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## The electoral consequences of the coal phase-out in Germany

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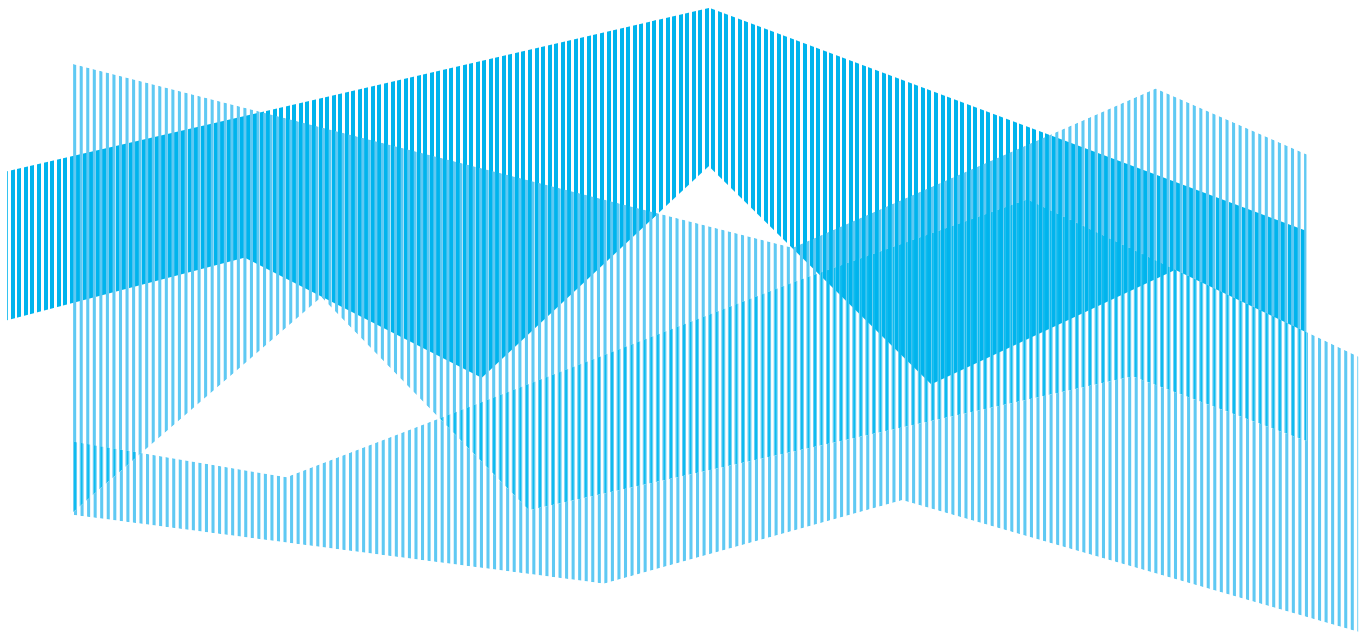
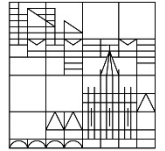
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# The Electoral Consequences of the Coal Phase-out in Germany

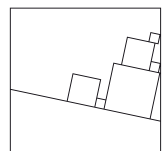
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### About the author

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# The Electoral Consequences of the Coal Phase-out in Germany

Sophia Stutzmann\*

## Abstract

Climate policies can have adverse social and economic effects on affected citizens. Against this backdrop, understanding the conditions under which electoral support or backlash to such policies occurs is crucial. In this paper, I set out to shed light on this issue by empirically analysing the electoral repercussions of the coal phase-out in Germany. By employing a series of fixed-effects models, I investigate whether the closures of coal plants and mines between 2007 and 2022 affected voting behaviour at the municipality level. I find that closures result in lower vote shares for the Social Democratic Party and higher abstention rates in affected municipalities. These findings document a punishment of the long-time issue owner and point towards the role of economic grievances in curbing political engagement. With the high politicisation around the issue of fossil fuel energy generation, these findings have important implications for the remaining coal phase-outs worldwide.

