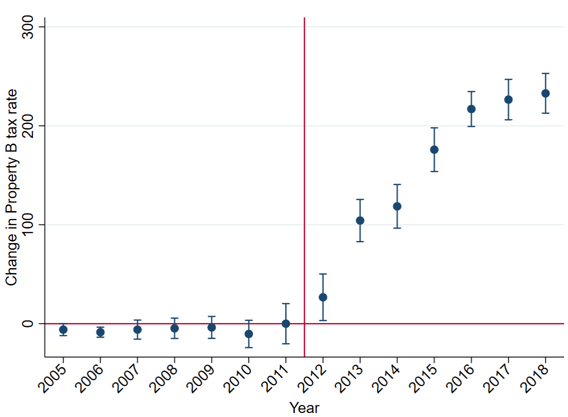
(b) LBT Hesse



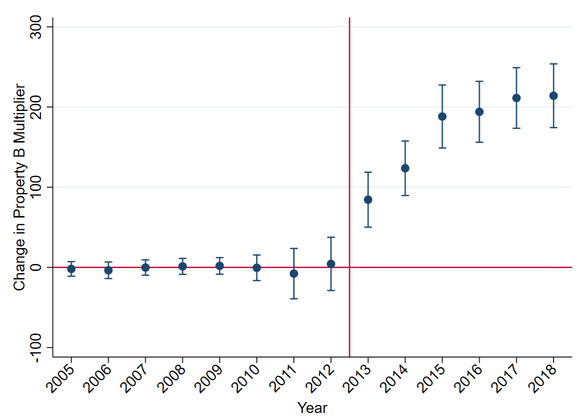
(c) Prop A NRW



(d) Prop A Hesse



(e) Prop B NRW



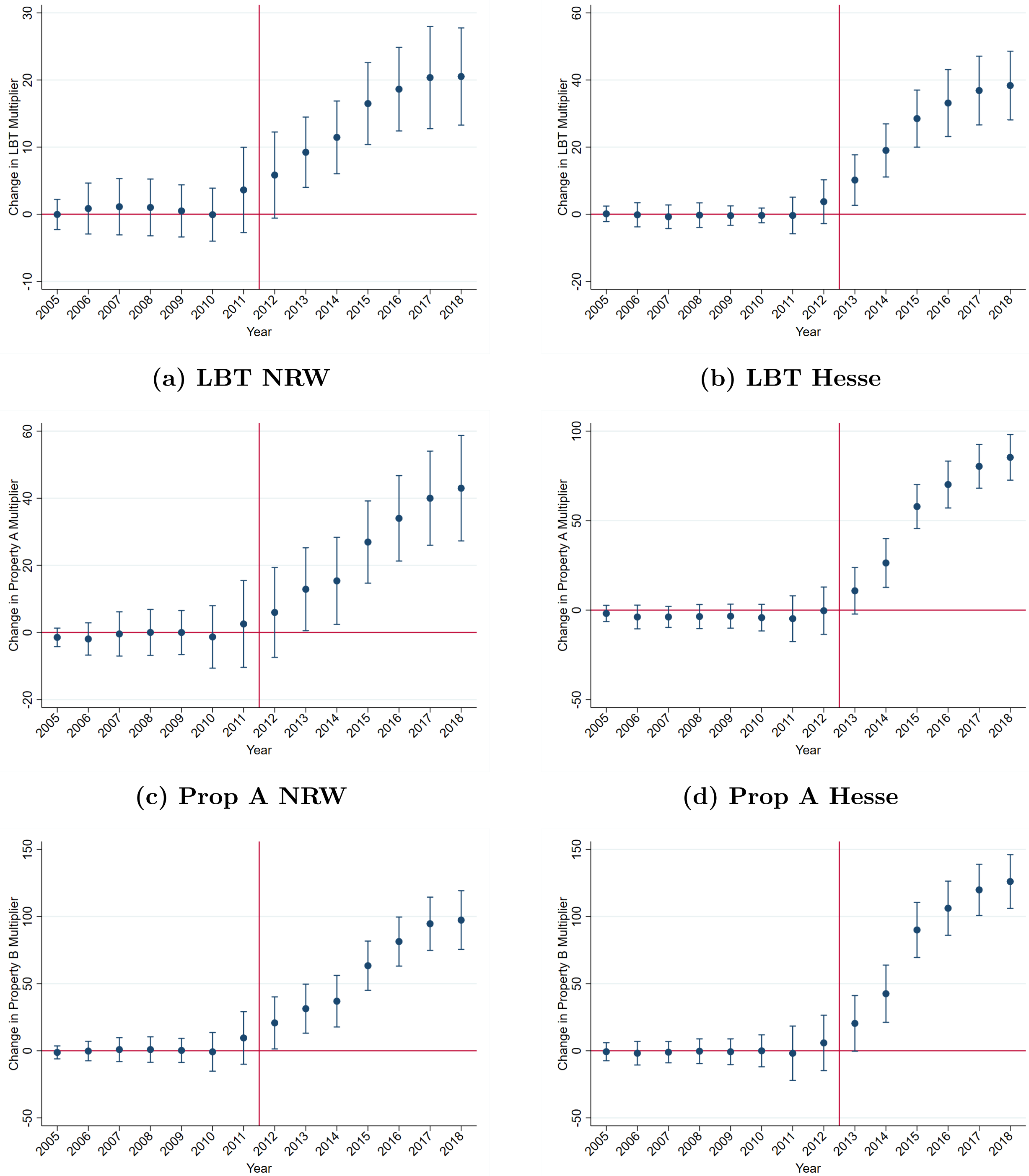
(f) Prop B Hesse

5.2 Tax-Setting Response

Given the baseline results for the Treated, we now turn to the tax-setting response of the Nontreated. Looking at Panel B of Table 2, we observe that nontreated municipalities in DRP states also increase their municipal tax rates. In the case of NRW, local business tax multipliers increase by approximately 14 basis points or 0.49%, which is more than half the increase of the treated municipalities. Turning to Column (4), we observe that nontreated municipalities in Hesse exhibit a larger LBT response of approximately 1 percentage point. In both states LBT multipliers increase substantially but less than proportional. Looking at the results in Column (2) and (3), we observe that nontreated municipalities in NRW also significantly raise both their property tax rates. Prop A multipliers increased by approximately 26 basis points (0.16 percentage points), which amounts to an 11.6% increase compared to pre-treatment levels. Prop B multipliers rose by 60 basis points (0.21 percentage points) or 15.3%. The increase in property tax multipliers is again less than proportionate compared to municipalities participating in the DRP, but economically and statistically significant. A similar picture emerges when looking at the results for Hesse in Columns (5) and (6). However, the response is larger in Hesse both in absolute and relative terms.

