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The Electoral Impact of Housing Climate Policy: Evidence from Germany

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Abstract
The transition to carbon-neutral residential heating poses extraordinary policy challenges to societies in Europe and beyond. In this paper, we study the electoral consequences of an amendment to the German Building Energy Act (GEG) aimed at phasing-out fossil-based heating systems. We use granular building stock data to approximate heterogeneity in household compliance costs and apply difference-in-differences and triple difference models to estimate its impacts on vote shares at the municipal level. For the state elections in Bavaria and Hesse, we find relative gains for the far-right (+2.4 pp) and conservative opposition parties (+6.5 pp) and losses for the incumbent federal government parties (−2.9 pp) in the baseline specification of our model. For the latter two, the effects are more pronounced in rural municipalities. These findings highlight the importance of holistic climate policy approaches that account for salient and heterogeneous costs to mitigate political backlash.

Keywords Climate policy · Public acceptance · Voting · Building sector · Difference-in-differences

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1 Introduction

The European Green Deal aims at achieving climate neutrality across the EU by 2050, leaving the member states 25 years to decarbonize their economies. Residential heating contributes significantly to greenhouse gas emissions as only 24.9% of heating and cooling energy in the EU originates from renewable energy sources. In Germany, this share is even lower, with renewable energy accounting for 17.5% (Eurostat 2024). Given the dominance of fossil-based residential heating and Germany's ambitious target of climate neutrality by 2045, the country exemplifies the transformation challenges EU member states and beyond face.

The energy price crisis in 2022 emphasized Germany's dependence on fossil fuel imports, particularly natural gas from Russia for the building and industry sector. In response, the German federal government at that time, formed by the social democratic (SPD), the green (Bündnis 90/Die Grünen), and the liberal party (FDP), aimed at accelerating the transition to carbon-neutral residential heating through an amendment to the German Building Energy Act[1]—in the following referred to as GEG amendment. A preliminary proposal of the GEG amendment was leaked to the media in February 2023 prior to the cabinet's approval[2]. It stated ambitious regulations for heating systems in residential buildings: all newly-installed heating systems from January 2024 were supposed to operate using at least 65% renewable energy. This would have banned the new installation of conventional fossil-based heating systems, which is the dominant technology to date. Importantly, a complementary subsidy regime, designed to compensate households for switching to a low-carbon heating technology, was approved only months after the GEG amendment had passed, leaving households uncertain about the required technology and retrofit investments.

The policy marks a turning point in Germany's effort to decarbonize residential heating. However, the substantial uncertainty surrounding future retrofit demand and investment costs—rooted in the initial leak of the first draft and amplified by a subsequent intense and polarized media coverage—triggered an emotional and contentious public debate[3]. Following multiple revisions, the parliament adopted a modified, less strict version of the GEG amendment in September 2023, incorporating transition periods, an expanded set of eligible heating technologies, and the prospect of a more generous subsidy scheme. By that time, however, the debate around the preliminary proposal of the GEG amendment had already shaped the public and political discourse. Beyond media speculation that this debate may have affected support for the incumbent federal government, the electoral repercussions of the GEG amendment remain unexplored, despite their potential to carry long-term implications for public acceptance of ambitious climate policy more broadly[4].

In this paper, we investigate how costs of complying with the GEG amendment affected the outcomes of two state elections in October 2023. Our analysis combines municipal-level voting data with high-resolution census data on the settlement structure of German households. The $100\,\mathrm{m} \times 100\,\mathrm{m}$-gridded census data give us a proxy for the share of citizens in each municipality financially affected by the policy change based on the prevailing building structure. Using this measure of treatment intensity, we implement continuous difference-

[1] German name: "Gebäudeenergiegesetz (GEG)", see https://www.gesetze-im-internet.de/geg/.

[2] Since to our knowledge the exact version of the leaked draft has not been officially confirmed, we refer to the version dated March 7, 2023 (see https://table.media/wp-content/uploads/2023/03/GEG-070323.pdf).

[3] A review of the political developments and debates can be found in ZEIT and Politico.

[4] See Sect. A.1 for a review on trends in voters' party preferences.

in-differences and triple difference approaches to isolate the effect of the GEG amendment from other concurrent crises and policies, such as the energy price shock. In particular, we compare election outcomes in Bavaria and Hesse with those in Lower Saxony, whose electoral cycle is shifted one year earlier. This strategy allows us to identify a plausibly causal impact of the financial burdens imposed by the GEG amendment on voters' electoral decisions.

Our baseline results suggest that the conservative (+6.5 pp) and far-right (+2.4 pp) opposition parties gained support in municipalities most strongly affected by the GEG amendment, while the incumbent federal government parties experienced losses (−2.9 pp). The gains for the far-right and conservative party are qualitatively robust across various specifications, including alternative computations of the continuous treatment variable, or more rigorous accounting of state-specific trends. We find more pronounced effects for the conservative and the governing parties in rural municipalities, characterized by lower population density and lower share of foreign residents. Overall, our findings suggest that public acceptance of ambitious climate policy in the building sector is shaped by horizontal dimensions of inequality—that is, the heterogeneity in the carbon intensity of buildings—which hardly correlates with the vertical income inequality. This highlights the importance of complementary compensation policies that specifically address such horizontal heterogeneity.

The findings can inform ongoing and contentious debates on European and national decarbonization targets for the building sector, particularly the planned extension of the EU Emissions Trading System in 2028[5]. Although housing costs constitute the largest share of household expenditures[6] and therefore a salient household concern (Voeten 2024), our understanding of the political economy of climate policies in housing remains limited. The GEG amendment represents a potentially costly regulatory intervention in the building sector and thus provides a valuable case for studying public support of climate policy.

Our paper contributes to three strands of the literature. First, it relates to the literature on public support for climate policies. Prior work has emphasized the role of beliefs about environmental effectiveness as well as perceived distributional fairness—both societal and individual—in shaping support (Bergquist et al. 2022; Dechezleprêtre et al. 2022; Douenne and Fabre 2022; Mildenberger et al. 2022; Sommer et al. 2022; Carattini et al. 2024; Fabre et al. 2025). Most of the evidence stems from survey experiments and thus relies on stated preferences, which may not necessarily materialize into electoral support. We complement this research strand by studying *actual* vote changes, i.e., revealed preferences, in elections following the introduction of a costly regulation[7].

Second, we contribute to the closely related literature on electoral backlash based on voting data. While most existing studies focus on the US context, characterized by a two-party system shaped by partisanship and political ideology (Holian and Kahn 2015; Stokes 2016; Egli et al. 2020; Anderson et al. 2023), evidence for multi-party systems is scarce (Otteni and Weisskircher 2022; Colantone et al. 2023). This emerging strand of literature docu-

[5] See Perdana and Vielle (2026) for a spatial distributional analysis between EU member countries

[6] Household data shows that spending for housing and utility costs from total spending reaches 24% in the EU and 23% in Germany on average (see https://ec.europa.eu/eurostat/cache/visualisations/economy/household-expenditure/). It thereby constitutes the largest expenditure item. In Germany, these costs have furthermore increased adversely along the income level over time (Dustmann et al. 2022).

[7] Both approaches have their advantages, and scholars have identified correlations between stated and revealed preferences, though the links are sensitive to policy contexts and institutional settings (Hainmueller et al. 2015; Funk 2016; Alberini 2019).

ments electoral backlash following the introduction of (uncompensated) climate policies, benefiting the opposition, far-right, and populist parties, whereas deliberative and compensating policy designs can mitigate such backlash (Colantone et al. 2023; Bolet et al. 2024). We extend this line of research by analyzing the electoral impact of an ambitious and costly climate policy in the German housing sector. Unlike climate policy in the transport and electricity sectors studied to date, housing policies entail substantial upfront retrofitting and investment costs for households. Our findings show that the imposed financial exposure significantly affects voting results in the German electoral context, in which voters have strategic choices between 5 and 7 parties, including new and growing populist parties that can act as key political actors fueling backlash (Bosetti et al. 2025).

Third, we contribute to the literature on distributional effects of climate policies. Previous studies have extensively analyzed potentially adverse burdens of policy reforms highlighting the impacts across income groups (i.e., vertical equity) and a variety of horizontal equity dimensions. The latter include, for example, commuting distances or characteristics of the housing stock that shape how individuals are affected by climate policies (Fullerton and Heutel 2007; Fullerton 2011; Pizer and Sexton 2019; Vona 2023). Most of this literature relies on ex-ante and descriptive analyses of horizontal inequality and shows that horizontal distributional differences can be pivotal for identifying winners and losers under hypothetical climate policy designs (Sallee 2019; Hardadi et al. 2021; Glaeser et al. 2023; Kalkuhl et al. 2024; Schlattmann 2024). Yet, the literature offers no direct evidence on how horizontal equity translates into political support. We seek to make an important step forward in filling this gap by quantifying a specific dimension of horizontal heterogeneity, i.e., the financial burden associated with the carbon intensity of households' heating technologies, and by providing an ex-post evaluation of how this heterogeneity shapes electoral responses. In doing so, we bridge the literature on distributional impacts discussed here with the literature on public support discussed above.

The remainder of this paper is structured as follows: Sect. 2 provides information on the legislative scope of the GEG amendment and a consideration of its impact on households. Section 3 describes the data and econometric methods employed in our analysis, leading to the results presented in Sect. 4, and the discussion and derived policy implications in Sect. 5.

2 Contextual background

Residential heating in Germany is to date predominantly provided on-site using fossil energy. About 75% of German households run a gas- or oil-fired[8] building or in-unit heating system (DESTATIS 2024b). Emissions from residential heating account for approximately 20% of Germany's total carbon emissions in 2020 and absolute emissions have stagnated for 20 years (Umweltbundesamt 2025).

In 2022, the energy price crisis led to stark price increases for fossil energy and imposed substantial financial burdens on German households (Kalkuhl et al. 2022; Kröger et al. 2023). In response, households' energy consumption changed (Ruhnau et al. 2023) and the government implemented relief measures (Arregui et al. 2022). In light of these develop-

[8] In rare cases, also coal-fired stoves are still being used.

ments, the federal ministry of economic affairs and climate protection suggested an amendment to the GEG[9] aiming at reducing the fossil dependence in the long-run[10].

2.1 The GEG amendment and its public debate

Prior to the cabinet's approval of this legislation, a draft was leaked to the media in February 2023. A key element of the reform mandated that all residential heating systems installed from 2024 onward must operate with a renewable energy share of at least 65%. This requirement is equivalent to a virtual ban of the installation of new fossil-based heating systems. Given the dominance of fossil-based on-site heating systems in Germany (75%), the short notice until January 1st, 2024, as well as the uncertainty about which technologies were considered as renewable, the GEG amendment was heavily discussed in the media. An emotional public debate unfolded that centered around the question of whether households could afford the transition to climate-neutral residential heating. This was further promoted by the uncertainty of corresponding subsidy measures addressing adverse individual burdens.

The Bundestag passed the GEG amendment on September 8th, 2023 in a version that differed from the leaked draft[11] in three ways. First, the GEG amendment was planned to be complemented shortly after introduction by an extended subsidy scheme which rewards early adopters and compensates low-income households with higher subsidy rates ranging from 30 to 70%—capped at 21,000 EUR—(see Sect. A.2 for the exact design of the subsidy scheme). However, the revision and expansion of the subsidy scheme for the installation of a heat pump was not agreed upon until shortly before the end of 2023[12]. The revision left accompanying retrofit measures of the building envelope unchanged[13]. Second, the enacted GEG amendment expanded the scope of heating systems classified as renewable. Third, and most importantly, it tied the guideline to the existence of a municipal level plan for local residential heating provision. This linkage extended transition periods for the 65%-rule, allowing household to decide on their heating system under full information about expected future residential heating provision, such as district heating or biogas. Until municipalities have created individual plans (mid-2026 to 2028 depending on the municipality size), households are still allowed to install fossil-based heating systems under specific conditions[14]. Apart from these changes, the law also permits the repair of installed fossil-based heating systems that are not fully broken, so that they do not need to be replaced immediately by a renewable alternative.

9 The coalition agreed on introducing this amendment with the beginning of 2025 in their coalition treaty. The ministry aimed at implementing the amendment for January 2024, one year earlier.

10 The amendment does not only target the reduction of foreign fossil energy dependency but has also started the implementation process of the EU "Energy Performance of Buildings Directive".

11 Section A.2 provides an overview of the legislative process.

12 The revised subsidy scheme was published on December 29th, 2023.

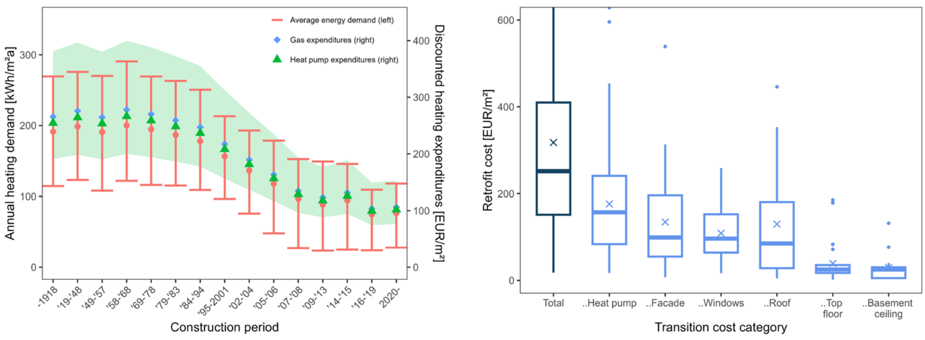
13 The amount of these subsidies (as reduced interest rate and/or reduced repayment) is highly heterogeneous as it depends on many aspects of the individual retrofit case, e.g., building characteristics, the targeted efficiency level, or a household's income.