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# Introduction

While societal transformations and their consequences for labour markets and political behaviour such as globalisation, technological change and deindustrialisation have received a lot of scholarly attention in the past years, the impact of the green transition on political behaviour has so far been neglected. More specifically, there has been a lot of research on how losers of the aforementioned transformations tend to turn towards populist and extreme parties (Gallego and Kurer 2022; Walter 2021). However, in light of the importance of electoral support for climate policies to limit global warming, analysing under what conditions green transition policies lead to electoral backlash can yield crucial insights for designing policies that find broad electoral support.

In this paper, I set out to shed light on this issue by empirically analysing the electoral repercussions of the 2007 hard coal phase-out law in the German federal state (*Bundesland*) of North Rhine-Westphalia. Germany can be regarded as a least-likely case to observe electoral backlash to the phasing out of coal for several reasons (Levy 2008; Flyvbjerg 2011). First, in contrast to the aforementioned transformations, the German coal phase-out has been accompanied by targeted compensation for affected workers (in the form of early retirement and retraining opportunities) as well as regional support schemes for affected regions, which were also more generous than compensation schemes in other countries that phased out coal and which might attenuate economic grievances induced by the decline of the coal industry (Gürtler and Herberg 2021). Second, the bulk of the decline of the German coal industry occurred between 1950 and the 1990s, with employment numbers dropping from 750,000 in the 1950s to 60,000 in 2005, which then reduced to merely 25,000 in 2018 (Kohlenwirtschaft e.V. 2018; Oei, Brauers, and Herpich 2020). Thus, the immediate labour market effect of the coal closures, i.e. the closure of coal-fired power plants and coal mines, after 2007 was very small. Lastly, Germany is characterised by a corpo-

ratist system of interest group intermediation which should make electoral backlash more unlikely as this favours the compensation of losers of policy change (Jahn 2016; Finnegan 2022). This corporatist element of the German political economy is clearly visible in the 2007 phase-out law, which was based on an agreement between not only the federal and regional governments but also trade unions and the main coal operator. For all these reasons, observing an electoral backlash to the coal closures in North Rhine-Westphalia would make it even more likely to observe a similar backlash in other countries that still face the phasing out of their coal industries over the next decades.<sup>1</sup>

Why would we expect coal closure to result in local electoral backlash in the first place? First of all, coal closures should lead to economic grievances in the form of a net loss of income that might fuel political disengagement in the form of higher abstention rates. Second, combined with feelings of social marginalisation as well as loss of social status among coal communities, this might translate into higher vote shares for extreme parties. Lastly, I expect affected municipalities to voice their resentment of the coal phase-out by punishing the long-term issue owner as well as political ally of coal communities, namely the Social Democratic Party (SPD), for coal closures.

In order to investigate the issue at hand, I use data on the location and date of closure of coal-fired power plants and mines between 2007 and 2022 as well as municipality (*Gemeinde*)-level data on regional election results in North Rhine-Westphalia between 2000 and 2022. In a first step, I estimate the effect of the first coal closure per municipality on voting behaviour using both fixed effects models as well as staggered difference-in-differences models. With the currently fast-evolving literature on difference-in-differences estimations in the presence of staggered or multiple treatments, the latter estimators have only very recently started to be used in the

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1. By signing the Glasgow Climate Pact of 2021, governments around the world have agreed on a phasing down of fossil fuel production to limit global warming.

political science literature. Thus, with this paper, I aim to further the understanding of the methodological and practical strengths and weaknesses of both models in the context of the data at hand. In a second step, I exploit the fact that some municipalities experienced multiple closures in multiple time periods to investigate the effect of compound treatment on electoral behaviour using fixed effects models.

I find strong support for an association of coal closures between 2007 and 2022 with an asymmetric backlash through a negative effect on vote shares for the Social Democrats and a positive effect on abstention rates in affected municipalities. Furthermore, I find weak support for higher vote shares for the far-right *Alternative für Deutschland* (AfD, Alternative for Germany) in municipalities affected by multiple coal closures. Providing the first empirical analysis of electoral backlash of a green transition policy in an explicitly least-likely context—characterised by the presence of targeted compensation, the involvement of unions and business interest through corporatist interest representation as well as a low number of immediately affected workers—, these findings highlight the difficulty of preventing local electoral backlash against coal closures. With the high salience and politicisation around the issue of fossil fuel energy generation, these findings have important implications for the upcoming coal phase-outs worldwide.