Looking at the dynamic DiD results depicted in Figure 3, we find similar patterns as in Figure 2. We observe no pre-trends across both states and all three policy instruments implying again that the common trends assumption holds and that nontreated municipalities in NRW and Hesse did not anticipate the DRP. The LBT and Prop A policy response of the Nontreated in NRW materializes with a one-year delay as coefficients for 2012 are statistically insignificant at the 5% level. Property tax-setting response in Hesse also exhibit a one-year lag. Similar to the Treated, tax multipliers have gradually increased over time until 2017 where the effect appears to converge to a new equilibrium. Thus, the Nontreated in both states exhibit substantial and persistent tax-setting responses to the DRPs. Due to the staggered response, the persistent post-reform level of all three multipliers is significantly larger than the implied average increase in Panel B of Table 2. However, confidence intervals

Figure 3: Effect of Debt Reduction Programs on the Nontreated



(a) LBT NRW **(b) LBT Hesse**

(c) Prop A NRW **(d) Prop A Hesse**

(e) Prop B NRW **(f) Prop B Hesse**

for nontreated municipalities are generally larger indicating that these municipalities exhibit substantial heterogeneity in their responses to DRPs.

5.3 Tax-Response Functions

Our estimation approach allows us to learn about the slope of the respective tax-reaction function. Based on the quasi-exogenous variation from the DRPs in Hesse and NRW, the slope is given by the ratio of the Nontreated and Treated ATT of the respective tax instrument in Panel A and B of Table 2.[36] Table 3 provides the response-function slopes for the two states and the different tax instruments.

Table 3: Implied slope of tax-reaction function

	NRW			Hesse		
TAX	LBT	Prop A	Prop B	LBT	Prop A	Prop B
Response:	0.62	0.34	0.37	0.77	0.49	0.50

Compared to the property taxes, the LBT response is stronger in both states. This is what we would expect as the tax base of the local business tax is presumably more mobile. The slope of the LBT response function is substantially larger compared to Büttner (2001) who only finds a slope of 0.05. Based on country-level data, Egger and Raff (2015) estimate a coefficient of about 0.15 which is also substantially smaller compared to our slope coefficient. Devereux et al. (2008), however, estimate slope functions of similar magnitude also when looking at international tax competition. Similarly, Thunecke (2022) finds a slope coefficient of 0.86 using the approach of Egger and Raff (2015). Thus, the slope of business-tax response functions appears to be symmetric for tax increases as in this paper and tax decreases as in the international tax competition literature. The slopes of the property-tax response functions are in a plausible range and in line with previous findings of Allers and Elhorst (2005), who suggest a slope coefficient of about 0.35. The earlier literature has interpreted the reactions to changes in local property tax setting as evidence for yardstick competition. This seems to be justified as the tax base in this context is fully immobile. While we believe that

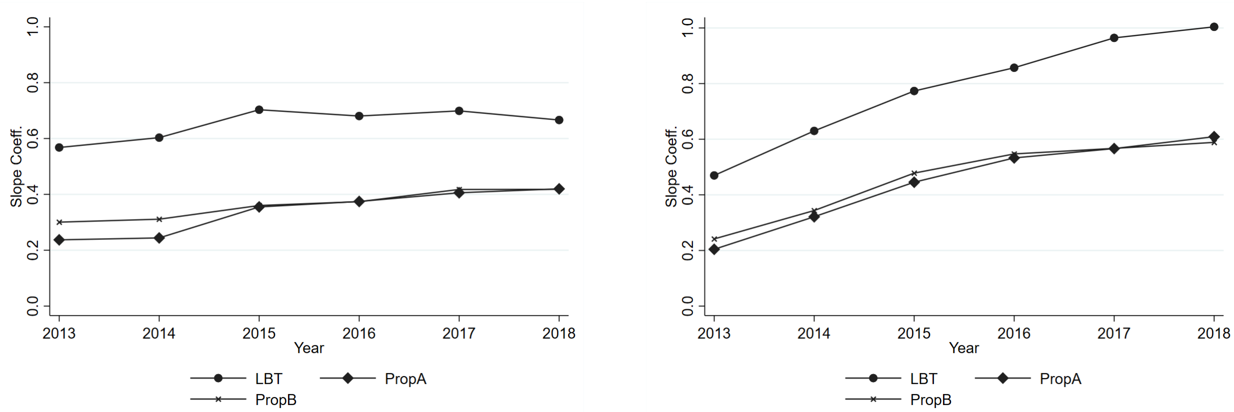
[36]For example, the estimated coefficients for the local business tax in NRW are 13.77 (for the Nontreated) and 22.19 (for the Treated), so that the slope of the reaction function is given by 13.77/22.19 = 0.62.

our findings can mainly be ascribed to mimicking behavior and thus yardstick competition in the short- and medium-run (see the discussion on the effect of distance below), there may be indirect effects through the mobility of people and Tiebout (1956) sorting. The latter may reflect in prices and long-run outcomes (see Suárez Serrato and Zidar, 2016).

Let us graphically look at the reaction slopes over time. Figure 4 suggests that it takes some time until competing municipalities fully respond to the tax setting of the treated – slopes are getting steeper over time. Interestingly, the extent to which the slope of the reaction function increases over time (i.e. the first derivative of the slope of the reaction function) gets smaller over the years after the reforms. This is also a plausible finding as tax rates converge to a new equilibrium and the reform effect stabilizes over time as depicted in Figure 2 and 3. In the case of Hesse, this produces a smooth concave function.

Surprisingly, the slope of the LBT response function in Hesse in 2018 is close to 1, implying that Nontreated responded almost proportionately to the tax-setting of the Treated by the end of the observational period. The pattern is less clear for NRW, although its form seems to be driven by the year 2016, where municipality-responses of the Nontreated were somewhat less pronounced. Let us add, however, that these slope coefficients are obtained from flexible DiD estimates (for the Treated and Nontreated) and the ratios from these estimate remain consistently positive and within a plausible range.

Figure 4: Slope of tax-reaction function over time



(a) NRW **(b) Hesse**

All in all, all three tax instruments in nontreated municipalities across both states exhibit substantial responses to the DRPs even though theses municipalities are not directly targeted. Given the slopes of the response functions, LBT, Prop A, and Prop B multipliers are complements implying that municipalities engage in tax competition and/or show non-base related spillovers related to yardstick competition or interjurisdictional learning. While these results are informative about the size of tax-setting responses of the Nontreated, the (spatial) scope of this response is yet unclear. We will explicitly focus on the spatial scope of these tax-setting responses in the following section.