14 These conditions include firstly the mandatory consulting by a professional, e.g., energy consultant or chimney sweeper, and secondly blending the fuel by incrementally increasing quotas of bio fuels, e.g., biogas, which is supposed to become effective in 2029. The second condition looses its validity as soon as the municipality plans to offer a given building district heating or hydrogen provision as long as the heating system can be operated with the latter.

Generally, to meet the 65%-rule in the medium-run, many households will need to install new heating systems, such as heat pumps. Differences in the building structure may result in variation in the retrofit measures required for cost-efficient heating, as well as in operating costs, both of which are outlined in the following.

2.2 Financial burden induced by the GEG amendment

The electrification of residential heating through heat pumps is considered a promising strategy to achieve carbon neutrality cost-efficiently for the majority of buildings (Luderer et al. 2025). However, the performance of a heat pump is a priori uncertain and negatively influenced by a low building energy efficiency. The German Heating and Housing Panel by Frondel et al. (2023) suggests an average heating demand of houses built before 1984 of about 190 kWh per sqm and year (see Fig. 1a). At the same time, this building age cohort represents a large share (about 70%) of the current building stock (DESTATIS 2024b). Over the lifetime of a heating system, which we approximate at 20 years, this implies average discounted heating expenditures of roughly EUR 260 per sqm for a gas heating. The equivalent electricity expenditures for a heat pump are influenced to a great extent by its efficiency, which is quantified by the annual performance factor (PF). This factor mostly varies between 2 and 4 (Bayer and Pruckner 2023; Gibb et al. 2023; Lämmle et al. 2023)[15]. For buildings built prior to 1984, this results in discounted heating expenditures that vary within a plausible range of approximately EUR 185 to EUR 370 per sqm (see Fig. 1a). In an average German single-family house with a living area of 130 sqm (DESTATIS 2024a), a well-performing heat pump (PF= 4) may achieve savings of about EUR 9,750 in operat-



(a) Heating demand (b) Transitions costs

Fig. 1 The heterogeneous transition to climate-neutral residential heating. (**a**) heating demand. (**b**) transitions costs. Notes: the left panel shows the average heating demand by construction period and its respective variation (1st-4th quintile, red error bars, left scale). Blue diamonds and and green triangles depict the corresponding discounted sum of heating expenditures per sqm for gas and heat pump electricity (average heating demand, PF $= 3$, 20 years, $r = 2\%$, EUR 0.08 per kWh gas, EUR 0.23 per kWh electricity, 2023-prices, right axis). The shaded area in green visualizes uncertainty of heat pump electricity expenditures for a plausible range of heat pump performance factors (PF $\in [2, 4]$). The right panel compares reported costs of different retrofit measures per sqm when households switch from a fossil-based heating system to a heat pump ($n = 110$, 2023-prices, source: own depiction based on Frondel et al. (2023))

[15] A performance factor (PF) of 3 implies that the heat pump transforms 1 kWh of electricity into 3 kWh of usable heat energy for the household.

ing costs over its lifetime compared to gas heating. However, heating demand shows a high degree of variation, and higher demand may be associated with a lower hypothetical PF score. Therefore, individual operating costs may be substantial and are not necessarily lower than those of gas heating when switching to a heat pump without increasing the building's energy efficiency[16]. Additional retrofit measures (e.g., insulation, radiators replacement) may often be necessary.

In total, the individual transition is likely to be associated with substantial and heterogeneous up-front investment cost, ranging from EUR 150 to EUR 410 per sqm (1st to 3rd quartile, see Fig. 1b). For an average house, this corresponds to total investments between EUR 20,000 and EUR 53,000. However, country-wide and large-scale assessments of retrofit costs and associated utility costs remain scarce. Households therefore face significant uncertainty about the optimal technology choices for retrofitting and their case-specific costs.[17].

Beyond these monetary burdens, the literature also identifies non-monetary disutility from retrofit measures, which is especially pronounced for building retrofitting (Fowlie et al. 2015; Ebrahimigharehbaghi et al. 2020; Lundmark 2022). These additional costs stem from transaction costs,[18] such as collecting information, finding contractors and decision-making, or from the disutility of nuisances associated with renovations.

2.3 Mechanisms for political consequences of the GEG amendment

Bosetti et al. (2025) provide a conceptual framework that helps explain electoral backlash following the introduction of climate policy. They show that public support for climate policies is subject to complex intertwined dynamics in which citizens' electoral preferences are conditional on socioeconomic circumstances, political grievances and narratives. Political actors stressing societal conservatism or even denying the necessity of climate action may then be able to mobilize electoral support when policies impose structural change without compensation or citizens' involvement. The GEG amendment can been viewed as imposing precisely this type of structural change by introducing stringent climate policy for residential heating. Given the heterogeneous building structure described above, the wide variation in required household-level investments, the initial lack of a clear compensation scheme, and the manner in which the policy was communicated and introduced, the GEG amendment provides a setting well-suited to empirically study whether political actors can successfully mobilize electoral support.

This mechanism of electoral backlash should be most evident among those segments of the population that are directly exposed to the policy's impacts. In order to identify these households, we consider three aspects of the building and housing structure. Firstly, compared to its European neighbors, Germany stands out due to its residential ownership structure that is nearly equally distributed between owner-occupiers and tenants whereas the

[16] This calculation assumes constant energy prices and the absence of climate polices, e.g., carbon pricing.

[17] For the illustrations in Fig. 1b, we are using a subset from a novel and unique panel survey on household and building characteristics which comprises about 110 observations for households that switched to heat pumps since 2000 (Frondel et al. 2023). Acknowledging the high degree of heterogeneity in the building sector, the collection of richer data sets is necessary to pin down individual transition necessity and associated costs precisely.

[18] Lundmark (2022) estimates these transaction costs to be ranging between 24% and 50% of the actual investment costs depending on the retrofit measure.

EU-ratio is 70:30 between owners and tenants[19]. In the medium-run, investment necessities are relevant and visible for owner-occupiers. In contrast, tenants are not directly affected by the policy and do not need to raise the up-front capital for modernizing their home[20].

Secondly, as argued above, the utility costs and up-front transition costs may vary considerably the more energy intensive, i.e., older, a building is. Especially, buildings built prior to 1977 exhibit higher levels of energy intensity as the first building energy regulation became effective only in 1977. We assume that those buildings require higher investments to switch to climate-neutral heating while younger buildings are more likely to be heat pump-ready.

Lastly and most obviously, only those buildings are affected by the policy that have not yet switched to a renewable energy source as defined by the GEG amendment, i.e., district heating, heat pumps, geothermal heating, solar heating, or biomass heating systems. Given that the GEG amendment does not demand any further energy efficiency requirements, these households are legally seen as decarbonized.

Based on these considerations, we argue that the three aspects of horizontal inequality—ownership occupation, building age and the type of energy source used for heating—can be used to construct a measure of treatment intensity approximating the share of households facing financial burdens implied by the GEG amendment. Using this treatment intensity, we examine whether the compliance costs induced by the GEG amendment had electoral implications.

3 Data and econometric specification

3.1 Data

Our analysis focuses on the results of the Hessian and Bavarian state elections in 2023. Both states and their potential shifts in voting preferences are relevant to the German society as they make up 23% of the German population and comprise 23% of dwellings (DESTATIS 2024b). For this purpose, we collect three types of data: First, election results at the municipal level as dependent variables, second, gridded data on housing and settlement structure for the treatment definition, and third, socio-economic control variables at the municipal level to control for confounding effects.

3.1.1 Election results

We consider results of the last two state elections in Bavaria, Hesse and Lower Saxony. The elections in Bavaria and Hesse happened in 2018 and 2023 whereas the ones in Lower Saxony took place in 2017 and 2022. All elections were conducted in October of the respective year. The energy price increases following the Russian invasion of the Ukraine in February 2022 affected similar segments of the population as those targeted by the GEG amendment in 2023 (see Sect. 2). In both cases, energy-inefficient, i.e., older, buildings with fossil-based heating systems are affected most. We use the election results of Lower Saxony that took place in autumn 2022—shortly after energy prices peaked and started to decrease again

[19] see https://ec.europa.eu/eurostat/cache/digpub/housing/bloc-1a.html

[20] Tenants may need to contribute to investment costs via the modernization levy in the long-run, though.

but before the legislation on the GEG amendment—as a control group to control for confounding effects of the energy price crisis. Data on election results for all three states at the municipal level are provided by the respective statistical regional authorities (Bayerisches Landesamt für Statistik 2023; Hessisches Statistisches Landesamt 2023; Landesamt für Statistik Niedersachsen 2024).

3.1.2 Housing and settlement structure

To define our treatment, we make use of gridded data capturing the number of inhabitants, the residential ownership structure, binned construction years and the local distribution of energy sources used for residential heating. These data primarily stem from the 2011 German census, conducted before all elections considered in this study, except for the data on energy sources, which are only available for the subsequent wave in 2022 (DESTATIS 2018, 2024b). It is provided at a $100\,\mathrm{m} \times 100\,\mathrm{m}$-grid.

Figure 2 visualizes the spatial granularity of the census data set for the area in and around the city of Augsburg. To define the local degree of being affected, we draw on three variables: the share of owner-occupied flats, the share of flats in buildings constructed before 1979, and the share of heating systems relying on fossil energy sources. The $100\,\mathrm{m} \times 100\,\mathrm{m}$ grid-level granularity reveals correlations among local settlement characteristics. For example, the share of owner-occupancy is low in the city center of Augsburg but higher in the neighboring, more rural municipalities. In contrast, the share of flats in pre-1979 buildings exhibits more variation but is on average higher in the city center, reflecting the older building stock. Finally, the share of fossil energy sources illustrates Germany's dependence on fossil-based heating systems, as the average magnitude is comparably high. Local clusters in the city center with lower shares of fossil-based heating reflect district heating provision. Buildings connected to district heating are excluded from the 65%-rule of the GEG amendment. In principle, district heating could in the future operate on renewable technologies,

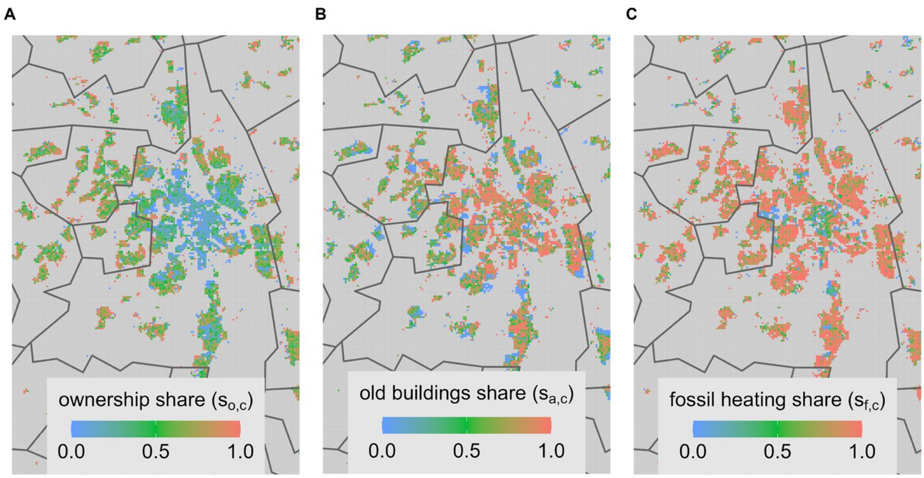


Fig. 2 Gridded settlement structure for Augsburg and neighboring municipalities, Bavaria. Notes: ratios are computed as share of apartments fulfilling a given criterion from the total number of apartments in a grid cell. We use data on the ownership status (**A**), the construction year (**B**), and the energy source for residential heating (**C**). The three panels show the city of Augsburg and its neighboring municipalities

such as larger centralized heat pumps, potentially at lower transition costs due to economies of scale, and with limited direct household involvement. Furthermore, local clusters with lower fossil dependency exist where households rely on heat pumps or solar and geothermal heating systems.

3.1.3 Control variables

The economic downturn has been shown to increase support for the far-right (Hernández and Kriesi 2016; Ahlquist et al. 2020). Thus, we use data on the annual municipal tax revenues, unemployment rate and per-capita income[21] to control for adverse local economic developments. In addition, we use data on the average age of citizens and population density to distinguish between urban and rural areas (Franz et al. 2024). Previous panel data studies have shown that immigration significantly influences the vote share of far-right parties. In line with those studies, we included the share of non-Germans (Dustmann et al. 2019; Edo et al. 2019; Kellermann and Winter 2022; Franz et al. 2024)[22]. Data on control variables stem from two statistical agencies that include Bundesinstitut für Bau-, Stadt- und Raumforschung (2024) (income, municipal tax revenues, average age), and Statistische Ämter des Bundes und der Länder (2024) (unemployment, population, non-German citizens).

3.2 Municipal treatment score

We construct a municipal treatment score to assess the degree by which citizens in a municipality are affected by the policy change based on the prevailing building structure. The high-resolution census data enables us to identify areas where large shares of the population are affected. We first identify affected grid cells and subsequently scale them up to the municipal level using population weights.

As outlined in Sect. 2.3, the GEG amendment imposes higher costs on those households living in buildings that require more extensive retrofitting or investment in a new heating system to comply with the regulation. The selection of grid cell indicators follows this reasoning:

1. Owner-occupiers (o): Citizens living in dwellings they own are in charge of their heating system and face the direct costs of retrofitting or installing a new system. At some point, the law forces them to switch to a system that (in parts) uses renewable energies to heat their home.
2. Old buildings (a): Citizens living in old buildings are more likely to be economically affected by the GEG amendment since individual transition costs may be higher for less efficient buildings as we argued in Sect. 2.2. We use the year 1979 as cut-off category as this is closest to the year of the first building energy regulation in 1977.