## Literature Review

This paper makes several contributions to the literature. First, there has been a large and still burgeoning literature in political economy that examines the political consequence of labour market change. Thereby, it has investigated how “losers” of deindustrialisation, globalisation and technological change tend to turn towards populist and extreme parties (Baccini and Weymouth 2021; Broz, Frieden, and Weymouth 2021; Gallego and Kurer 2022; Gingrich 2019; Walter 2021). However, this

analysis has not yet been extended to the ongoing and future transformation of the labour market and society more broadly through the green transition.

There are at least two important ways in which the green transition differs from the aforementioned transformations and thus merits further investigation. First, contrary to deindustrialisation and automation trends, the green transition is a governmentally induced transformation for which the coal sector is a prime example since it is the first time that governments worldwide have decided to deliberately shut down an entire industry. Mayer's (2022) survey evidence for the US provides further support to this argument as he finds that environmental regulation is perceived to be the main cause of the decline of the coal sector.

Second, the decline of the coal sector in Germany has been accompanied by compensation programmes both for individual workers as well as for affected coal mining companies, regions and communities (Diluiso et al. 2021). This is in line with the compensation hypothesis originally developed by Cameron (1978) and, so far, applied to the case of trade (Schaffer and Spilker 2016; Walter 2010), according to which it would be expected that losers of the green transition who express feelings of economic insecurity respond by demanding an expansion of the welfare state. While there have also been assistance programs for workers displaced by trade in the US, these schemes have had limited uptake with mixed findings regarding their success (D'Amico and Schochet 2012).

Whether the presence and the design of compensation measures for workers have the potential to attenuate possible electoral backlash remains a somewhat open question, although the literature on the compensation of losers of globalisation points to such an effect (Colantone and Stanig 2018; Margalit 2011). Relatedly, Colantone et al. (2022) find that after the introduction of a ban on polluting cars in Milan, individuals that received compensation from the government did not have a higher probability of voting for the far-right Lega, while this was the case for individuals that



were not compensated for their loss. This is in line with the more general finding by Vlandas and Halikiopoulou (2022) that compensatory spending reduces the likelihood of individuals exposed to high economic and social risk of voting for far-right parties. However, in the context of workers experiencing automation risk, Gingrich (2019) paints a more pessimistic picture by providing evidence that compensation does not reduce voting for populist parties. Yet, the effect of compensation policies has only very scarcely been examined for workers at risk of losing their employment due to the green transition. Only two contributions have analysed compensation in the context of the coal industry: On the one hand, Gaikwad et al. (2022) have conducted a survey experiment which focuses on preferences for individual or community-level compensation schemes. On the other hand, Bolet et al. (2023) have used observational data to analyse the electoral repercussions of the just transition agreement to phase out coal in Spain, which led to electoral gains for the incumbent party in the subsequent national election. They argue that this electoral boost was enabled by the union’s endorsement of the just transition agreement. However, as their analysis only covers a short time period, by empirically investigating this issue over a considerably longer time span, this paper contributes to a clearer understanding of the role of compensation for coal transition losers in alleviating electoral backlash—which is currently still lacking as pointed out by Gazmararian (2022).

Lastly, another broad stand of literature that this paper speaks to is the currently scarce literature on the politics of the energy transition, of which a large part has focused on the coal sector, as its decline in former big coal countries such as the US, Germany and the UK already started decades ago with coal becoming less economically competitive than other energy sources (Schulz and Schwartzkopff 2016). This has motivated a number of contributions on the political economy and the comparative politics of coal phase-outs (Brauers, Oei, and Walk 2020; Diluiso et al. 2021; Lauber and Jacobsson 2015). Within this realm, some papers have taken a closer look

at the consequences of coal phase-outs on employment (Heinisch, Holtemöller, and Schult 2021; Kalt 2021; Oei, Brauers, and Herpich 2020). However, in addition to the aforementioned study by Bolet et al. (2023), only the recent contributions by Egli et al. (2022) and Gazmararian (2022) have so far examined the electoral consequences of the decline of the coal industry, both with a focus on the US. Both document an increase in the vote share of the Republican party in those counties heavily affected by employment loss in the coal sector. This paper somewhat builds on their findings but adds more nuance to the argument by focusing on the German multi-party system instead of the US two-party system.