5.4 Spatial Effects

Finally, we are interested in the spatial scope of the effect of the two state DRPs on the Nontreated. Based on Figure 1, it appears as if there are spatial patterns in the tax-setting of municipalities in Hesse and NRW. We thus estimate equation (3) to analyze these spatial relationships. Results are reported in Panel C of Table 2. Looking at Columns (1) and (3), we find statistically significant ATTs as well as negative coefficients for NRW, implying that LBT (Prop B) multipliers are on average 0.11 (0.67) points lower per kilometer between a non-participating municipality and the closest treated municipality after treatment. Consequently, the effect vanishes, on average, for a municipality located about 80 kilometers away from the nearest treated municipality.[37] The results are less clear for the Prop A. The average treatment effect for the Prop A disappears and the distance coefficient is only weakly significant. This is, however, unsurprising as the results in Panel A and B of Table 2 suggest that the Prop A is less relevant than Prop B in NRW.

Turning to the results for Hesse in Columns (4)-(6), we observe that the ATT remains statistically significant. For the LBT, however, this effect is now only significant at the 5% level. The spatial response for both property tax rates is negative and statistically significant and stronger compared to NRW. Consequently, the effects on property taxes are more

[37] Note that the maximum distance to the nearest Treated in NRW is 76km.

localized in Hesse and vanish at around 66 kilometers (Prop A) and 44 kilometers (Prop B Hesse).[38] This localized pattern of property tax-setting responses indicates that geographical proximity is very relevant, which is consistent with yardstick competition behavior. Interestingly, the spatial interaction coefficient for the LBT is positive implying that municipalities located in Hesse, but further away, show larger increases in their LBT. This finding indicates that for the LBT not only the 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).

At this point, we can conclude that municipality responses in property taxes but also in the LBT in NRW are highly dependent on being located closely to a municipality participating in the DRP. The fact that spatial aspects matter for the scope of the tax-setting responses also demonstrates that the observed effects on the Nontreated are not driven by state-specific time-trends or general efforts of Hesse and NRW to consolidate municipal budgets.

Note that we do not generally believe that spatial spillovers stop at the state borders to the DRP states. We exclude the municipalities in non-DRP states along the borders for several reasons, though. First, most Treated in NRW are very centrally located and NRW is a relatively large state (see above). The municipalities along the NRW border should not be affected by the programs given our results on distance to the treated (we find that the effects are very local in space, see below). Second, we want to make sure that we do not confound our estimates through municipalities in states that also implemented some form of DRP (such as Rhineland-Palatinate). NRW is for example entirely surrounded by states that also implemented DRPs. Third, the average distance of border municipalities in non-DRP states to the nearest treated in NRW or Hesse is more than 93 kilometers. Again, given that the spatial effects are very local (see the findings below), there should not be any spillovers on these municipalities. We still test for this 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

[38]Note that the maximum distance to the nearest Treated in Hesse is 36km.

behavior of these municipalities, suggesting that our results are not biased by focusing on the Nontreated in a respective state (this is consistent with the findings in Baskaran (2014)).

6 Robustness Checks

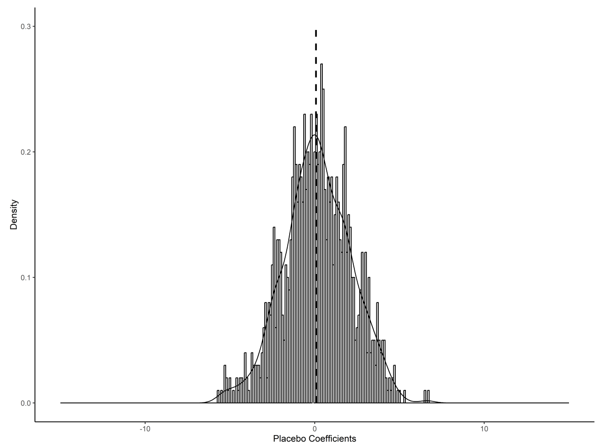
In the following we present robustness checks to test the validity of our results. First, we conduct permutation tests focusing exclusively on potential control municipalities located in states without a DRP to validate the DiD results depicted in Table 2 Panel B. This is done by randomly re-shuffling treatment across control municipalities and estimating equation (1). We repeat this procedure 1,000 times for each tax instrument-state pair. Treatment timing and the original size of the nontreated and control groups in Hesse and NRW are maintained (654 municipalities in Hesse and 652 in NRW). Figure 5 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 ATTs in Panel B of Table 2. Looking at Table 4, we observe that the placebo ATTs are not only significantly different from the actual ATTs, but they are also not statistically different from zero. Consequently, the permutation test confirms that the increase in municipal tax instruments of the Nontreated is driven by the introduction of the DRP.

Table 4: Estimated placebo coefficients

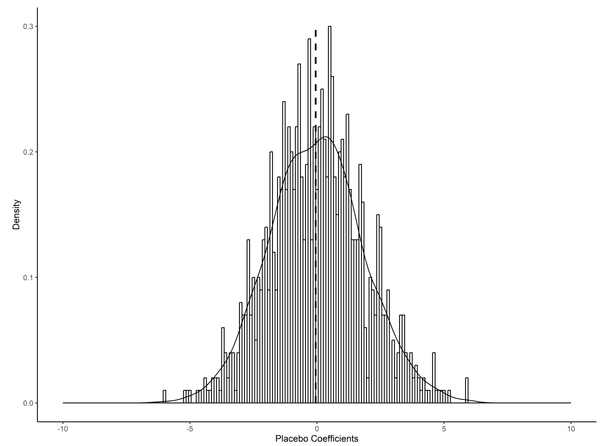
	NRW			Hesse		
TAX	LBT	Prop A	Prop B	LBT	Prop A	Prop B
Placebo ATT	0.17	0.21	0.18	-0.02	0.07	-0.08
	(1.97)	(2.57)	(2.77)	(1.84)	(2.47)	(2.40)
Actual ATT	13.768***	25.777***	59.634***	27.496***	57.998***	84.221***
	(1.104)	(2.910)	(4.023)	(3.019)	(3.007)	(4.540)

For the analysis in Panel C of Table 2, we have employed the linear distance between the centroids of two municipalities. However, this approach disregards topographical obstacles

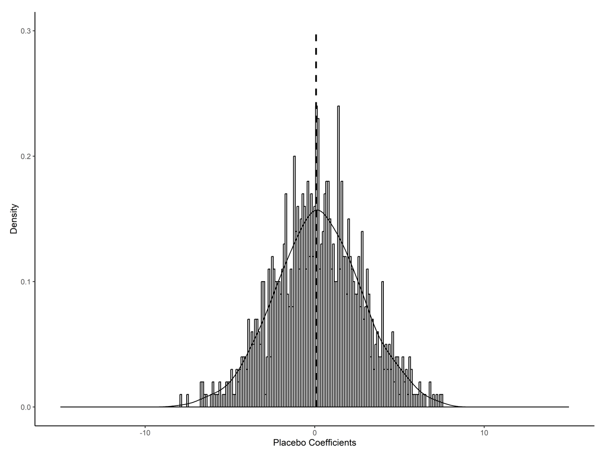
Figure 5: Density of Placebo Test Coefficients for Nontreated Response