[21] measured by the per capita purchasing power.

[22] Data on the number of persons without a German ID at the municipality level were not available for Bavaria and Lower Saxony which is why we deduced it from election data. As citizens need a German ID for being eligible to vote, we subtracted the number of eligible voters in a given election year from the number of persons above the legal age to come up with a proxy on the number of non-German citizens in a municipality. This approach assumes that the share of non-German from total full-aged citizens is equally high between full-aged and underage citizens. In the few cases where this approximation yielded negative values due to differences in timing of reporting, we considered a share of zero.

3. Fossil energy source (f): On-site fossil-based heating systems (gas, oil, coal) must at some point be replaced by renewable alternatives (district heating, heat pump, solar/geothermal heating) under the GEG amendment.

We apply the following calculations to our gridded settlement structure data: A grid cell c is strongly affected by the GEG amendment if a large share of the population living in the cell satisfies each of the conditions listed above. Let k be any of these conditions, i.e., $k \in \{o, a, f\}$. For each condition k, we calculate the share $s_{k,c}$ of the number of dwellings satisfying the condition from all dwellings in cell c. The product of the three shares then yields a proxy for the policy-induced compliance costs[23]. Mathematically, that is:

$$\text{cost proxy}_c = s_{o,c} \times s_{a,c} \times s_{f,c}. \tag{1}$$

Assuming statistical independence of the three criteria, the proxy yields the share of the population living in the grid cell that may be particularly economically affected by the GEG amendment. Arguably there is some correlation between the criteria, e.g., heating systems in older buildings more likely rely on fossil energy than in newly built dwellings. We therefore argue that the proxy constitutes a lower bound of the share of households affected by the GEG amendment.

Based on the cost proxy at the grid level, we derive a treatment score T_m at the municipal level. We compute the weighted sum of the cell-level proxies for the set C_m of all cells which lie inside municipality m. Using the cell-specific population share κ_c from the total number of citizens in municipality m as a weight, we acknowledge that populous cells are more influential on the election outcome of a municipality. The treatment score reads as follows:

$$T_m = \sum_{c \in C_m} \kappa_c \times \text{cost proxy}_c. \tag{2}$$

The treatment score provides a continuous measure approximating the share of households living in a municipality that potentially face substantial compliance costs from retrofitting or investments in new technology induced by the GEG amendment. Figure 3 shows the distribution of the treatment score. Averaged over all three states, the score is distributed around a median value of 0.23, suggesting that on average 23% of the households in a municipality are exposed to policy-induced costs under our approximation. We identify differences between the three states (panel B). Treatment scores are on average lower in Bavaria than in Hesse and Lower Saxony due to smaller shares of old buildings and fossil-based heating systems in Bavaria. In addition, the score tends to be higher in rural areas, whereas bigger cities like Munich or Frankfurt show small values (panel A). Lower ownership ratios and higher prevalence of district heating in cities drive these results (see Fig. 2). Finally, higher treatment score values are associated with (larger) gains for the far-right opposition party and higher losses for the federal government parties between the two elections in Hesse and Bavaria (panel C).

[23] For sparsely populated cells, building stock data is missing due to data protection regulations. We excluded all grid-cells with missing data for at least one of our conditions as the proxy is not defined meaningfully in such cases.

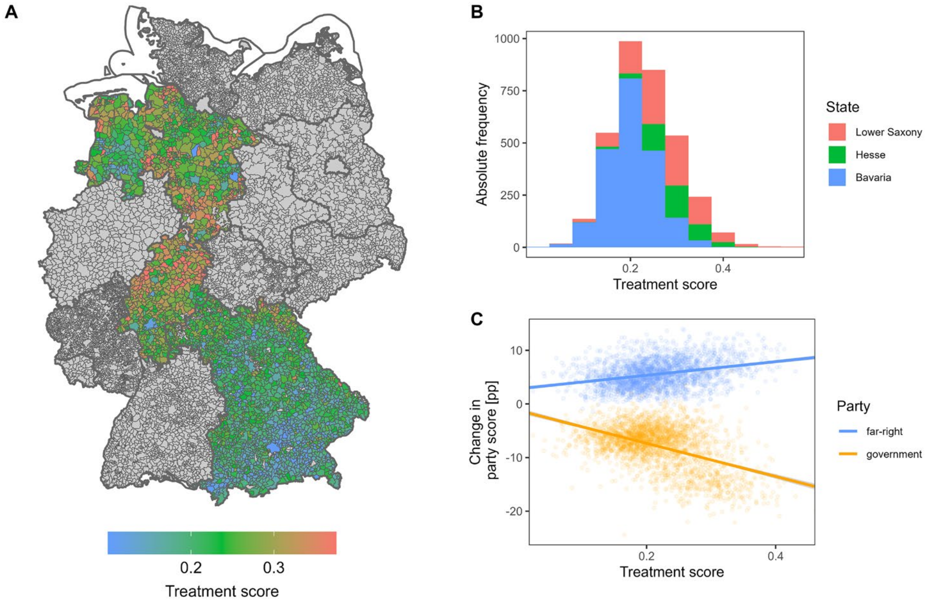


Fig. 3 Distribution of treatment score. Notes: Panel A depicts the spatial distribution and Panel B the distribution of the treatment score in Lower Saxony, Hesse and Bavaria. Panel C shows the change in the party score between the two elections in Bavaria and Hesse for the far-right and government parties by the treatment score

Figure 4 examines the distribution of the treatment score across income levels at the municipal level by plotting the average per-capita disposable income against the treatment score. We observe a slightly negative correlation but the relationship is largely heterogeneous and driven by substantial dispersion (panel A). Panel B further confirms high and relatively uniform variation in treatment scores for all income quartiles. We therefore infer that the treatment score quantifies a specific dimension of horizontal inequality linked to heterogeneity in the carbon intensity of dwellings.

In addition, the treatment score tends to be higher in regions with higher unemployment and lower municipal tax revenues as well as in rural areas characterized by higher average age, lower share of foreigners and a smaller population density (see Sect. A.3).

3.3 Econometric design and identification

For causal identification, our econometric approach must isolate the effect of the GEG amendment on state-level election outcomes. The treatment score defined above allows us to rank municipalities by the approximated share of households exposed to policy-induced compliance costs. However, several additional crises and policies during the period from 2018 to 2023, such as the energy price crisis in 2022 induced by the war in Ukraine, the land tax reform, or even the Covid-19 pandemic, may also have affected households living in dwellings with similar characteristics. To absorb these confounders and isolate the time period relevant to the GEG amendment, we compare state elections held after the Bundestag's approval of the amendment on September 8th, 2023, to state elections held in late

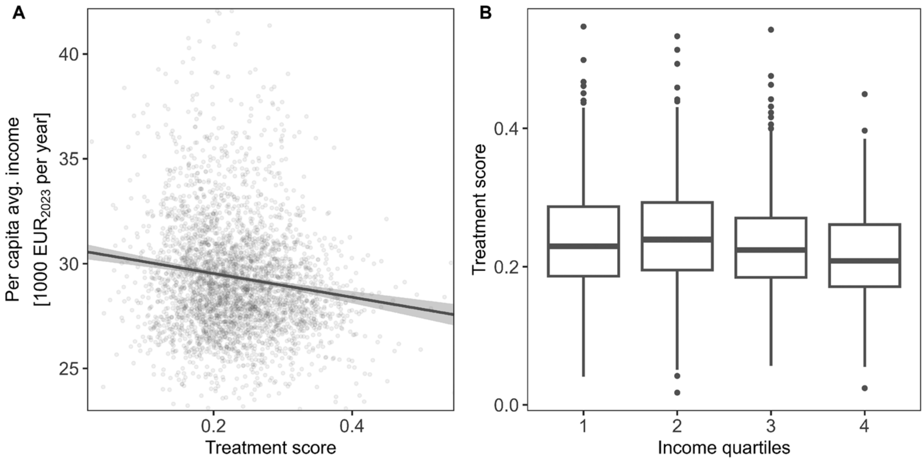


Fig. 4 Descriptive relationship of the treatment score and the income. Notes: Panel A shows the distribution of the per capita income level (2023-prices) by the treatment score. The 1st and 99th percentile yield the limits of the y-axis. The box plots of the treatment score for income quartiles explore the descriptive relationship further (panel B)

2022, after the peak of the energy price crisis. Treated states accordingly include Bavaria and Hesse where elections took place on October 8th, 2023, i.e., one month after the GEG amendment. The control group is given by Lower Saxony where the most recent state election took place in October 2022, as its electoral cycle is shifted one year earlier relative to Bavaria and Hesse. We argue that the GEG amendment and its public debate were the primary event particularly affecting owner-occupiers in older, inefficient, and fossil-heated dwellings between the Lower Saxony election and the elections in Bavaria and Hesse. Since the draft of the GEG amendment leaked unexpectedly, citizens are unlikely to have anticipated the policy reform at the time of the Lower Saxony elections.

We omit election data of five other states that held elections in 2022 and 2023. The state election in Bremen (May 2023) is excluded because the legislative process surrounding the GEG amendment was still ongoing at the time of the election, leaving its outcome uncertain. This contrasts with the aim of the analysis to estimate the electoral impact of the costs induced by the GEG amendment. In addition, we exclude Berlin (February 2023) and Bremen because both are city-states comprising one and two municipalities, respectively. As this coincides with our unit of analysis, it precludes meaningful cross-municipal variation in the treatment. Finally, elections in Saarland, Schleswig-Holstein, and North Rhine-Westphalia, all held in spring 2022, are omitted because they preceded the peak of the energy price crisis. Including them would confound identification, as household exposure to energy price shocks is correlated with exposure to GEG compliance costs.

In what follows, we employ a series of difference-in-differences approaches. We present three models to progressively isolate treatment effects, culminating in a triple difference model, which serves as our preferred specification.

We begin with a two-way fixed effects model using all municipalities in Bavaria and Hesse:

$$E_{m,y} = \alpha_m + \beta_y + \gamma_0 T_m \times post_y + \delta X_{m,y} + \varepsilon_{m,y}. \tag{3}$$

Equation 3 regresses the party share $E_{m,y}$ for municipality m and year y on the interaction of the treatment score T_m and a dummy variable $post_y$ indicating the second election following the GEG amendment, i.e.,

$$post_y = \begin{cases} 1, & \text{if } y = 2023 \\ 0, & \text{otherwise.} \end{cases} \tag{4}$$

Given the continuous treatment design, γ_0 generally captures the additional absolute increase in a party's vote share in municipalities with a treatment score T_m of one, relative to municipalities in Bavaria and Hesse with a score of zero. Municipality fixed effects α_m and year fixed effects β_y absorb time-invariant confounders and common time trends in voting behavior, respectively. Additional municipal-level control variables $X_{m,y}$, including per capita income, unemployment rate, per capita tax revenues, share of non-German residents, average age and population density, account for time-varying confounding factors.

To better account for correlated policy and price shocks, we extend this *naive DD* approach by adding all municipalities in Lower Saxony as a control group, resulting in the following *base DD* specification:

$$E_{m,y} = \alpha_m + \beta_y + \gamma_0 T_m \times post_y \times treated\_state_s + \delta X_{m,y} + \varepsilon_{m,y}, \tag{5}$$

where γ_0 is the coefficient of interest and dummy variables $post_y$ and $treated\_state_s$ indicate treated time periods and states, where

$$post_y = \begin{cases} 1, & \text{if } y \in \{2022, 2023\} \\ 0, & \text{otherwise} \end{cases} \tag{6}$$

and

$$treated\_state_s = \begin{cases} 1, & \text{if } s \in \{\text{Bavaria, Hesse}\} \\ 0, & \text{otherwise.} \end{cases} \tag{7}$$

All remaining variables are defined as above.

Our preferred specification is a triple difference (*DDD*) regression model. It explicitly accounts for variation in electoral support arising from heterogeneity across treated and untreated states, across time, and across the continuous treatment score, as well as their interactions. For example, the interaction of the treated state-dummy and the post-treatment dummy captures changes in electoral support between the 2022 elections in Lower Saxony and the 2023 elections in Hesse and Bavaria. The *DDD* regression equation is given by:

$$\begin{aligned} E_{m,y} = {} & \alpha_m + \gamma_0 T_m \times post_y \times treated\_state_s \\ & + \gamma_1 T_m \times post_y + \gamma_2 post_y \times treated\_state_s + \gamma_3 T_m \times treated\_state_s \\ & + \gamma_4 T_m + \gamma_5 post_y + \gamma_6 treated\_state_s + \delta X_{m,y} + \varepsilon_{m,y} \end{aligned} \tag{8}$$

where γ_0 is the coefficient of interest indicating the additional increase in vote shares in Bavarian and Hessian municipalities with a treatment score of one, relative to municipalities with a score of zero. Standard errors are clustered at the municipality level in all three specifications.

We follow common practice in the literature (Otteni and Weisskircher 2022; Colantone et al. 2023) and present treatment effects only for a selected set of parties that are most relevant in our study context. Those parties include the two major opposition parties which are the far-right and conservative party and the incumbent federal government parties that are responsible for the policy change. The federal government was formed by a three-party coalition at that time consisting of the social democratic, green and liberal party. To estimate the treatment effect on this coalition, we aggregate the individual party shares[24].

To assess the robustness of our preferred DDD model, we demonstrate that our results hold under two alternative specifications. First, we augment Eq. (8) with state-year fixed effects. While this accounts for state-specific party trends, it may absorb some of the variation in the treatment effect we aim to identify. Secondly, we test the robustness of our treatment definition by varying the construction of the treatment score. Further details on these robustness analyses are provided in Sect. A.6.