## Theoretical Discussion

Before delving into the hypotheses, it is necessary to theoretically clarify the level of analysis for the present study, which is the municipality level. The theoretical mechanism underpinning my arguments also operates on the individual level, as this is the level of analysis that the literature which informs these theoretical priors is based on. However, I expect coal closures to yield an impact particularly on the aggregate, municipality level. This is because coal closures do not only influence the behaviour of immediately affected persons (such as workers in the mines or plants and coal-reliant industries) but are also likely to spill over to individuals in their wider communities. This is in line with previous research which highlights that coal industries serve as a base for a shared identity and common bond among communities in coal areas (Bell and Braun 2010; Carley, Evans, and Konisky 2018; Mayer 2018). Gazmararian's (2022) findings show, for instance, that almost all surveyed individuals in a US coal area have at least one close social contact that works in the coal industry, which is why he argues that the "community-level is essential" (p. 1). The importance of the community as the appropriate level of analysis is further corroborated by sur-

vey evidence collected by Gaikwad et al. (2022) in the US and India showing that individuals in coal areas have a strong preference for community-level compensation over individual-level compensation, which they link back to a shared identity in coal communities. For these reasons, it is plausible to assume that individual-level mechanisms spill over into the wider coal communities as captured by the municipality level.

Coming back to the main research question: How should coal closures affect voting behaviour?

First of all, in line with previous work on how economic inequality and structural economic disadvantage relative to other people depress political participation, in particular among disadvantaged groups (Kurer et al. 2019; Schäfer and Schwander 2019; Schäfer, Schwander, and Manow 2016; Schwander, Gohla, and Schäfer 2020; Solt 2008), I expect coal closures to lead to higher abstention rates in affected municipalities compared to municipalities without closures. Despite the existence of compensation in the form of early retirement benefits for workers in coal mines and plants that were directly affected by closures as well as investment into regional infrastructure, coal closures arguably still represent a net loss of income for workers. Moreover, workers in downstream industries dependent on coal were indirectly affected by this economic shock without benefiting from targeted compensation. Overall, coal closures are thus expected to trigger economic grievances among individuals in affected municipalities compared to individuals in unaffected municipalities. Affected individuals, which are at an economic disadvantage compared to individuals in unaffected municipalities, should therefore exhibit lower levels of political engagement, such as participation in elections (Solt 2008). In addition to these economic considerations that might trigger political disengagement among coal communities that experience coal closures, political abstention in affected municipalities might also be a form of protest voting that is done in order to “send a signal of disapproval with a party,

government or institution” (Hobolt and Spoon 2012). For these reasons, affected municipalities might protest the coal closures by abstaining from voting.

**Hypothesis 1:** A coal closure is associated with a higher abstention rate in the affected municipality.

Second, income inequality and relative deprivation have not only been shown to affect political participation but also support for populist and extreme parties (Engler and Weisstanner 2021). According to Burgoon et al. (2019), the dominant feeling among individuals voting for radical parties is that of “a feeling of ‘losing out’ compared with one’s own past and compared with other groups in society” (p. 52). They go on to show that experiencing ‘positional deprivation’ in terms of the growth of a person’s income compared to that of others in society is associated with higher support for radical left and radical right parties (ibid.). Bridging thus far competing explanations of the economic or cultural roots of populism (Schäfer 2022), this is corroborated by Gidron and Hall (2020), who show that feelings of social marginalisation are associated with higher support for the radical left and right. This arguably applies to the case of coal municipalities in which individuals are very likely to experience positional deprivation or social marginalisation due to both economic grievances as well as a loss in social status.