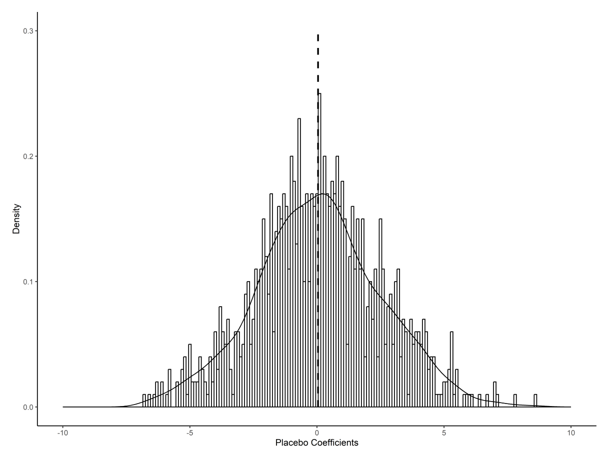
(a) LBT NRW



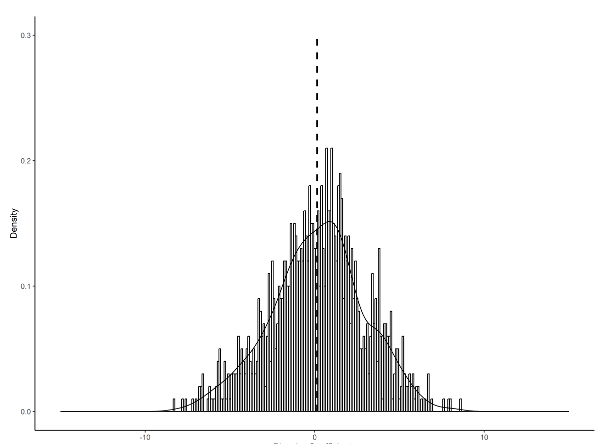
(b) LBT Hesse



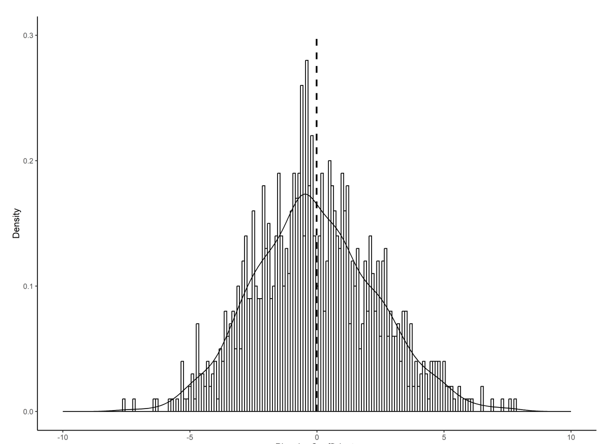
(c) Prop A NRW



(d) Prop A Hesse



(e) Prop B NRW



(f) Prop B Hesse

or a lack of transportation infrastructure between municipalities. In order to address these concerns, we replicate these results in Table 5 using the driving distance and driving time as spatial proximity measures. The results only change quantitatively except for the LBT ATT in NRW, which is now statistically insignificant. The distance coefficients are generally smaller compared to Table 2 as driving distances are generally larger than linear distances.

We may finally argue that not only proximity but also treatment intensity matters for tax-setting responses. We define treatment intensity as the number of treated units within a pre-defined radius.[39] We drop all control municipalities located within this radius. Finally, we divide the Nontreated into quartiles based on the number of treated neighbors in their vicinity. We then rerun equation (1) replacing the treatment dummy with quartile dummies. The results are depicted in Table 6. Looking at Column (1) we observe that all municipalities raise their LBT by more than the lowest intensity quartile. However, the magnitude decreases with intensity. While the latter may also be the result of less support in the assignment of treated to quartiles, for Prop B (NRW), Prop A (Hesse), and Prop B (Hesse), we confirm a non-monotonic increase in treatment intensity.

The findings in Column 4 of Table 5 on the LBT in Hesse is in line with the positive distance coefficient in Table 2. Coefficients for the Prop A in Hesse and Prop B in both states are also consistent with the findings in Table 2. The more Treated are located close by, the stronger the tax-setting response of the Nontreated. This again underscores the presence of non-base related spillovers that cannot be attributed to general developments in the respective state.

7 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

[39]The radius for Hesse is 40km and for NRW 80km. The radius is chosen in a way that for each nontreated municipality at least one Treated is located within this radius.

Table 5: Alternative Distance Measures

Panel A: Driving Distance

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Post × Dist	-0.025**	-0.071***	-0.061**	-0.008	-0.008	-0.019
	(0.009)	(0.013)	(0.018)	(0.017)	(0.027)	(0.023)
Nontreat × Post	6.130	-3.619	46.263***	23.038***	66.394***	100.755***
	(3.983)	(5.943)	(8.201)	(3.813)	(4.263)	(4.974)
Nontreat × Post × Dist	-0.064***	-0.021	-0.495***	0.341***	-0.861***	-1.839***
	(0.009)	(0.013)	(0.018)	(0.017)	(0.027)	(0.023)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9780	9780	9780	9810	9810	9810

Panel B: Driving Time

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Post × Time	-0.041**	-0.112***	-0.101***	-0.016	-0.013	-0.031
	(0.012)	(0.012)	(0.020)	(0.030)	(0.052)	(0.046)
Nontreat × Post	6.218	-3.293	48.477***	25.097***	70.846***	101.547***
	(3.327)	(3.847)	(5.903)	(4.337)	(5.268)	(5.701)
Nontreat × Post × Time	-0.064***	0.013	-0.599***	0.134**	-1.058***	-1.660***
	(0.012)	(0.012)	(0.020)	(0.030)	(0.052)	(0.046)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9780	9780	9780	9810	9810	9810

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.

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.

Table 6: Treatment Intensity

	NRW			Hesse		
	(1)	(2)	(3)	(4)	(5)	(6)
	LBT	Prop A	Prop B	LBT	Prop A	Prop B
2.Quartile × Post	15.381***	28.622***	45.204**	27.763**	44.989***	67.339***
	(2.778)	(6.383)	(11.942)	(7.163)	(10.230)	(13.993)
3.Quartile × Post	11.200**	14.185*	51.895***	22.095**	51.483***	77.252***
	(2.778)	(6.383)	(11.942)	(7.163)	(10.230)	(13.993)
4.Quartile × Post	9.214**	18.196**	59.181***	15.461*	70.475***	105.243***
	(2.778)	(6.383)	(11.942)	(7.163)	(10.230)	(13.993)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9780	9780	9780	9840	9840	9840

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.