4 Results

4.1 Main results

Figure 5 presents the regression results for the naive DD (Eq. 3), the base DD (Eq. 5) and the DDD (Eq. 8) models. The colors differentiate between parties. The values shown on the y-axis indicate the coefficient of interest γ_0 observed for the respective party. Given the continuous treatment design in all three models, the coefficients can be interpreted as the absolute change in a party's vote share if the entire population of a municipality m were economically affected by the GEG amendment (i.e., $T_m = 1$), relative to no economic effect (i.e., $T_m = 0$). Full regression results are provided in Sect. A.5.

The results are broadly consistent across all three model specifications. We find statistically significant positive effects of the GEG amendment for the vote share of both opposition parties. Under full treatment, the conservative party gains between 30 pp and 35 pp, while the far-right party gains between 11 pp and 12 pp. For the governing parties, we observe significant negative effects ranging from −23 pp to −13 pp. The DDD specification yields more conservative estimates for each party relative to the DD models. It is our preferred specification because it more effectively isolates the impact of the GEG amendment from other factors, such as underlying differences in electoral support across areas with varying building structure over time, which are absorbed through the interaction of the treatment score with the post-treatment dummy.

Figure A.3 in Sect. A.4 shows the effect on all parties competing in the state elections[25]. The impact on the social democrats accounts for a substantial share of the overall effect on the governing coalition. The losses for the liberals, however, are more pronounced in the

[24] Party names: *Union, formed by CDU and CSU* (conservative); *Alternative für Deutschland, AfD* (far-right); the government formed by *Bündnis 90/Die Grünen* (green); *Sozialdemokratische Partei Deutschlands, SPD* (social democrats); *Freie Demokratische Partei, FDP* (liberal).

[25] The coefficients of all parties sum up to zero as discussed in Sect. A.4.

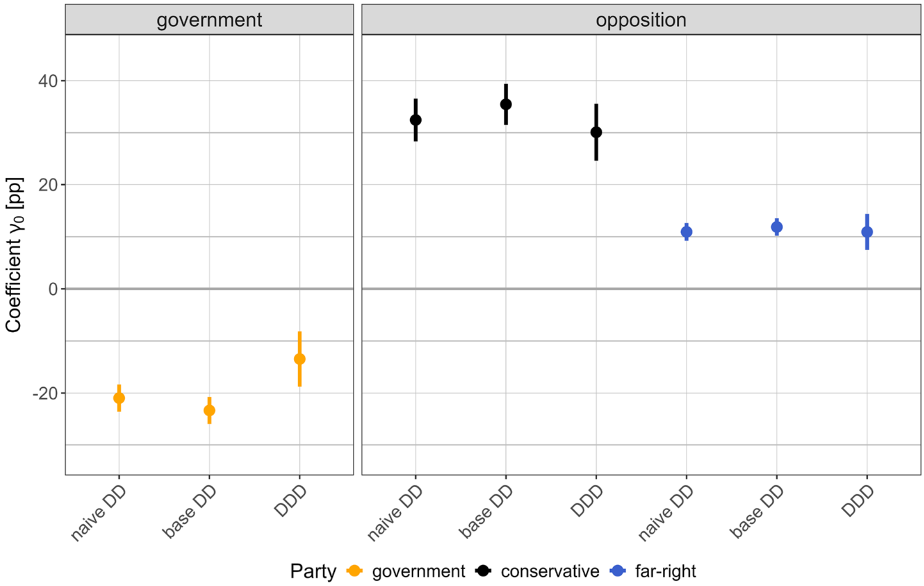


Fig. 5 Results of the three model specifications. Notes: the figure shows the coefficient of interest with the corresponding 95% confidence interval as error bars. Colors correspond to parties. The coefficients depicted in orange show the joint effect for the three parties that formed the federal government. The underlying model specifications are shown on the x-axis. Detailed regression results are provided in Sect. A.5. Separate effects for all parties are shown in Sect. A.4

preferred DDD specification. By contrast, we do not find a significant effect on the green's vote share in the DDD analysis, a finding we explain in Sect. 5[26].

To help build some intuition for the magnitude of the amendment's electoral effect at the municipal level, we approximate average treatment effects by multiplying the party-specific triple-difference coefficients (Fig. 5) with the arithmetic mean of the treatment score across all municipalities in Bavaria and Hesse ($\bar{T}_m = 0.22$). The results suggest that the conservative party has gained about 6.5 pp and the far-right party about 2.4 pp, respectively. Conversely, the government parties lost about 2.9 pp following the amendment of the GEG. Because the treatment score only approximates the municipal-level share of households financially exposed to the GEG amendment, rather than the actual costs borne by individual households, this exercise is intended to provide intuition rather than precise local electoral estimates.

4.2 Robustness checks

The validity of our empirical strategy hinges on the parallel trends assumption. Given the low-frequency nature of voting data, directly testing for pre-treatment trends is challenging. Extending the pre-treatment period requires including the 2013 elections[27], a period during

[26] We find a negative coefficient on "other parties", which can be attributed to the party "Free Voters" being part of this category. However, the party's unique characteristics (decentralized structure and regional programmatic heterogeneity) limit the explanatory power of this coefficient as discussed in Sect. A.4.

[27] Elections took place in Lower Saxony in January 2013 and in Bavaria and Hesse in September 2013.

which the state-level party landscape differed markedly from that observed in the 2018 and 2023 elections. In particular, the far-right party was founded only in 2013, subsequently underwent major programmatic shifts, and did not contest in the 2013 state elections in Bavaria and Lower Saxony. With these caveats in mind, we explore longer-term trends in electoral support for governing and opposition parties that contested in the respective elections. To facilitate visual inspection, we restrict attention to municipalities most strongly exposed to the policy, defined by an above-median treatment score or a score in the top decile. Figures A.4 and A.5 show that exposed municipalities in treated states (Bavaria and Hesse) and control states (Lower Saxony) exhibit reasonably parallel vote share trajectories in the pre-treatment period, lending support to the parallel trends assumption.

Next, to further assess the robustness of the triple difference results, we augment Eq. 8 with state-year fixed effects. This represents the most stringent specification we can estimate. As shown in Fig. A.6, the positive effects for the two opposition parties remain: for the far-right party the estimated effect magnitude is close to our preferred estimate, whereas the effect for the conservative party becomes smaller. If we again translate the coefficient estimate for the conservatives to an approximate average treatment effect, we find that the party only gains 1.5 pp rather than 6.5 pp based on the specification without state-year fixed effects. In contrast to the robust findings for the opposition parties, the estimate for the governing parties becomes statistically insignificant. The reduced magnitudes and the loss of precision may reflect important trade-offs associated with this specification. Firstly, the state-year fixed effects likely absorb part of the GEG amendment effect we aim to identify. Secondly, in such a saturated model, any measurement error in the treatment variable (e.g., arising from aggregating gridded data to municipalities), can exacerbate attenuation bias in the estimated coefficients. We therefore interpret this robustness check as providing lower bound estimates.

For our final robustness check, we estimate our DDD model based on several alternative specifications of the treatment score, varying both the aggregation strategy and the functional form of the cost proxy. All specifications yield findings that are qualitatively and quantitatively consistent with our preferred DDD specification—showing increased support for the conservative and far-right parties and reduced support for the governing parties (see Sect. A.6). These findings highlight the robustness of our estimates with respect to the construction of the treatment score.

4.3 Heterogeneity

Our descriptive correlation analysis of the treatment score in Sect. 3.2 did not reveal a clear relationship between lower income levels and higher treatment scores, i.e., a greater degree of economic exposure to the GEG amendment. However, because the transition to climate-neutral residential heating may impose more severe relative financial burdens on low-income households, the electoral impact of the GEG amendment in areas with a high share of less affluent households may be larger. This motivates our heterogeneity analysis. We use six municipal-level, socio-economic variables introduced in Sect. 3.1 to split our municipality sample at the state-specific median values, creating two subsets for each variable. We then estimate the treatment effects for the governing, conservative, and far-right parties using our *DDD* model. Figure 6 presents the resulting estimates.

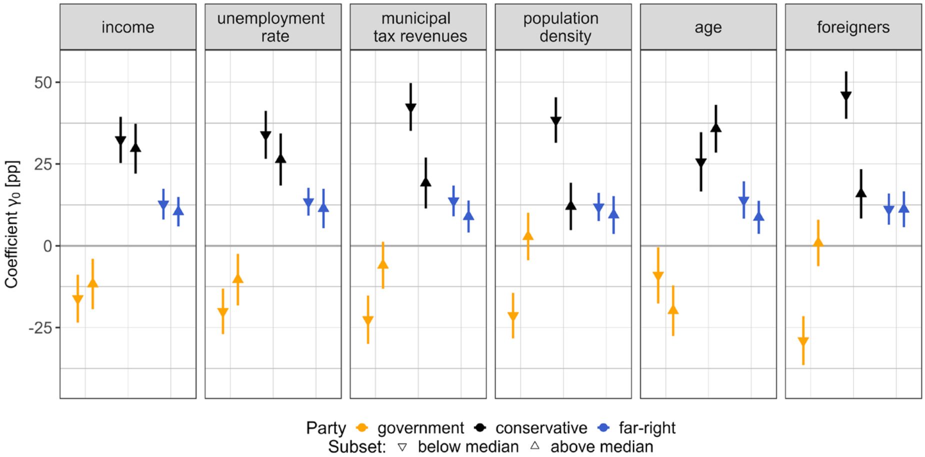


Fig. 6 Heterogeneity and treatment effects. Notes: treatment effect sizes are shown with their corresponding 95% confidence interval as error bars around the average effect. Arrow marker symbolize below- and above-median subgroups. Detailed regression results for selected models are provided in Sect. A.7

We do not find significant differences in effects between municipalities above and below the median for income or unemployment for any of the three parties. However, we observe a stronger effect for the conservative party and a larger decrease in support for the governing parties in less affluent municipalities, as measured by municipal tax revenues. This suggests that heterogeneity is driven more by differences in the regional economic strength than by household-level economic well-being.

In rural municipalities with lower population density and smaller shares of non-German residents, the effects for the conservative party are significantly larger than in more urban municipalities with higher population densities and larger shares of foreign-born populations. Similarly, the negative effects for the government parties are more pronounced for rural municipalities. Overall, we do not find any significant differences in the effects for the far-right party across any of the subset analyses.

5 Discussion and policy implications

This study aims at investigating the impact of the financial costs implied by the GEG amendment on the state elections in Bavaria and Hesse. To this end, we construct a proxy for the policy's aggregate financial burden at the municipal level and examine its impact on voting behavior using continuous difference-in-differences and triple difference approaches. The baseline results indicate that higher expected costs from the GEG amendment led to increased vote shares for opposition parties—the conservative and the far-right party—while the governing parties experienced losses.

Our findings are broadly consistent with prior research on the political economy of climate and energy policies, which documents electoral punishment of the parties responsible for a costly policy change and corresponding losses for the opposition parties (Stokes 2016; Otteni and Weisskircher 2022; Colantone et al. 2023; Voeten 2024). Also the correlation of voters' reaction intensity and the degree to which households are exposed to a climate policy—here measured by the treatment score—mirrors findings in the literature, e.g., households living nearer to wind energy projects voted more strongly for opposition parties subsequently (Stokes 2016).

Turning to distributional patterns, we do not find significant differences in treatment effects between municipalities with lower and higher average income. The absence of income-related treatment effect heterogeneity aligns with the weak correlation between municipal average household income and our treatment score (see Sect. 3.2). This suggests that the distributional implications of the policy along the income dimension are ambiguous. On the one hand, higher-income households are more likely owner-occupiers living in larger dwellings, whereas lower-income households tend to be tenants who may be less directly affected by the GEG amendment in the short run. This would point toward progressivity of the GEG amendment. On the other hand, the high up-front investment costs associated with heating systems or insulation may disproportionately burden low-income owner-occupiers facing tighter financial constraints, such as limited access to credit or higher risk premia. These constraints would introduce regressive effects that cannot be observed within our empirical setting at the municipality level.

The subsidy scheme targeting heat pumps may also shape the distributional effects of the policy, and, in turn, its electoral support. However, as discussed above, the specific design of these subsidies remained unclear until three months after the GEG amendment was enacted. In addition, subsidy programs for retrofit measures beyond the heating system itself, such as building insulation, were not revised during the legislative process of the GEG amendment but had been in place throughout the entire study period. We therefore argue that subsidy-related considerations are unlikely to have played a major role in shaping the observed electoral outcomes.

However, we find substantial differences in electoral reactions between rural and urban municipalities. These results may reflect differences in compliance costs between rural and urban areas which go beyond the GEG amendment exposure captured by our treatment score. Plausible explanations include that many households in rural areas occupy (semi-) detached houses with more living space per capita, implying also higher investment costs whereas economies of scale in multi-party buildings might cushion investment costs. In addition, the urban-rural divide might also reflect behavioral anomalies, as populations in rural areas tend hold less progressive attitudes (Luca et al. 2023), potentially amplifying disutility arising from status-quo bias (Blasch and Daminato 2020).