For a long time, coal workers were endowed with a high social status and a distinct community identity formed in coal areas (Carley, Evans, and Konisky 2018; Diluiso et al. 2021; Mayer 2022). This is especially the case in Germany, where the historical strength of the coal industry can be seen as both the starting point for European integration after the Second World War and the foundation of the country’s current prosperity (Herpich, Brauers, and Oei 2018). The loss of this social status induced by coal closures is then expected to contribute to feelings of status decline, which has been linked to support for right-wing populist parties by recent contributions to the literature (Gidron and Hall 2017; Engler and Weisstanner 2021). Regarding losers

of structural changes in the labour market, the link between relative status anxiety and voting for populist right-wing parties has already been established for workers threatened by automation (Kurer 2020). Yet, this is even more plausible for workers in the coal sector due to the high social status with which the coal industry has for a long time been associated. This might make municipalities that experienced coal closures more receptive to the far-right *Alternative für Deutschland* (AfD)'s populist appeals and its socially conservative and nostalgic propositions. Moreover, the AfD is the only party that still campaigns against the phase-out of coal in Germany, both at the level of North Rhine-Westphalia as well as the federal level (Alternative für Deutschland 2021; Alternative für Deutschland NRW 2022). This gives disappointed communities not only a symbolic but also a substantive reason to vote for the AfD to voice their discontent with the coal closures.

Thus, the expected grievances due to relative economic deprivation as well as feelings of social marginalisation might lead to higher support for extreme parties on the left, which is represented in Germany through the Left Party, and right, with the case for higher far-right support being even stronger because of the importance of social status decline among affected coal communities in fueling far-right voting.

**Hypothesis 2a:** A coal closure is associated with a higher vote share for the far-right AfD in the affected municipality.

**Hypothesis 2b:** A coal closure is associated with a higher vote share for the far-left Left Party in the affected municipality.

Apart from these two general hypotheses on electoral backlash against coal closures, a third hypothesis more specific to the German case is that coal closures might lead to affected communities punishing the Social Democratic Party, which was not only the issue owner of the topic of coal-fired energy politics but also a long-standing political ally of coal workers. In line with the conceptualisation of an issue owner as

the party that is associated with a specific topic (Budge and Farlie 1983; Budge 2015), the Social Democrats can be regarded as the party that had always represented the interests of coal workers. Not only were many of the workers in coal mines members of the Social Democrats but also the influential trade union that represented coal workers had close ties to the party (Renn and Marshall 2016). This also translated into the Social Democratic Party in North Rhine-Westphalia, along with the coal miners' union and the coal industry, pushing for a later coal phase-out compared to the Christian Democratic Party, the Green Party and the Liberal Party. The coal alliance, which included the Social Democrats, ultimately succeeded in delaying the phase-out (Herpich, Brauers, and Oei 2018). However, as I will explain in more detail in the following section, the actual coal closures might arguably still trigger feelings of betrayal and disappointment with the Social Democrats in affected municipalities.

This specific disappointment with the Social Democrats regarding the coal closures ties in with a general trend of alienation of social democratic parties in Europe with their previous core constituency, the working class, in favour of a more educated middle class (Abou-Chadi and Wagner 2020; Gingrich and Häusermann 2015). This is also the case for the German Social Democrats (Schwander and Manow 2017; Schwander, Gohla, and Schäfer 2020), for which coal workers were the prototype of the traditional working class whose interest they represented for so long. This general alienation constitutes a second possible source of disappointment of coal communities with the Social Democrats. They might feel like their voices are not heard by their long-term political ally not only regarding the specific topic of the coal phase-out but also regarding politics in general. Both factors are expected to lead to municipalities that experience coal closures punishing the Social Democrats by withdrawing their support for the party.

**Hypothesis 3:** A coal closure is associated with a lower vote share for the Social Democratic Party (SPD) in the affected municipality.