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.[40]

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 7 summarizes the results for the Treated (Panel A) and Nontreated (Panel B). We then calculate the average change in revenue per multiplier point by dividing the coefficients in Table 7 by the results depicted in Panel A and B of Table 2. This allows us to determine the elasticity of revenue as $\rho = \frac{d\widehat{R}/R}{d\widehat{\tau}/\tau}$.[41] 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 7, we observe that the MCPF for the property tax rates lies in a range between 1.03 and 1.44. This finding is consistent for both property taxes Prop A and Prop B, both states NRW and Hesse, and for both treated and nontreated 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.[42] This suggests that treated 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 Prop A and Prop B multipliers. In particular, our findings suggest that for the treated and nontreated in Hesse, it is efficient to rely more on Prop B. For both Treated as well as Nontreated in NRW, we find that the use of Prop A is associated with the lowest efficiency cost.

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

[41]For τ we take the mean multiplier for the respective subgroup (see Table 7). 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.

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

Table 7: Difference-in-Differences Results: Revenue

Panel A: Treated

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Treat × Post	-0.183***	0.235***	0.253***	-0.050	0.258***	0.435***
	(0.006)	(0.016)	(0.012)	(0.032)	(0.027)	(0.021)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	1825	1828	1830	2728	2757	2760
Mean Tax	454.59	283.45	520.19	356.94	351.97	369.08
ϵ	-3.76	0.86	0.811	-0.50	0.76	0.95
$MCPF$	-0.27	1.15	1.23	-1.99	1.31	1.06

Panel B: Nontreated

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Nontreat × Post	-0.109**	0.103***	0.110***	-0.017	0.134***	0.267***
	(0.033)	(0.005)	(0.007)	(0.013)	(0.007)	(0.011)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9767	9764	9780	9798	9807	9840
Mean Tax	422.76	240.73	424.70	342.28	299.82	304.87
ϵ	-3.35	0.96	0.78	-0.22	0.69	0.968
$MCPF$	-0.30	1.04	1.28	-4.62	1.44	1.03

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.

8 Conclusion

In this paper we exploit quasi-exogenous tax rate changes to analyze the size and spatial scope of tax-setting responses among German municipalities for both mobile and immobile tax bases. Following the financial crisis in 2008, the states of Northrhine-Westfalia and Hesse introduced state debt-reduction programs (DRPs) that quasi-exogenously assigned participation to municipalities. Treated municipalities had to prepare and execute feasible and binding consolidation measures leading to heterogeneous increases in local business and property tax rates. First, we demonstrate that the Treated exhibit substantial and persistent rises in both local business and property tax rates of up to 58% compared to the pre-treatment period. Second, we illustrate that nontreated municipalities located in Hesse or NRW which are not directly targeted by these programs exhibit sizable tax-setting responses in all three instruments with a slope of 0.62 to 0.77 for the local business tax and 0.34 to 0.50 for the property tax. Lastly, we highlight that tax-setting responses varies in the spatial dimension emphasizing that our findings are not driven by state-specific time trends. Policy responses of the property tax are particularly localized indicating that German municipalities are engaged in yardstick competition or subject to other non-base related spillovers. Additionally, we find evidence for corporate tax competition. Looking at the efficiency implications of the DRP-related tax hikes, we find MCPFs between 1.03 and 1.44 for the property tax rate A and B, while LBT increases are associated with revenue losses.

This study adds to the literature by analyzing tax-setting responses related to tax and yardstick competition within a common legal framework, by exploiting quasi-exogenous and heterogeneous variation in local tax instruments. The literature has so far found mixed evidence for (local and international) tax competition. Additionally, the importance of spatial factors has been largely disregarded. If anything, the choice of control groups in the literature has been driven by geographical proximity, potentially resulting in endogeneity problems and biased results. We explicitly account for the role of space and illustrate its importance. We demonstrate that non-base related spillovers are highly localized in a narrow geographical area around a policy shock.

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. Our results confirm that the MCPFs in the case of property taxes are relatively low, sometimes close to 1. The sizeable tax responses we find for both property tax rates in Germany on the Nontreated therefore suggest efficiency gains, and 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.

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A Appendix

A.1 Mean and median multipliers over time

Figure A.1

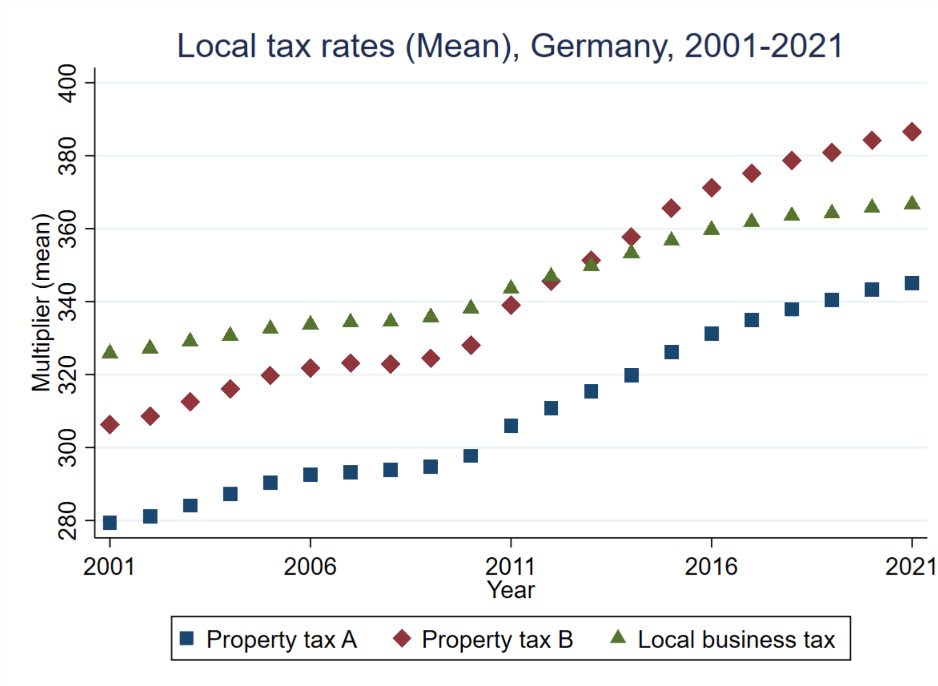
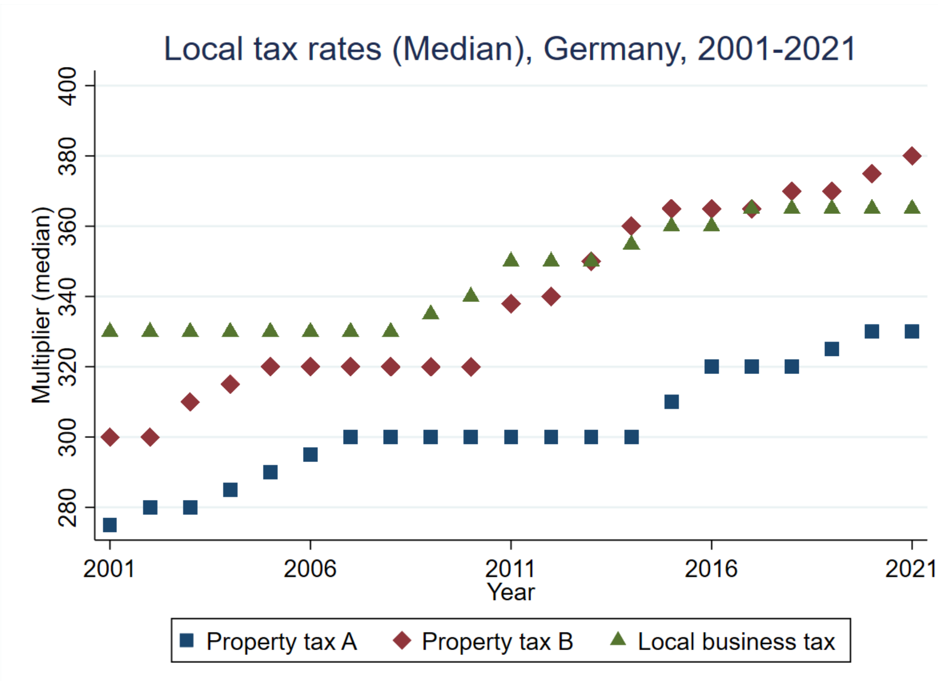