Public support for climate policies often arises from a complex interplay of socioeconomic conditions, political dynamics, and prevailing narratives (Bosetti et al. 2025), and the policy environment surrounding the GEG amendment is no exception. The government's decision to accelerate the amendment of the GEG was itself a response to the energy price crisis and the heightened awareness of Germany's dependence on Russian fossil fuels following the invasion of Ukraine. The energy price crisis affected households with similar profiles to those targeted by the GEG amendment and together these developments likely shaped broader political attitudes. Consequently, they may also have influenced voting behavior in Lower Saxony in 2022, which serves as our control group. We argue that our triple difference approach controls for the confounding effect and isolates the effect of the GEG amendment. At the same time, we regard our estimated effects as conservative: voters most exposed to the GEG amendment were also likely burdened by the 2022 energy price surge and may have already adjusted their electoral preferences in the 2022 election. In line with this hypothesis, the interaction term between the treatment score and the indicator for the second election, 2022 in Lower Saxony and 2023 in Bavaria and Hesse, in our triple difference model shows a significant negative coefficient (−10 pp) for the governing parties and a positive one (+5.7 pp) for the conservative party, but no significant effect on the far-right party (see Table A.2).

Disentangling the reduced support for the governing parties, our analysis does not reveal negative effects on the vote share of the green party (see Sect. A.4). This may be explained with the alignment of the GEG amendment aims—accelerating the decarbonization of residential heating—with the environmental priorities of green party voters. Otrachshenko and Popova (2026) highlight that the translation of green preferences into green voting depends critically on households' economic security. It is difficult to assess the prevalence of such green preferences among green party voters in our setting. However, because our triple difference approach isolates the impact of the GEG amendment from the energy price crisis in 2022, the relevant group of green party voters in our control group may have consisted primarily of those who remained economically secure throughout the crisis. In Sect. A.8, we provide suggestive evidence consistent with this mechanism: Despite the party's generally strong performance in 2022, the greens lost vote share in Lower Saxon municipalities with high treatment scores.

Another important consideration concerns the different channels through which the GEG amendment may have affected electoral outcomes. Our analysis focuses on the economic implications of the GEG amendment at the municipal level, with the treatment score approximating the share of households that may be directly affected financially. However, the intense and polarized public debate following the leak of the draft likely generated additional effects beyond the direct economic channel we focus on. Political turbulence within the government and unbalanced media coverage—also highlighting extreme and unrepresentative cases of potential compliance costs—amplified concerns among large parts of the population, even though most households were unlikely to face costs anywhere near those featured[28]. This imbalance may have inflated perceived personal exposure relative to actual financial burdens, potentially influencing voting behavior beyond the purely economic effect captured by our treatment score. Furthermore, the overall intensity of the public debate may have shifted electoral preferences more broadly across the electorate, independent of households' individual exposure to the GEG amendment. Such general shifts are not measured in our analysis and would be absorbed in the fixed effects by our econometric design.

Our findings, together with previous research, suggest that public acceptance for ambitious climate policies in the building sector, and beyond, would benefit from addressing heterogeneous individual burdens, which do not necessarily correlate with the vertical income dimension. In particular, our results suggest that the horizontal dimension of carbon-intensity heterogeneity can play a crucial role in shaping electoral support. This implies that holistic policy approaches explicitly accounting for such heterogeneity may achieve higher levels of public support. Recent studies by Kalkuhl et al. (2024) and Schlattmann (2024) indicate that carefully designed policy mixes can maximize welfare and stimulate public support in the context of the urban-rural divide and building-stock heterogeneity, respectively. Further research on how policy design can accommodate spatial and structural differences represents a promising avenue for fostering broader public acceptance of climate policies.

[28] A phenomenon that has been observed in the past, as for example in Douenne and Fabre (2022).

Appendix

A.1 Trends in party preferences

With the formation of the federal government coalition in late 2021, the political landscape in Germany underwent significant changes. The political support started to decline for all three governing parties at some point within the first eight months of 2022, while the far-right party, and to a lesser extent the conservatives, saw an increase in their support (see Fig. A.1). Several societal and political factors may have contributed to this development. One possible factor is the energy price crisis in 2022, and another one the GEG amendment and the accompanying political and public discourse as outlined above. In Fig. A.1, Google search requests indicate that the interest in search items related to on-site residential heating provision (”gas heating” and “costs heat pump”) correlate with the course of voters’ prefer-

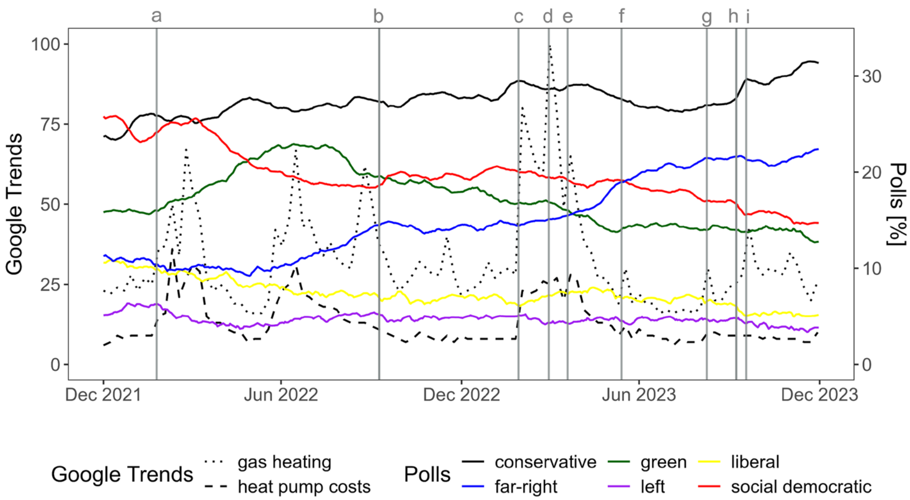


Fig. A.1 Stated party preferences and GEG relevant Google search requests over time. Notes: the figure shows stated preferences for the most relevant German parties (colors, right scale) and normalized Google trends search requests (line types, left scale) between Jan 2022 and Dec 2023. Letters indicate selected events: (**a**) Russia’s invasion of Ukraine, (**b**) state election in Lower Saxony, (**c**) public leak of draft to media, (**d**) agreement by government, (**e**) draft by cabinet, (**f**) complementary paper, (**g**) bundestag passes amendment, (**h**) state elections in Bavaria and Hesse, and (**i**) media reporting on disagreement about subsidies. The original search terms are “gasheizung” (gas heating) and “wärmepumpe kosten” (heat pump costs). (Sources: Google trends, poll of polls) ences. In particular, during the peak of the energy price crisis (late summer/autumn 2022) or the leak of the first draft, interest in these search items was comparably high and at the same time stated public support for the far-right party increased. This observation suggests that the context of the GEG amendment presents an interesting case study for analyzing how climate policy influences voting behavior and electoral support.

A.2 Overview on legislative process

Table A.1 Overview on legislative process

Feb 28, 2023	Leak of draft to media	Newspaper headlines about banning oil and gas heating systems in 2024
Mar 07, 2023	Publication of ministry draft	Prospect of longer transition periods bound to commitment to district heating
Mar 31, 2023	Political agreement between government parties	Emphasizing the freedom of choice in choosing heating system (like hydrogen-ready gas heating systems), exception rules for homeowners older than 80 years
Apr 19, 2023	Cabinet resolution	Formal agreement on above mentioned points
Jun 13, 2023	Complementary paper	Linkage to municipal heat planning, classification of biomass as carbon neutral energy source, announcement of subsidy program
Jun 15, 2023	Start of parliamentary debate	Government push for final reading and resolution on Jul 07
Jul 05, 2023	Decision by the Federal Constitutional Court	Prohibition of final reading prior to summer break due to short consulting time for MP
Sep 08, 2023	Bundestag passes amendment to the GEG	Inclusion of complementary paper into final law, longer transition periods, allowing temporary installation of fossil-based boilers for five years instead of exemptions for aged homeowners, exception rules for hydrogen-ready gas heating systems
Dec 29, 2023	Revision of subsidy scheme for low-carbon heating systems	The scheme includes a basic ad-valorem subsidy rate of 30%, additional 20 pp for soon adoption which fades out over time, additional 30 pp for low-income households, and additional 5 pp if specific heat pump technologies are chosen, i.e., geothermal/groundwater heat pumps or heat pumps which use a natural refrigerant. The total ad-valorem subsidy rate is capped at 70% and total investment costs of up to 30,000 EUR are being subsidized. The subsidy scheme for accompanying retrofit measures as described in Sect. 2.2 were not revised (i.e., credit programs with reduced interest payment when reaching a specific energy efficiency target).

A.3 Descriptive analysis of the treatment score

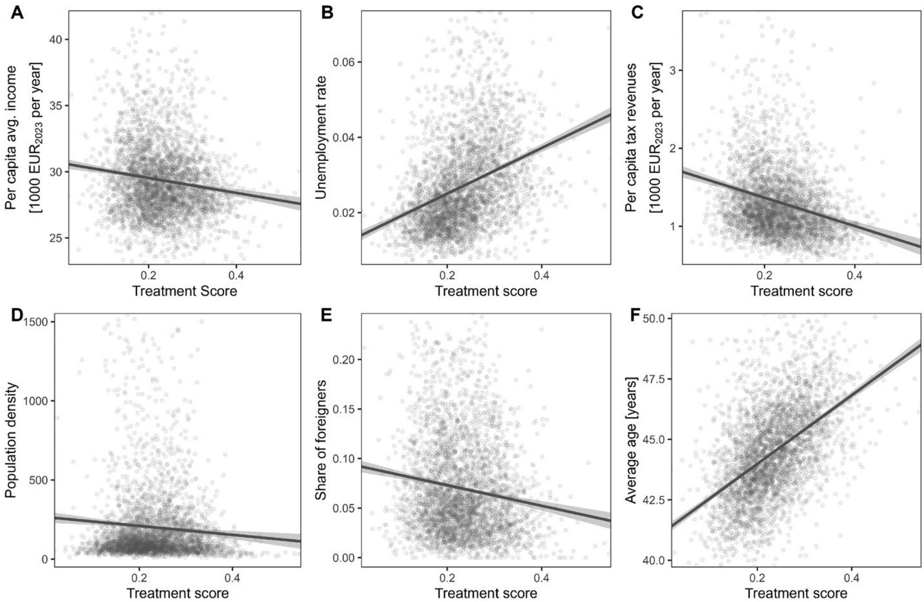


Fig. A.2 Descriptive exploration of the control variables and the treatment score. Note: the 1st and 99th percentile were chosen as the limits of the y-axis to assure comparability of the dispersion of the control variables

A.4 Baseline regression results for all parties

Figure A.3 reports the effects for all parties competing in the state elections in Bavaria, Hesse, and Lower Saxony. Due to the compositional nature of vote shares, the estimated coefficients sum to zero across all parties, up to minor imprecision of -0.0009. The large negative coefficient for the group of "other parties" reflects heterogeneity in party systems across federal states and is primarily driven by differences in the electoral relevance of the Free Voters. In Bavaria, the Free Voters received 11.6% in the 2018 election and 15.8% in 2023, compared to 3.0% (2018) and 3.5% (2023) in Hesse and 0.4% (2017) and 0.8% (2022) in Lower Saxony. Furthermore, the party's structure is characterized by a strong role of local citizen associations and programmatic heterogeneity within but also between states which lead to positions that may not necessarily be aligned with the umbrella organization at the state or federal level. These disparities may limit the informative value for an analysis of party-level treatment across states for the Free Voters.

We discuss the statistically insignificant effect for the Green Party in Sects. 5 and A.8.

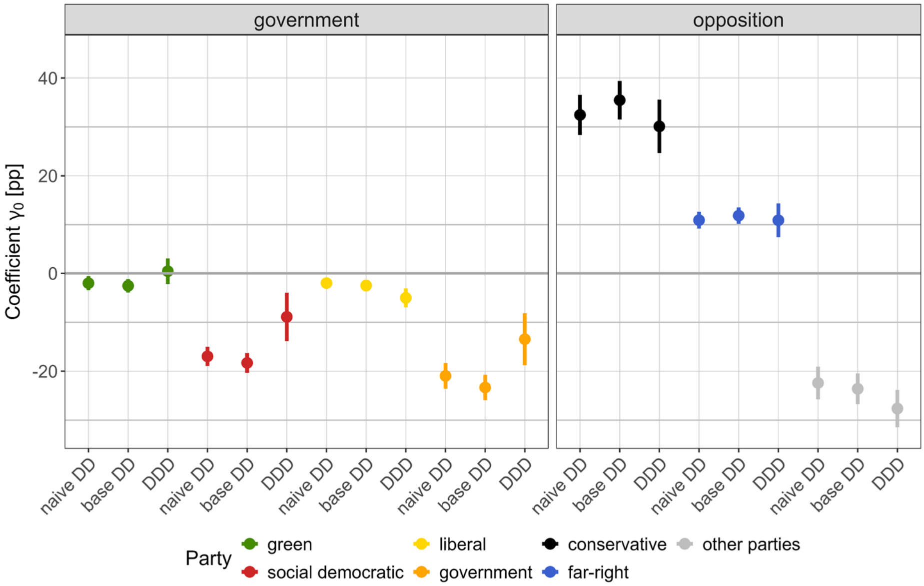


Fig. A.3 Results for all parties competing in the state elections. Note: the figure visualizes the treatment coefficient with the corresponding 95% confidence interval as error bars. Colors differentiate between parties. The coefficients shown in orange represent the joint effect for the three parties forming the federal government (here in colors green, red, and yellow), while the coefficients shown in gray represent the joint effect for all remaining parties participating in the state elections, primarily the free voters and the left party. The model specifications corresponding to each estimate are indicated on the x-axis

A.5 Detailed baseline regression results

Table A.2 Detailed regression results for regression specifications in Fig. 5 and A.3