# The Decline of the German Coal Industry and the 2007 Phase-out Law

The German coal industry experienced a long and gradual decline in its employment numbers which started in the 1950s. For a long time, this was mainly due to economic reasons as domestic hard coal became less competitive compared to imported hard coal<sup>2</sup> and other forms of energy generation (Herpich, Brauers, and Oei 2018). However, in contrast to countries like the United Kingdom, where the drop in coal mining occurred comparatively rapidly, extensive subsidies by the German government kept the uneconomical German coal sector alive (Brauers, Oei, and Walk 2020). This was driven by the influence of the coal and steel industry, which formed an alliance with politicians, among which especially the Social Democratic Party had strong ties to the coal industry, as well as the unions that represented coal workers (Herpich, Brauers, and Oei 2018). Moreover, the coal industry had served as the backbone of the German economy for decades as well as the motor of integration into the European Community, which tied local identities and economic dependence to this sector (Kalt 2021).

However, the year 2007 arguably marks the starting point of the influence of environmental concerns as a contributing factor to the decline of the coal industry in Germany. This is reflected in the debates within the *Bundestag*, in which, after 2007, environmental concerns superseded economic topics as the dominant frame associated with the coal industry (Müller-Hansen et al. 2021). With the start of the Emissions Trading Scheme by the European Union (EU) in 2005, which included emissions from coal-fired power plants, the burning of coal became more expensive (Commis-

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2. While hard coal can be easily transported between countries, the transportation of lignite over long distances is rather uneconomical because it contains a higher share of water (Herpich, Brauers, and Oei 2018). This explains why lignite power plants cluster around lignite mines, while this is not the case for hard coal such that hard coal power plants can also be operated with imported hard coal.

sion 2022). Moreover, the EU changed its state aid regulations which effectively prohibited subsidies to the German coal sector by 2018 (Schulz and Schwartzkopff 2016). This effectively forced the German government to adopt a law in 2007 that mandated the phase-out of hard coal mining until 2018<sup>3</sup> (Herpich, Brauers, and Oei 2018; Steinkohlefinanzierungsgesetz 2007).

The hard coal phase-out law of 2007 was adopted following an agreement between the federal government, the governments of North Rhine-Westphalia and Saarland (which were the only two states with active hard coal mines at that time) as well as the union of mining workers, IG BCE (which represents workers in coal mines and which was closely affiliated with the Social Democrats), and the mining company Ruhrkohle AG (Schulz and Schwartzkopff 2016). While the Christian Democrats, the Liberals as well as the Green Party had advocated for an earlier phase-out until 2012, an alliance of the mining company, unions (both IG BCE, as well as the service-sector union *ver.di*, which represents coal workers in coal plants) and the Social Democrats, successfully pushed for a phase-out until 2018 for a “socially compatible” phase-out given that in 2007, 5 to 10 per cent of the workforce in the Ruhr area still worked in the mining sector (Herpich, Brauers, and Oei 2018). This included the guarantee that every coal mine worker aged 42 or older was secured against unemployment through an early retirement programme (Oei, Brauers, and Herpich 2020). In addition to this compensation of affected workers, the phase-out was accompanied by structural and economic policies such as the investment into transport infrastructure and higher education (Herpich, Brauers, and Oei 2018; Oei, Brauers, and Herpich 2020).

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3. For reasons of energy security, lignite mining was not part of the phase-out law of 2007 (Renn and Marshall 2016).