Figure A.2



A.2 Generalized DiD Tables

Table A.1: Generalized Difference-in-Differences Treated

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Treat × 2005	-0.689	-5.098**	-5.984*	-0.833	-2.757	-1.875
	(1.600)	(1.030)	(1.906)	(1.150)	(2.948)	(3.542)
Treat × 2006	-1.508	-8.049***	-8.607**	-2.192	-3.844	-3.592
	(2.849)	(0.890)	(1.599)	(1.963)	(3.209)	(4.012)
Treat × 2007	-0.230	-7.049*	-5.984	-1.525	-2.554	-0.179
	(3.190)	(2.309)	(3.026)	(1.860)	(3.562)	(3.727)
Treat × 2008	0.967	-6.639*	-1.085	-4.516	1.277	-4.672
	(3.680)	(2.622)	(3.225)	(1.843)	(6.894)	(3.867)
Treat × 2009	-1.574	-5.902	-3.787	-0.752	-6.549	1.857
	(1.131)	(2.622)	(3.483)	(1.501)	(9.439)	(4.032)
Treat × 2010	-1.197	-6.967**	-10.377*	-1.395	-8.159	-0.476
	(0.880)	(1.922)	(4.329)	(1.338)	(9.534)	(6.203)
Treat × 2011	1.082	-4.066	0.000	-5.264	-14.781	-7.751
	(1.468)	(3.832)	(6.377)	(6.414)	(12.080)	(12.211)
Treat × 2012	6.574**	13.951**	26.705**	-3.100	-7.689	4.370
	(1.287)	(3.891)	(7.383)	(6.361)	(12.342)	(12.917)
Treat × 2013	16.262***	54.328***	104.230***	21.661**	52.833***	84.435***
	(0.585)	(2.549)	(6.700)	(7.292)	(12.587)	(13.318)
Treat × 2014	18.984***	63.000***	118.607***	30.188***	82.007***	123.658***
	(0.585)	(2.703)	(6.936)	(7.304)	(12.308)	(13.224)
Treat × 2015	23.443***	75.869***	175.869***	36.841***	129.865***	188.168***
	(0.669)	(2.703)	(6.936)	(8.265)	(13.505)	(15.282)
Treat × 2016	27.377***	90.787***	216.951***	38.663***	131.702***	194.022***
	(0.814)	(1.677)	(5.548)	(8.426)	(13.894)	(14.773)
Treat × 2017	29.115***	98.590***	226.459***	38.217**	141.822***	211.283***
	(1.324)	(2.371)	(6.410)	(9.670)	(14.163)	(14.705)
Treat × 2018	30.787***	102.393***	232.787***	38.185**	140.094***	214.076***
	(1.261)	(1.946)	(6.319)	(9.863)	(17.956)	(15.457)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	1830	1830	1830	2760	2760	2760

The table depicts the results of the generalized 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.

Table A.2: Generalized Difference-in-Differences Nontreated

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Nontreat × 2005	-0.029	-1.451	-1.230	0.126	-1.859	-0.708
	(0.872)	(1.071)	(1.879)	(0.895)	(1.766)	(2.616)
Nontreat × 2006	0.848	-1.927	-0.220	-0.167	-3.841	-1.818
	(1.476)	(1.872)	(2.821)	(1.400)	(2.575)	(3.420)
Nontreat × 2007	1.119	-0.429	0.875	-0.753	-3.811	-1.057
	(1.633)	(2.565)	(3.465)	(1.367)	(2.291)	(3.080)
Nontreat × 2008	1.014	0.024	0.892	-0.265	-3.579	-0.314
	(1.644)	(2.659)	(3.699)	(1.422)	(2.610)	(3.569)
Nontreat × 2009	0.496	0.006	0.264	-0.408	-3.377	-0.744
	(1.512)	(2.550)	(3.497)	(1.127)	(2.612)	(3.731)
Nontreat × 2010	-0.065	-1.313	-0.799	-0.346	-4.209	-0.034
	(1.535)	(3.621)	(5.608)	(0.851)	(2.890)	(4.626)
Nontreat × 2011	3.621	2.545	9.545	-0.367	-4.765	-1.861
	(2.470)	(5.028)	(7.620)	(2.118)	(4.966)	(7.877)
Nontreat × 2012	5.834*	5.978	20.753**	3.740	-0.320	5.848
	(2.496)	(5.205)	(7.545)	(2.538)	(5.140)	(8.021)
Nontreat × 2013	9.236***	12.889**	31.339***	10.176**	10.788*	20.388*
	(2.038)	(4.806)	(7.103)	(2.931)	(5.051)	(8.060)
Nontreat × 2014	11.452***	15.382**	36.913***	19.015***	26.346***	42.488***
	(2.107)	(5.046)	(7.467)	(3.080)	(5.303)	(8.294)
Nontreat × 2015	16.483***	26.946***	63.345***	28.493***	57.846***	89.977***
	(2.370)	(4.767)	(7.144)	(3.310)	(4.773)	(7.975)
Nontreat × 2016	18.633***	34.015***	81.331***	33.136***	70.163***	106.169***
	(2.422)	(4.949)	(7.109)	(3.878)	(5.094)	(7.851)
Nontreat × 2017	20.354***	40.008***	94.592***	36.854***	80.328***	119.821***
	(2.958)	(5.454)	(7.722)	(3.984)	(4.753)	(7.434)
Nontreat × 2018	20.515***	42.995***	97.328***	38.342***	85.342***	126.025***
	(2.816)	(6.110)	(8.504)	(3.982)	(4.955)	(7.778)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	9780	9780	9780	9840	9840	9840

The table depicts the results of the generalized 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.3 Unmatched Results

This subsection depicts the estimation results of equations (1) and (2) for the Treated and Nontreated 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 results for the Treated in NRW in Panel A of Tables 2 and A.3, we find that the coefficient for the LBT is slightly smaller and statistically insignificant. However, this insignificance is explained by the large change is in the standard error which are nine-fold larger for the unmatched sample. Turning to the property taxes, we find quantitatively similar coefficients, but again substantially larger standard errors. Looking at the results for the Treated in Hesse, the coefficients are quantitatively almost identical with larger standard errors in the case of the LBT and Prop B.