Dependent Variables:	spd			greens			fdp			governmental_parties		
Model:	naive DD (1)	base DD (2)	DDD (3)	naive DD (4)	base DD (5)	DDD (6)	naive DD (7)	base DD (8)	DDD (9)	naive DD (10)	base DD (11)	DDD (12)
Variables												
unemployment_rate	-0.1387	-0.0221	-0.0276	-0.0049	0.0190	0.0173	0.1176**	0.0099	0.0114	-0.0260	0.0068	0.0011
	(0.1056)	(0.0721)	(0.0719)	(0.0684)	(0.0510)	(0.0503)	(0.0492)	(0.0361)	(0.0356)	(0.1456)	(0.0855)	(0.0851)
nongerman_rate	-0.3111***	-0.2218***	-0.2139***	-0.0734***	-0.0650***	-0.0625***	-0.0687***	-0.0301***	-0.0322***	-0.4531***	-0.3169***	-0.3087***
	(0.0231)	(0.0232)	(0.0231)	(0.0160)	(0.0151)	(0.0150)	(0.0113)	(0.0111)	(0.0110)	(0.0343)	(0.0299)	(0.0299)
population_density	0.1940***	0.1767***	0.1567***	0.0507***	0.0326***	0.0262**	0.0232***	0.0163*	0.0216**	0.2679***	0.2255***	0.2046***
	(0.0177)	(0.0194)	(0.0193)	(0.0130)	(0.0121)	(0.0123)	(0.0082)	(0.0092)	(0.0090)	(0.0245)	(0.0248)	(0.0250)
income	-0.0324	-0.0277	-0.0379	0.0306*	-0.0198	-0.0231	0.0641***	0.0276**	0.0304***	0.0622*	-0.0199	-0.0306
	(0.0244)	(0.0241)	(0.0249)	(0.0184)	(0.0163)	(0.0165)	(0.0126)	(0.0117)	(0.0113)	(0.0328)	(0.0349)	(0.0360)
tax_revenues	-0.0056**	0.0059**	0.0054*	-0.0037**	-0.0040**	-0.0042***	-0.0009	-0.0013	-0.0012	-0.0102***	0.0006	2.81×10^{-5}
	(0.0024)	(0.0028)	(0.0028)	(0.0019)	(0.0016)	(0.0016)	(0.0014)	(0.0014)	(0.0014)	(0.0033)	(0.0032)	(0.0032)
average_age	0.0028***	0.0042***	0.0033***	0.0009	0.0004	0.0001	-0.0007*	-0.0006	-0.0004	0.0029**	0.0039***	0.0030***
	(0.0009)	(0.0010)	(0.0010)	(0.0007)	(0.0006)	(0.0006)	(0.0004)	(0.0004)	(0.0004)	(0.0011)	(0.0012)	(0.0012)
weighted_mean_prod_vars × post_dummy	-0.1697***		-0.0993***	-0.0201***		-0.0314***	-0.0199***		0.0266***	-0.2097***		-0.1042***
	(0.0100)		(0.0236)	(0.0073)		(0.0120)	(0.0045)		(0.0088)	(0.0134)		(0.0244)
weighted_mean_prod_vars × post_dummy × treated_state		-0.1831***	-0.0889***		-0.0254***	0.0044		-0.0249***	-0.0501***		-0.2334***	-0.1346***
		(0.0103)	(0.0252)		(0.0071)	(0.0134)		(0.0047)	(0.0098)		(0.0132)	(0.0271)

Table A.2 (continued)

Dependent Variables:	spd			greens			fdp			governmental_parties		
Model:	naive DD (1)	base DD (2)	DDD (3)	naive DD (4)	base DD (5)	DDD (6)	naive DD (7)	base DD (8)	DDD (9)	naive DD (10)	base DD (11)	DDD (12)
post_dummy			-0.0041			0.0478***			-0.0327***			0.0110
			(0.0068)			(0.0036)			(0.0025)			(0.0070)
post_dummy × treated_state			0.0236***			-0.0787***			0.0175***			-0.0377***
			(0.0067)			(0.0036)			(0.0026)			(0.0072)
Fixed-effects												
ags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Fit statistics												
Observations	4,954	6,828	6,828	4,954	6,828	6,828	4,954	6,828	6,828	4,954	6,828	6,828
R^2	0.96103	0.98548	0.98569	0.97075	0.96400	0.96412	0.90835	0.91213	0.91256	0.97445	0.98406	0.98423
Within R^2	0.33179	0.17764	0.46296	0.03139	0.01868	0.79182	0.05170	0.02142	0.68608	0.31506	0.19666	0.78299

Table A.2 (continued)

Dependent Variables:		afd			union			other_parties	
Model:	naive DD(13)	base DD(14)	DDD(15)	naive DD(16)	base DD(17)	DDD(18)	naive DD(19)	base DD (20)	DDD (21)
Variables									
unemployment_rate	-0.0399	-0.1744***	-0.1739***	0.0721	0.2528***	0.2559***	-0.0063	-0.0852	-0.0832
	(0.1094)	(0.0572)	(0.0571)	(0.2169)	(0.0963)	(0.0968)	(0.1815)	(0.0732)	(0.0731)
nongerman_rate	0.1034***	0.0752***	0.0744***	0.5917***	0.4029***	0.3985***	-0.2420***	-0.1612***	-0.1642***
	(0.0208)	(0.0203)	(0.0203)	(0.0588)	(0.0431)	(0.0432)	(0.0425)	(0.0315)	(0.0318)
population_density	-0.0387**	0.0044	0.0065	-0.3568***	-0.3580***	-0.3466***	0.1277***	0.1280***	0.1356***
	(0.0159)	(0.0149)	(0.0153)	(0.0422)	(0.0337)	(0.0338)	(0.0335)	(0.0227)	(0.0232)
income	0.2690***	0.1751***	0.1762***	-0.8296***	-0.3290***	-0.3232***	0.4984***	0.1737***	0.1776***
	(0.0246)	(0.0245)	(0.0244)	(0.0553)	(0.0591)	(0.0596)	(0.0475)	(0.0318)	(0.0315)
tax_revenues	0.0002	-0.0008	-0.0008	0.0032	-0.0042	-0.0038	0.0068	0.0044	0.0046
	(0.0026)	(0.0023)	(0.0023)	(0.0060)	(0.0046)	(0.0045)	(0.0048)	(0.0035)	(0.0035)
average_age	-0.0022***	-0.0020**	-0.0019**	-0.0021	-0.0032**	-0.0027*	0.0014	0.0012	0.0015
	(0.0008)	(0.0008)	(0.0008)	(0.0019)	(0.0014)	(0.0014)	(0.0016)	(0.0011)	(0.0011)
weighted_mean_prod_vars × post_dummy	0.1093***		0.0100	0.3245***		0.0565***	-0.2242***		0.0377***
	(0.0087)		(0.0161)	(0.0209)		(0.0204)	(0.0170)		(0.0107)
weighted_mean_prod_vars × post_dummy × treated_state		0.1186***	0.1091***		0.3546***	0.3011***		-0.2399***	-0.2756***
		(0.0086)	(0.0176)		(0.0201)	(0.0279)		(0.0159)	(0.0180)

Table A.2 (continued)

Dependent Variables:	afd			union			other_parties		
Model:	naive DD(13)	base DD(14)	DDD(15)	naive DD(16)	base DD(17)	DDD(18)	naive DD(19)	base DD (20)	DDD (21)
post_dummy			0.0532***			-0.0588***			-0.0054
			(0.0048)			(0.0061)			(0.0036)
post_dummy × treated_state			-0.0306***			-0.0114			0.0797***
			(0.0048)			(0.0072)			(0.0045)
Fixed-effects									
ags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes		Yes	Yes		Yes	Yes	
Fit statistics									
Observations	4,954	6,828	6,828	4,954	6,828	6,828	4,954	6,828	6,828
R^2	0.94857	0.94619	0.94620	0.85810	0.91235	0.91249	0.91296	0.95317	0.95322
Within R^2	0.16124	0.10557	0.84462	0.31465	0.24448	0.43314	0.16981	0.13439	0.38146

Clustered (ags) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Note: The table lists regression results for different model specifications. For each variation in the dependent variable (party score), the table lists the regression results for all three applied econometric approaches, i.e., the naive (Eq. 3), the base difference-in-differences (Eq. 5), and the triple differences (8)

A.6 Robustness analyses

Exploration of pre-trends

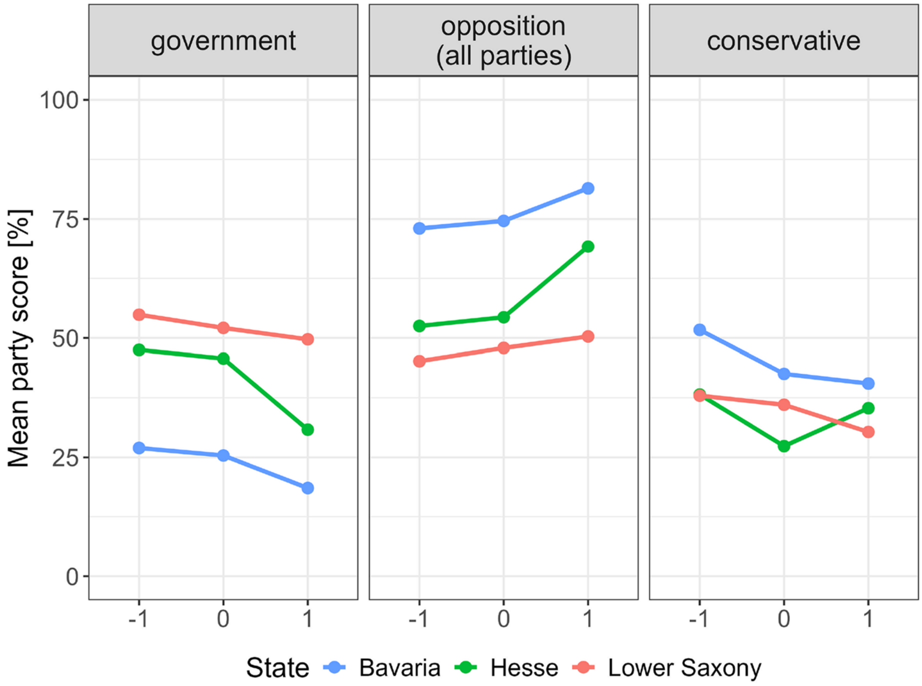


Fig. A.4 Trends in average vote shares in 50% most affected municipalities

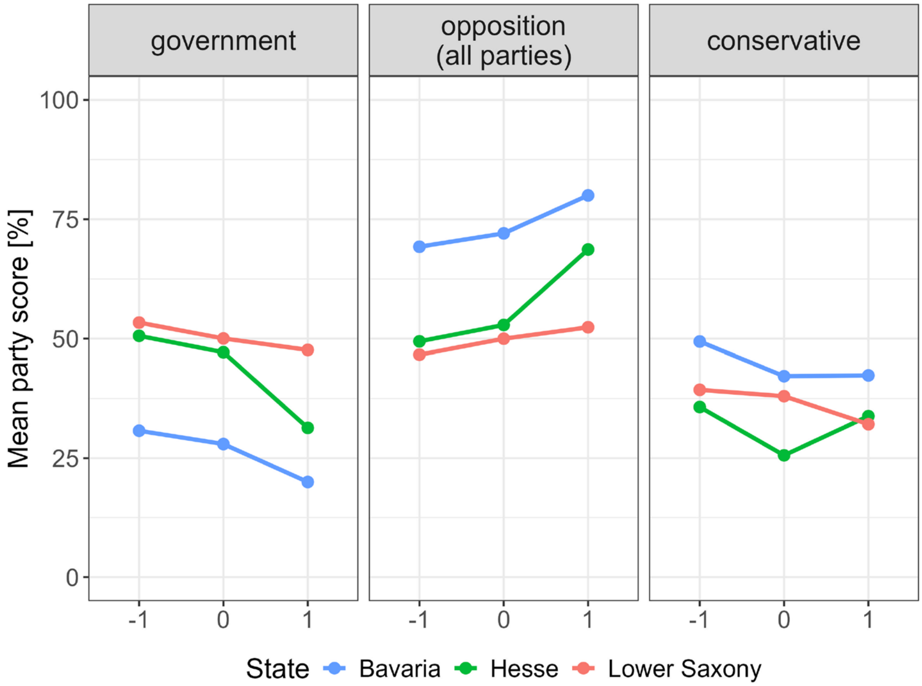


Fig. A.5 Trends in average vote shares in 10% most affected municipalities. Note: Figs. A.4 and A.5 depict the state-specific trends in the average vote share for municipalities with a treatment score T_m above the respective state-wide median (Fig. A.4) or within the top 10% of the state-respective distribution (Fig. A.5). In each figure, the three panels show the party scores for the government parties, all other (opposition) parties, and additionally the shares for the conservative party for all three states respectively. The x-axis presents the election year by referring to before (−1) and after (1) the starting year of our empirical analysis. Note that election years vary by state (−1: 2013, 0: 2017/2018, 1: 2022/2023)

Accounting for state-specific trends

To analyze sensitivity of our results to potential state-specific differences in party trends in Bavaria and Hesse, we added state-year fixed effects $\zeta_{s,y}$ to the triple difference model (see Eq. 8). Note that the latter already captures different time trends between the non-treated state Lower Saxony and the treated states Bavaria and Hesse by the coefficient γ_2. The resulting regression equation reads as follows:

$$\begin{aligned} E_{m,y} = {} & \alpha_m + \gamma_0 T_m \times post_y \times treated\_state_s \\ & + \gamma_1 T_m \times post_y + \gamma_2 post_y \times treated\_state_s + \gamma_3 T_m \times treated\_state_s \\ & + \gamma_4 T_m + \gamma_5 post_y + \gamma_6 treated\_state_s + \delta X_{m,y} + \zeta_{s,y} + \varepsilon_{m,y}. \end{aligned} \tag{A.1}$$

Figure A.6 provides the regression results for this model and Table A.3 gives the detailed estimates.