## Methods and Data

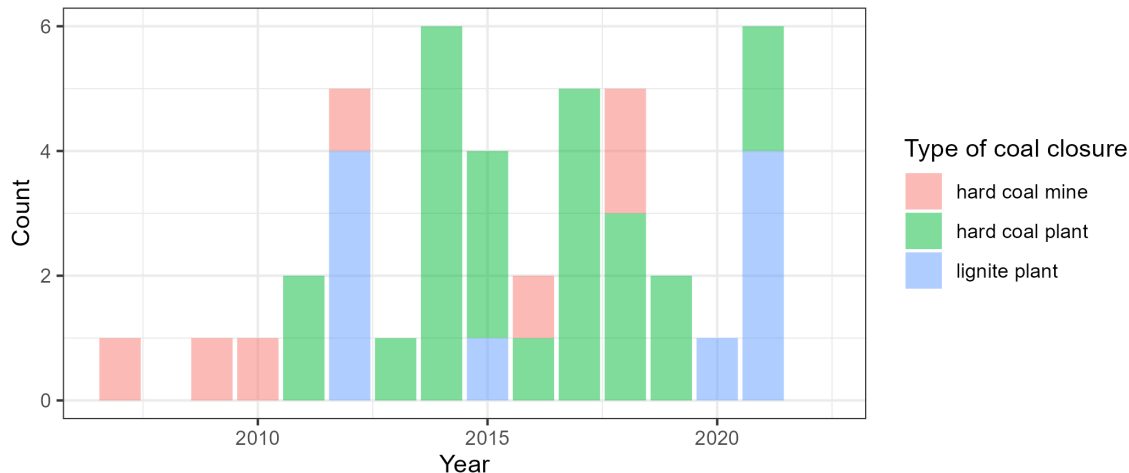
I use a series of fixed effects models and staggered difference-in-differences estimations in order to estimate the effect of coal closures on electoral results. More specifically, I zoom in on the case of North Rhine-Westphalia to analyse how municipality-level vote shares for all parties represented in the regional parliament of North Rhine-Westphalia changed after a coal closure occurred. The focus on North-Rhine Westphalia is motivated by the fact that the majority of German coal closures after 2007 occurred in this state. Therefore, in order to reduce heterogeneity among treated and control units, my empirical analysis focuses solely on this state. The level of analysis is the municipality.

### Data and Operationalisation

In this paper, I rely on observational data on the location and date of closure of coal mines and coal-fired power plants between 2007 and 2022, as well as municipality-level data on the regional election results in North-Rhine Westphalia between 2000 and 2022, for which I describe the data collection in the following.

In order to test the effect of coal closures on voting behaviour, data on the precise point in time of the closures as well as the geographical location of the coal plants and mines is needed. For the closed coal plants, the data that I use stems mainly from the German Federal Network Agency (2023), which operates a list of closed lignite and hard coal plants since 2011. I obtained data on the closures of coal plants between 2007 and 2011 from the websites of the specific coal plants or their operators. For the closure of coal mines, I relied on data provided by the organisation *Statistik der Kohlenwirtschaft* (2019) (Statistics of the coal industry) which has been publishing statistical data on the German coal industry since 1954, which I cross-checked against the data of the websites of the coal mines or their operators.

Figure 1: Temporal distribution of coal closures in North Rhine-Westphalia, 2007-2022



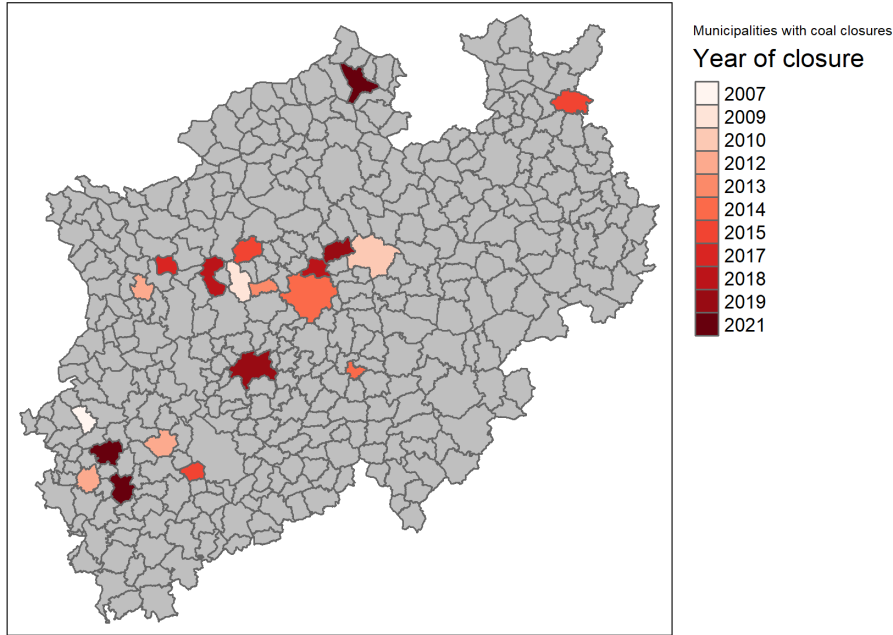
This data collection process resulted in a sample of 65 coal closures between the adoption of the phase-out law in 2007 and the regional elections in North Rhine-Westphalia in May 2022. However, in three municipalities that experienced coal closures as well as one municipality without a coal closure in that time period, additional coal plants were built during the same time period.<sup>4</sup> As the analysis of this paper focuses only on the electoral implications of the closure of coal plants and mines and not those associated with their construction, these four municipalities were dropped from the analysis to not bias the estimates.<sup>5</sup> This results in a final sample of 42 closures, of which 7 were closed hard coal mines, 25 closed hard coal plants and 10 closed lignite plants. Figure 1 shows the distribution of these closures over time. These closures are located in 20 municipalities in North Rhine-Westphalia, for which Figure 2 depicts the year in which the municipalities experienced their first closure.