Regarding the results for the Nontreated in Panel B of Tables 2 and A.3, 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 matched sample. Concerning the spatial results, a similar picture emerges for Hesse. Interestingly, the spatial response in columns (4)-(6) is almost identical to the estimated coefficients in Panel C of Table 2. The spatial results for NRW differ from the ones in Table 2. The ATT is now statistically insignificant for all three tax instruments. Again, standard errors at least triple in size. The spatial interaction in the case of the LBT is now also statistically insignificant. However, the spatial response on the property taxes remains statistically significant and negative.

The generalized DiD results depicted in Figures A.3 and A.4 provide a more in-depth view on the findings for the unmatched sample. Looking at the results for NRW in Figure A.3,we again observe flat and mostly insignificant pre-treatment differences, but no pre-trends, 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 substantially larger especially for the LBT compared to the results in Figure 2. The generalized DiD results for the Treated in Hesse are almost identical to the ones for the matched sample in Figure 2. As for the results of the Nontreated in Figure A.4, we again observe flat and statistically insignificant pre-trends (except for the LBT in NRW in 2010) 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 Nontreated in NRW where the upward trend only materializes 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. Given these findings for the unmatched sample, it seems that the matching approach is not principally driving the results. 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.3: Difference-in-Differences Results

Panel A: Treated

	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Treat × Post	15.698	69.285***	159.164***	33.804**	119.701***	169.784***
	(9.094)	(8.526)	(11.653)	(8.757)	(8.053)	(10.985)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	69045	69045	69045	69510	69510	69510
Change in p.p.	0.55	0.42	0.56	1.18	0.71	0.59
Change in %	3.58	28.75	36.67	10.06	40.44	58.35

Panel B: Nontreated

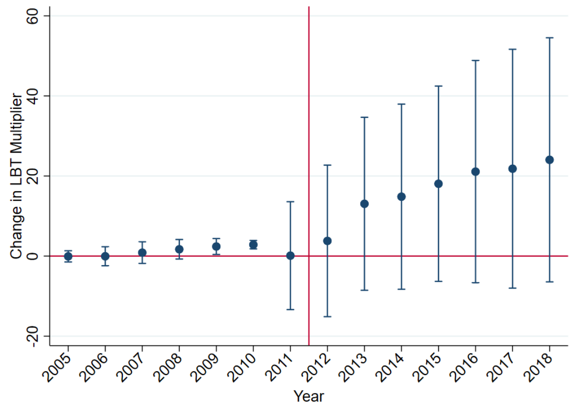
	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Nontreat × Post	4.339	18.185*	51.031***	21.464*	54.259***	80.028***
	(9.094)	(8.526)	(11.653)	(8.757)	(8.053)	(10.985)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	73020	73020	73020	73050	73050	73050
Change in p.p.	0.15	0.11	0.17	0.75	0.33	0.28
Change in %	1.05	8.19	13.12	6.56	20.25	30.43

Panel C: Spatial

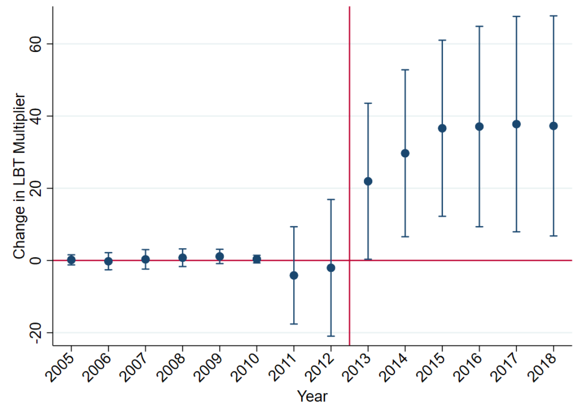
	NRW			Hesse		
	(1) LBT	(2) Prop A	(3) Prop B	(4) LBT	(5) Prop A	(6) Prop B
Post × Dist	-0.104	-0.103	-0.135	-0.079	-0.058	-0.099
	(0.080)	(0.063)	(0.087)	(0.070)	(0.061)	(0.074)
Nontreat × Post	-21.924	-4.076	34.540	6.996	56.012**	87.128**
	(30.724)	(25.127)	(34.796)	(17.993)	(14.601)	(19.835)
Nontreat × Post × Dist	-0.078	-0.216**	-0.702***	0.422***	-0.963***	-2.090***
	(0.080)	(0.063)	(0.087)	(0.027)	(0.024)	(0.030)
Municipality FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Observations	66000	66000	66000	66000	66000	66000

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.

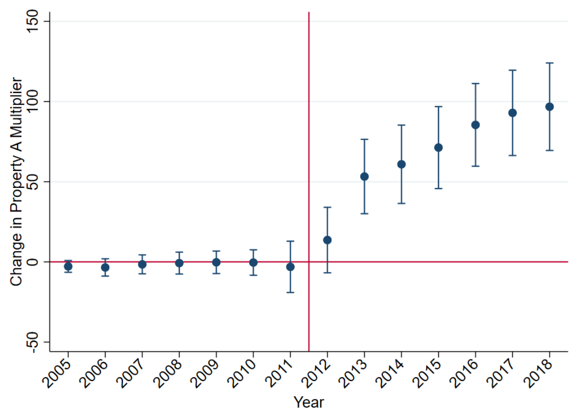
Figure A.3: Effect of Debt Reduction Programs on the Treated