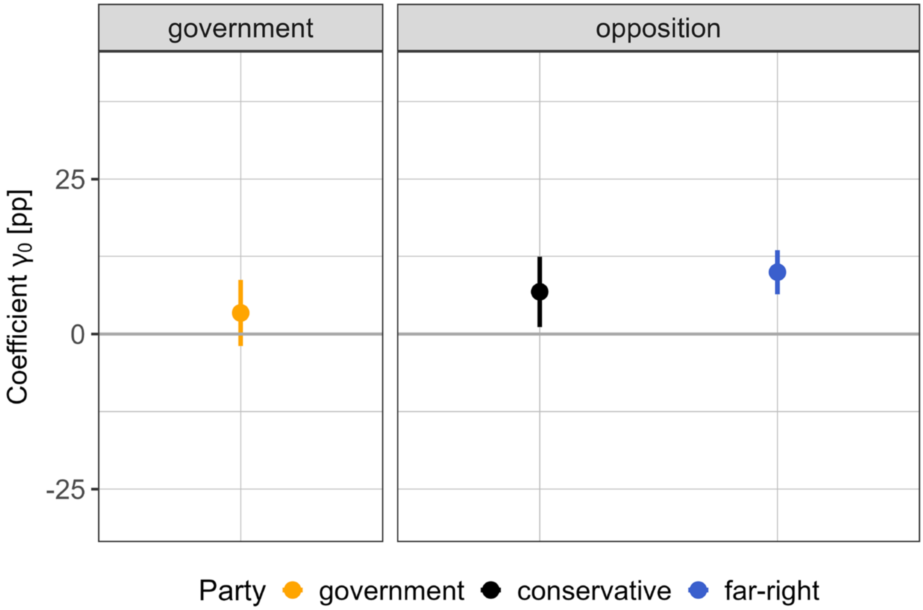


Fig. A.6 Robustness check: extension to control for state-specific trends. Notes: the figure visualizes the coefficient of interest with the corresponding 95% confidence interval as error bars. Colors differentiate between parties. The coefficients depicted in orange show the joint effect for the three parties that formed the federal government. The underlying model specifications are shown on the x-axis. The underlying equations and regression results are provided in Sect. A.6

Table A.3 Detailed regression results for regression with state-year fixed effects (Equation A1)

Dependent Variables:	governmental_parties	afd	union
	DDD		
Model:	(1)	(2)	(3)
Variables			
post_dummy	0.0128*	0.0531***	−0.0612***
	(0.0068)	(0.0048)	(0.0058)
unemployment_rate	0.0987	−0.1796***	0.1207
	(0.0789)	(0.0571)	(0.0837)
nongerman_rate	−0.0541*	0.0595***	0.0456
	(0.0285)	(0.0215)	(0.0399)
population_density	0.1037***	0.0124	−0.2069***
	(0.0239)	(0.0156)	(0.0309)
income	−0.0050	0.1747***	−0.3586***
	(0.0370)	(0.0244)	(0.0597)
tax_revenues	0.0066**	−0.0012	−0.0130***
	(0.0029)	(0.0024)	(0.0041)
average_age	0.0023**	−0.0018**	−0.0017
	(0.0011)	(0.0008)	(0.0013)
weighted_mean_prod_vars × post_dummy	−0.1136***	0.0106	0.0696***
	(0.0240)	(0.0161)	(0.0197)
post_dummy × treated_state	−0.0650***	−0.0290***	0.0265***
	(0.0071)	(0.0049)	(0.0072)
factor(year)2018 × factor(id_state)6	0.0646***	−0.0038**	−0.0896***
	(0.0021)	(0.0016)	(0.0027)
weighted_mean_prod_vars × post_dummy × treated_state	0.0338	0.0993***	0.0677**
	(0.0270)	(0.0182)	(0.0288)
Fixed-effects			
ags	Yes	Yes	Yes
Fit statistics			
Observations	6,828	6,828	6,828
R^2	0.98735	0.94628	0.92933
Within R^2	0.82589	0.84484	0.54220

Variation of the treatment score

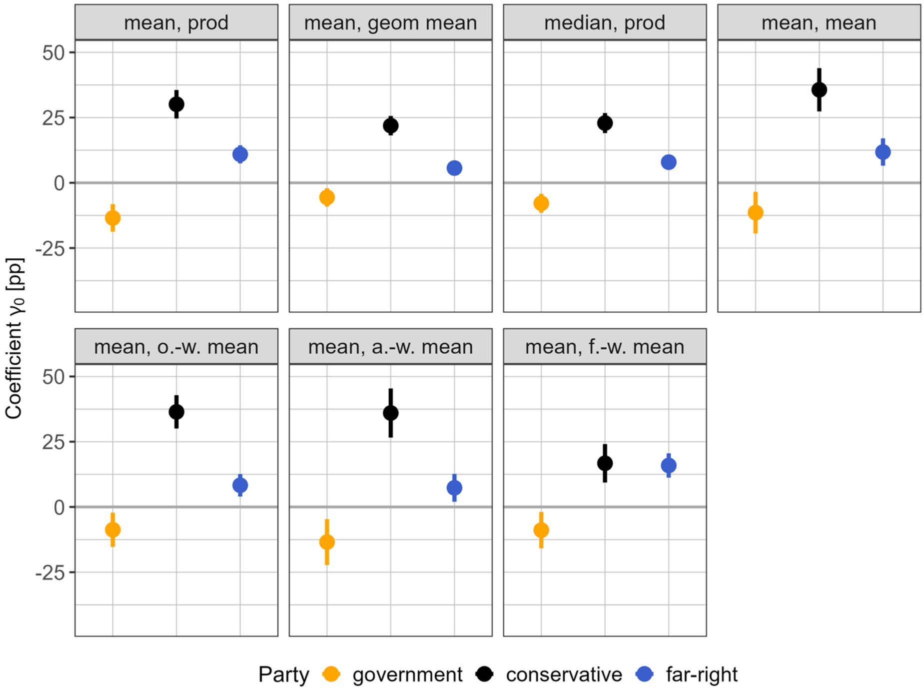


Fig. A.7 Results of the DDD regression model for different specifications of the treatment score. Note: the figure visualizes different robustness checks performed within each panel. Treatment coefficients are given with their 95% confidence interval as error bars. Colors differentiate between parties. The coefficients depicted in orange show the joint effect for the three parties that formed the federal government. All models use the triple difference model (Eq. 8). Each panel uses a different combination of the calculation of the cost proxy at the grid cell level (second part of each panel's header) and the aggregation to the municipality level (first part of each panel's header). On the one hand, the presented models apply a varied calculation of the treatment score at the municipality level T_m by using the mean (”mean,”) or the median (”median,”) to aggregate the cell-specific cost proxy compared to the mean metric in our baseline specification (Eq. 2). On the other hand, the models differentiate the product (”, prod”), the mean (”, mean”), the geometric mean (”, geom mean”), or weighted mean (”, x-w. mean”) to define the cost proxy as a function of the share of owner-occupied dwellings (*o*), the share of old dwellings (*a*) and the share of fossil-based heating systems (*f*) at the grid cell level compared to the product metric used in our baseline specification (Eq. 1). The ownership-weighted mean is defined as $(0.5{\times}s_o{+}s_a{+}s_f)/2.5$, the mean weighted with respect to old buildings is defined as $(s_o{+}0.5{\times}s_a{+}s_f)/2.5$ and similarly the fossil-based heating-weighted mean is defined as $(s_o{+}s_a{+}0.5{\times}s_f)/2.5$. All specifications use population weights to aggregate the grid cell level proxies to the municipality level

A.7 Detailed regression results for the heterogeneity analyses

Table A.4 Detailed regression results for heterogeneity analysis shown in Fig. 6

Dependent Variable:						union					
Model:	rich TRUE (1)	rich FALSE (2)	high_unemp TRUE (3)	high_unemp FALSE (4)	high_tax TRUE (5)	high_tax FALSE (6)	old TRUE (7)	old FALSE (8)	dense TRUE (9)	dense FALSE (10)	high_non-german TRUE (11)
Variables post_dummy	-0.0511***	-0.0857***	-0.0468***	-0.0714***	-0.0634***	-0.0683***	-0.0367***	-0.0791***	-0.0868***	-0.0667***	-0.0868***
	(0.0083)	(0.0082)	(0.0083)	(0.0088)	(0.0082)	(0.0088)	(0.0089)	(0.0091)	(0.0085)	(0.0082)	(0.0079)
unemployment_rate	0.1995	0.2104	0.1696	0.3933 ***	0.2260	0.2569 **	0.0473	0.7479 ***	0.1456	0.1917	0.1795
	(0.1238)	(0.1297)	(0.1883)	(0.1146)	(0.1470)	(0.1240)	(0.1030)	(0.2097)	(0.1121)	(0.1377)	(0.1258)
nongerman_rate	0.5091 ***	0.4597 ***	0.3858 ***	0.3736 ***	0.5075 ***	0.2795 ***	0.3022 ***	0.5237 ***	0.3745 ***	0.4666 ***	0.4776 ***
	(0.0569)	(0.0682)	(0.0536)	(0.0669)	(0.0570)	(0.0610)	(0.0533)	(0.0692)	(0.0544)	(0.0561)	(0.0541)
population_density	-0.3945 ***	-0.3716 ***	-0.3725 ***	-0.2909 ***	-0.4586 ***	-0.2159 ***	-0.3299 ***	-0.3537 ***	-0.3084 ***	-0.3609 ***	-0.3494 ***
	(0.0405)	(0.0467)	(0.0417)	(0.0510)	(0.0410)	(0.0455)	(0.0423)	(0.0523)	(0.0393)	(0.0413)	(0.0418)
income	-0.2802 ***	-0.0759	-0.4204 ***	-0.2462 ***	-0.3911 ***	-0.1535 **	-0.3704 ***	-0.2649 ***	-0.2708 ***	-0.0727	-0.1698 ***
	(0.0470)	(0.0644)	(0.0481)	(0.0808)	(0.0476)	(0.0688)	(0.0427)	(0.0879)	(0.0638)	(0.0584)	(0.0638)
tax_revenues	-0.0001	-0.0063	0.0024	-0.0098	-0.0067	0.0108	0.0011	-0.0086	-0.0020	-0.0013	-0.0150 ***
	(0.0067)	(0.0059)	(0.0057)	(0.0072)	(0.0054)	(0.0085)	(0.0064)	(0.0066)	(0.0068)	(0.0062)	(0.0056)
average_age	0.0005	-0.0075 ***	-0.0076 ***	0.0026	-0.0036 *	-0.0017	-0.0050 ***	0.0005	0.0011	-0.0055 ***	-0.0009

Table A.4 (continued)

Dependent Variable:	union										
Model:	rich TRUE (1)	rich FALSE (2)	high_unemp TRUE (3)	high_unemp FALSE (4)	high_tax TRUE (5)	high_tax FALSE (6)	old TRUE (7)	old FALSE (8)	dense TRUE (9)	dense FALSE (10)	high_non-german TRUE (11)
	(0.0018)	(0.0019)	(0.0020)	(0.0021)	(0.0021)	(0.0018)	(0.0019)	(0.0024)	(0.0018)	(0.0019)	(0.0019)
weighted_mean_prod_vars × post_dummy	0.0385	0.0888 ***	0.0484	0.0646 **	0.0870 ***	0.0495 *	-0.0018	0.1187 ***	0.1579 ***	0.0276	0.1342 ***
	(0.0290)	(0.0259)	(0.0295)	(0.0277)	(0.0288)	(0.0274)	(0.0280)	(0.0336)	(0.0274)	(0.0251)	(0.0275)
post_dummy × treated_state	-0.0034	-0.0232 **	-0.0058	-0.0169 *	0.0223 **	-0.0479 ***	-0.0302 ***	0.0002	0.0473 ***	-0.0455 ***	0.0353 ***
	(0.0096)	(0.0095)	(0.0104)	(0.0095)	(0.0097)	(0.0100)	(0.0103)	(0.0105)	(0.0092)	(0.0092)	(0.0093)
weighted_mean_prod_vars × post_dummy × treated_state	0.2967 ***	0.3236 ***	0.2634 ***	0.3392 ***	0.1917 ***	0.4242 ***	0.3577 ***	0.2561 ***	0.1204 ***	0.3842 ***	0.1586 ***
	(0.0390)	(0.0361)	(0.0405)	(0.0375)	(0.0395)	(0.0374)	(0.0374)	(0.0461)	(0.0369)	(0.0356)	(0.0385)
Fixed-effects ags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics Observations	3,416	3,412	3,416	3,412	3,416	3,412	3,426	3,402	3,416	3,412	3,416
R^2	0.89609	0.92771	0.90356	0.91478	0.91342	0.91718	0.90889	0.91580	0.91340	0.91867	0.91925
Within R^2	0.43833	0.49878	0.40147	0.46647	0.45213	0.45673	0.38855	0.47551	0.45382	0.50771	0.46535

Table A.4 (continued)