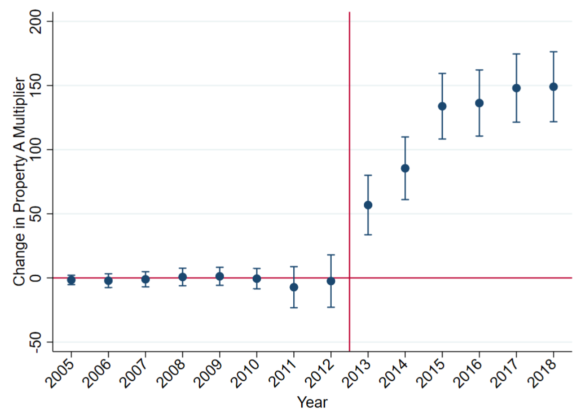
(a) LBT NRW



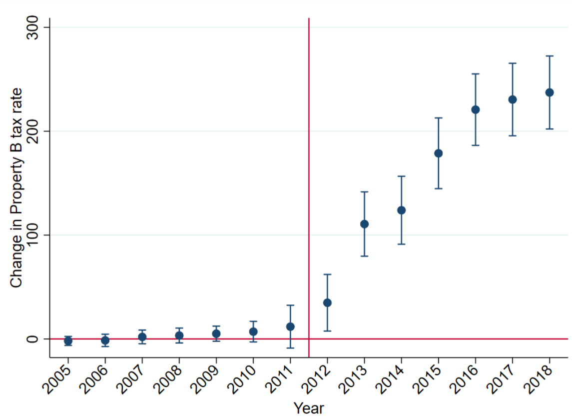
(b) LBT Hesse



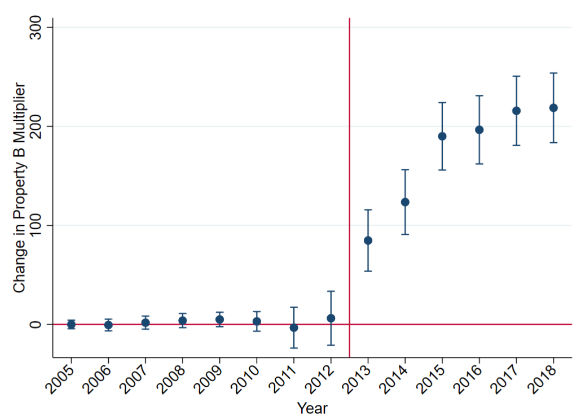
(c) Prop A NRW



(d) Prop A Hesse

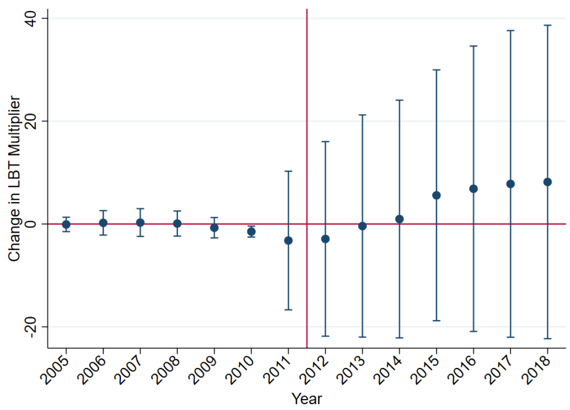


(e) Prop B NRW

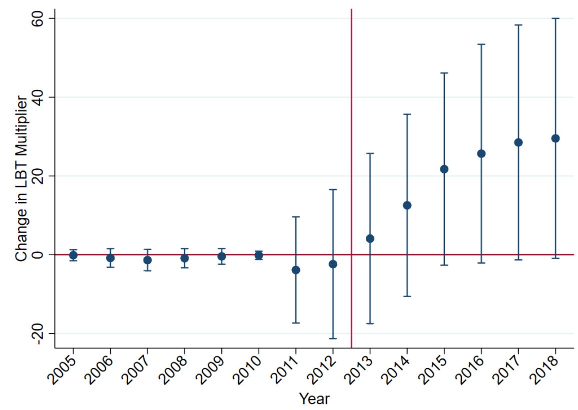


(f) Prop B Hesse

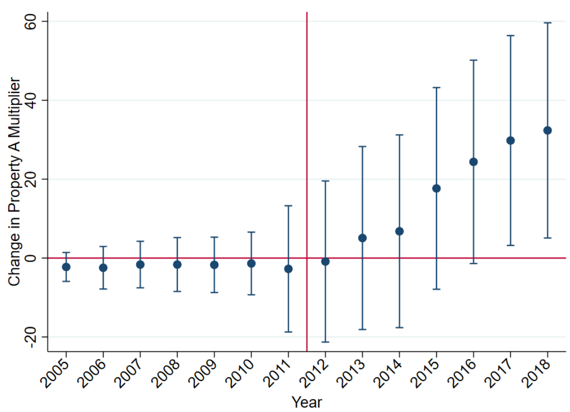
Figure A.4: Effect of Debt Reduction Programs on the Nontreated



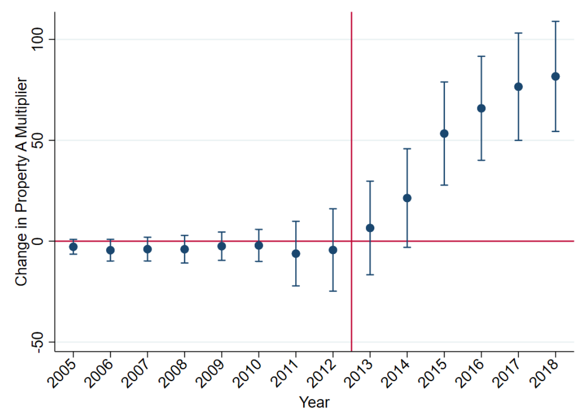
(a) LBT NRW



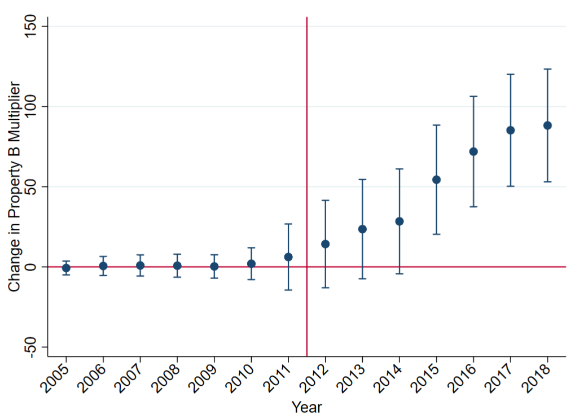
(b) LBT Hesse



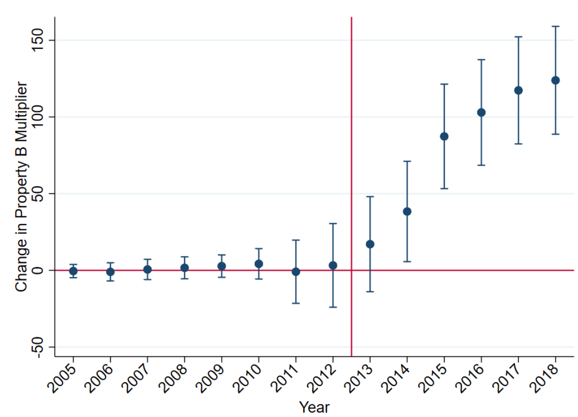
(c) Prop A NRW



(d) Prop A Hesse



(e) Prop B NRW



(f) Prop B Hesse