Dependent Variables:	union					afd					
Model:	high_nongerman FALSE (12)	rich TRUE (13)	rich FALSE (14)	high_unemp TRUE (15)	high_unemp FALSE (16)	high_tax TRUE (17)	high_tax FALSE (18)	old TRUE (19)	old FALSE (20)	dense TRUE (21)	dense FALSE (22)
Variables											
post_dummy	-0.0448***	0.0494***	0.0737***	0.0527***	0.0589***	0.0431***	0.0753***	0.0436***	0.0607***	0.0486***	0.0614***
	(0.0088)	(0.0058)	(0.0069)	(0.0083)	(0.0058)	(0.0062)	(0.0070)	(0.0072)	(0.0073)	(0.0080)	(0.0060)
unemployment_rate	0.1920	0.0228	-0.2478***	-0.1362	0.0044	-0.1752*	-0.1620**	-0.0452	-0.4823***	-0.1614**	-0.1326
	(0.1284)	(0.0721)	(0.0813)	(0.1023)	(0.0713)	(0.0918)	(0.0710)	(0.0664)	(0.1073)	(0.0803)	(0.0843)
nongerman_rate	0.4062***	0.0121	0.0251	0.0916***	0.0370	0.0624**	0.0941***	0.1309***	0.0204	0.0674***	0.0706**
	(0.0682)	(0.0244)	(0.0292)	(0.0312)	(0.0270)	(0.0286)	(0.0299)	(0.0319)	(0.0288)	(0.0247)	(0.0321)
population_density	-0.3063***	0.0672***	-0.0005	0.0375	-0.0001	0.0131	-0.0011	-0.0426*	0.0174	0.0562**	-0.0262
	(0.0454)	(0.0198)	(0.0217)	(0.0244)	(0.0197)	(0.0215)	(0.0203)	(0.0243)	(0.0224)	(0.0231)	(0.0207)
income	-0.2921***	0.1298***	0.0536	0.2129***	0.1431***	0.1642***	0.1183***	0.1732***	0.1610***	0.2133***	0.0915***
	(0.0579)	(0.0246)	(0.0328)	(0.0331)	(0.0328)	(0.0276)	(0.0322)	(0.0275)	(0.0353)	(0.0446)	(0.0286)
tax_revenues	0.0122*	0.0024	-0.0043	-0.0014	0.0017	-0.0042	0.0018	8.53×10^{-5}	-0.0024	0.0047	-0.0052*
	(0.0073)	(0.0033)	(0.0031)	(0.0032)	(0.0034)	(0.0029)	(0.0042)	(0.0035)	(0.0031)	(0.0038)	(0.0028)
average_age	-0.0021	-0.0021**	-0.0009	-0.0003	-0.0031***	-0.0018	-0.0022**	-0.0029***	-0.0020*	-0.0030**	-0.0010
	(0.0020)	(0.0010)	(0.0010)	(0.0012)	(0.0010)	(0.0012)	(0.0010)	(0.0010)	(0.0012)	(0.0012)	(0.0010)

Table A.4 (continued)

Dependent Variables:	union					afd					
Model:	high_nonger-man FALSE (12)	rich TRUE (13)	rich FALSE (14)	high_unemp TRUE (15)	high_unemp FALSE (16)	high_tax TRUE (17)	high_tax FALSE (18)	old TRUE (19)	old FALSE (20)	dense TRUE (21)	dense FALSE (22)
weighted_mean_ prod_vars × post_dummy	-0.0016	-0.0008	-0.0102	0.0236	-0.0283	0.0245	-0.0311	0.0366	-0.0123	0.0196	-0.0012
	(0.0276)	(0.0204)	(0.0218)	(0.0288)	(0.0193)	(0.0222)	(0.0215)	(0.0236)	(0.0261)	(0.0276)	(0.0194)
post_dummy × treated_state	-0.0624***	-0.0295***	-0.0365***	-0.0367***	-0.0324***	-0.0222***	-0.0431***	-0.0243***	-0.0358***	-0.0297***	-0.0303***
	(0.0099)	(0.0060)	(0.0069)	(0.0087)	(0.0057)	(0.0064)	(0.0069)	(0.0075)	(0.0070)	(0.0079)	(0.0061)
weighted_mean_ prod_vars × post_dummy × treated_state	0.4607***	0.1040***	0.1273***	0.1139***	0.1346***	0.0894***	0.1371***	0.0868***	0.1397***	0.0939***	0.1187***
	(0.0369)	(0.0228)	(0.0239)	(0.0307)	(0.0216)	(0.0249)	(0.0238)	(0.0256)	(0.0290)	(0.0295)	(0.0220)
Fixed-effects											
ags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics											
Observations	3,412	3,416	3,412	3,416	3,412	3,416	3,412	3,426	3,402	3,416	3,412
R^2	0.91471	0.94457	0.95203	0.94157	0.95152	0.94688	0.94788	0.95013	0.94378	0.94053	0.95242
Within R^2	0.45934	0.84061	0.86876	0.85005	0.84499	0.83703	0.86073	0.85731	0.83618	0.83700	0.85752

Table A.4 (continued)

Dependent Variables:	afd					governmental_parties					
Model:	high_non-german TRUE (23)	high_nongerman FALSE (24)	rich TRUE (25)	rich FALSE (26)	high_unemp TRUE (27)	high_unemp FALSE (28)	high_tax TRUE (29)	high_tax FALSE (30)	old TRUE (31)	old FALSE (32)	dense TRUE (33)
Variables											
post_dummy	0.0512***	0.0662***	0.0077	0.0132	0.0032	0.0106	0.0284***	-0.0100	-0.0041	0.0221**	0.0404***
	(0.0070)	(0.0072)	(0.0102)	(0.0099)	(0.0102)	(0.0092)	(0.0095)	(0.0101)	(0.0106)	(0.0104)	(0.0095)
unemployment_rate	-0.0984	-0.1997***	-0.1467	0.1200	-0.1684	-0.2193**	-0.1260	0.0924	-0.1109	0.2563	0.0548
	(0.0865)	(0.0730)	(0.1070)	(0.1221)	(0.1562)	(0.1034)	(0.1137)	(0.1162)	(0.0985)	(0.1586)	(0.1122)
nongerman_rate	0.0044	0.1492***	-0.2987***	-0.3248***	-0.2965***	-0.2778***	-0.3210***	-0.3037***	-0.3280***	-0.3094***	-0.2972***
	(0.0241)	(0.0339)	(0.0354)	(0.0481)	(0.0380)	(0.0474)	(0.0368)	(0.0460)	(0.0418)	(0.0480)	(0.0404)
population_density	0.0439**	-0.0457**	0.1632***	0.2389***	0.1445***	0.2172***	0.2376***	0.1622***	0.2388***	0.1994***	0.1467***
	(0.0201)	(0.0225)	(0.0305)	(0.0376)	(0.0318)	(0.0378)	(0.0316)	(0.0335)	(0.0343)	(0.0369)	(0.0324)
income	0.1617***	0.1198***	0.0002	-0.0796	-0.0243	-0.0371	0.0314	-0.0824	0.0209	-0.0677	-0.0472
	(0.0308)	(0.0310)	(0.0319)	(0.0631)	(0.0377)	(0.0569)	(0.0330)	(0.0501)	(0.0374)	(0.0551)	(0.0321)
tax_revenues	-0.0018	0.0020	-0.0037	0.0031	-0.0063	0.0040	0.0059	-0.0140**	-0.0032	0.0033	-0.0074*
	(0.0031)	(0.0037)	(0.0041)	(0.0046)	(0.0041)	(0.0048)	(0.0036)	(0.0064)	(0.0046)	(0.0044)	(0.0044)
average_age	-0.0038***	-0.0010	0.0020	0.0043**	0.0019	0.0033**	0.0029*	0.0035**	0.0045***	0.0023	0.0014
	(0.0011)	(0.0011)	(0.0015)	(0.0017)	(0.0016)	(0.0017)	(0.0016)	(0.0016)	(0.0015)	(0.0018)	(0.0017)
weighted_mean_prod_vars × post_dummy	0.0132	-0.0196	-0.0897**	-0.1067***	-0.1117***	-0.0619*	-0.1522***	-0.0435	-0.0626*	-0.1378***	-0.2271***
	(0.0248)	(0.0225)	(0.0360)	(0.0329)	(0.0354)	(0.0321)	(0.0332)	(0.0336)	(0.0348)	(0.0404)	(0.0331)

Table A.4 (continued)

Dependent Variables:	afd					governmental_parties					
Model:	high_non-german TRUE (23)	high_nonger-man FALSE (24)	rich TRUE (25)	rich FALSE (26)	high_unemp TRUE (27)	high_unemp FALSE (28)	high_tax TRUE (29)	high_tax FALSE (30)	old TRUE (31)	old FALSE (32)	dense TRUE (33)
post_dummy × treated_state	-0.0316***	-0.0320***	-0.0422***	-0.0298***	-0.0336***	-0.0312***	-0.0649***	-0.0043	-0.0173	-0.0517***	-0.0750***
	(0.0070)	(0.0072)	(0.0102)	(0.0102)	(0.0108)	(0.0091)	(0.0094)	(0.0103)	(0.0113)	(0.0103)	(0.0097)
weighted_mean_prod_vars × post_dummy × treated_state	0.1115***	0.1119***	-0.1170***	-0.1619***	-0.1038***	-0.2009***	-0.0597	-0.2261***	-0.1987***	-0.0903**	0.0281
	(0.0278)	(0.0242)	(0.0392)	(0.0372)	(0.0400)	(0.0353)	(0.0368)	(0.0376)	(0.0394)	(0.0439)	(0.0370)
Fixed-effects											
ags	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics											
Observations	3,416	3,412	3,416	3,412	3,416	3,412	3,416	3,412	3,426	3,402	3,416
R^2	0.94473	0.94879	0.98648	0.98166	0.98518	0.98367	0.98619	0.98304	0.98475	0.98354	0.98505
Within R^2	0.83557	0.85764	0.81288	0.76168	0.79899	0.77703	0.81396	0.76723	0.80744	0.75539	0.81060

Table A.4 (continued)

Dependent Variable:	governmental_parties		
Model:	dense FALSE (34)	high_nongerman TRUE (35)	high_nongerman FALSE (36)
Variables			
post_dummy	0.0025	0.0418***	-0.0268**
	(0.0095)	(0.0085)	(0.0110)
unemployment_rate	-5.71×10^{-5}	-0.0886	0.0663
	(0.1233)	(0.1147)	(0.1187)
nongerman_rate	-0.3148***	-0.2840***	-0.3752***
	(0.0423)	(0.0359)	(0.0528)
population_density	0.2369***	0.1637***	0.2401***
	(0.0343)	(0.0328)	(0.0347)
income	-0.0637	-0.0869*	-0.0027
	(0.0621)	(0.0488)	(0.0471)
tax_revenues	0.0040	0.0062	-0.0112**
	(0.0044)	(0.0038)	(0.0056)
average_age	0.0039**	0.0031**	0.0028*
	(0.0015)	(0.0016)	(0.0017)
weighted_mean_prod_vars × post_dummy	-0.0518*	-0.1957***	0.0109
	(0.0311)	(0.0314)	(0.0359)
post_dummy × treated_state	-0.0212**	-0.0786***	0.0103
	(0.0097)	(0.0090)	(0.0108)

Table A.4 (continued)

Dependent Variable:		governmental_parties	
Model:	dense FALSE (34)	high_nongerman TRUE (35)	high_nongerman FALSE (36)
weighted_mean_prod_vars × post_dummy × treated_state	-0.2138***	0.0086	-0.2902***
	(0.0353)	(0.0363)	(0.0380)
Fixed-effects			
ags	Yes	Yes	Yes
Fit statistics			
Observations	3,412	3,416	3,412
R	0.98260	0.98418	0.98492
R^2	0.76475	0.80021	0.77979

Clustered (ags) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Note: The table lists the regression results for the different heterogeneity analyses shown in Fig. 6. Each column shows the estimated coefficients for a combination of dependent variable (union: conservative party, afd: far-right party, and governmental_parties: government parties) and control variable for splitting in above- or below-median subset. The boolean after a sociodemographic variable indicates if the listed coefficients stem from analysis of the above-median subset, e.g., "rich TRUE" indicates that the above-median income subset was used, i.e., the subset containing the richer half of the municipalities. All regressions use the triple difference model (Eq. 8)

A.8 Green party support changes at the 2022 election

As outlined in Sect. 5, electoral shifts for the green party may have materialized directly in the aftermath of the energy price crisis 2022 and may therefore be already subtracted out by our triple difference approach which uses the Lower Saxon election results as control group.

To investigate this possible explanation for the zero effect for the green party in our baseline specification (see Fig. A.3), we perform a difference-in-differences analysis with the election data in Lower Saxony only. The econometric approach follows the one presented in Eq. 3. The treatment effect γ_0 can be interpreted as the change in the green share among treated municipalities at the 2022-election. Treated municipalities are similarly measured as in our baseline analysis using the treatment score. Table A.5 lists the regression results and shows that the green party was already facing losses in the 2022-election in treated Lower Saxon municipalities, i.e., with higher treatment scores. For the hypothetical scenario of a municipality with treatment score $T_m = 1$, the green party share declined by 4.4 pp compared to non-treated municipalities at the 2022-election. This result is opposed to the general peak of the green party in 2022 with an overall gain of +3.8 pp

Table A.5 Difference-in-differences for greens party share at 2022 election in Lower Saxony

Dependent Variable:	greens
Model:	(1)
Variables	
unemployment_rate	0.0327
	(0.0674)
nongerman_rate	−0.0568*
	(0.0326)
population_density	−0.0401*
	(0.0235)
income	−0.0878***
	(0.0250)
tax_revenues	−0.0044
	(0.0030)
average_age	−0.0015
	(0.0011)
weighted_mean_prod_vars × post_dummy	−0.0443***
	(0.0127)
Fixed-effects	
ags	Yes
year	Yes
Fit statistics	
Observations	1,874
R^2	0.93176
Within R^2	0.03328

Clustered (ags) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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Declarations

Competing interests The authors declare that they have no competing interests.

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