For the first step of the empirical analysis, the main independent variable of

4. Among these four municipalities that experienced the construction of a coal plant, the three municipalities with coal closures are Grevenbroich, Datteln and Duisburg, which in total experienced 23 closures during the observed time period (1 hard coal mine, 7 hard coal plants and 15 lignite plants), while the municipality without coal closure is Köln.

5. As a robustness check, I replicate all the analyses with the complete sample of all municipalities of North Rhine-Westphalia, see Section D in the Appendix.

Figure 2: Map of municipalities in North Rhine-Westphalia which experienced at least one coal closure between 2007 and 2022



interest, namely the closure of coal plants and mines, is operationalised as the election period<sup>6</sup> in which a municipality was treated for the first time, i.e. the election period in which it experienced its first coal closure. In a second step, I exploit the fact that 6 out of the 20 municipalities experienced multiple closures both within a given election period as well as over different election periods. For this part of the analysis, the independent variable is measured as a count variable which indicates the number of closures that occurred within a given election period of regional elections.

The dependent variables for the analyses here are the election results of all parties currently represented in the Regional Parliament of North Rhine-Westphalia as well as the turnout rate between 2000 and 2022, for which I collected the data from the regional statistical office of North Rhine-Westphalia (Landesdatenbank NRW [2023](#)). This results in two election years before treatment (2000 and 2005) and four election

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6. The regional elections in North Rhine-Westphalia included in this analysis took place on May 9 2010, May 13 2012, May 14 2017, and May 15 2022.

years after 2007 (2010, 2012, 2017 and 2022). While the Social Democrats, Greens, Christian Democrats and Liberals have existed during the whole time period under observation, this is not the case for the Left Party and the AfD (in North Rhine-Westphalia), which were founded in 2007 and 2013, respectively.

## Empirical Strategy

In order to identify the effect of a coal closure on voting behaviour at the municipality level, I rely on two-way fixed effects (TWFE) models. Fixed effects models have been commonly used to identify causal effects in panel data settings (Brüderl and Ludwig 2015, Chaisemartin and D’Haultfoeuille 2020; Wooldridge 2010). By including municipality-fixed effects, I control for unobserved time-invariant confounders, i.e. unobserved heterogeneity between my units of analysis which potentially impact both the coal closures as well as voting behaviour, such as the level of urbanisation. Moreover, including time-fixed effects allows for controlling for temporal trends that occur in all municipalities. For these estimations, I use ordinary least square regressions with cluster-robust standard errors at the municipality level to account for heteroscedasticity and regional spatial dependence.

For the first step of the analysis, where I only consider the first coal closure that occurred in the treated municipalities, the TWFE model is specified as follows:

$$VoteShare_{mt} = \beta * FirstCoalClosure_{mt} + \delta_m + \lambda_t + \epsilon_{mt} \quad (1)$$

where  $VoteShare_{mt}$  identifies a municipality  $m$ 's vote share for the specific party at election period  $t$  and  $\beta$  is the parameter of interest which identifies the effect of the first coal closure ( $FirstCoalClosure_{mt}$ ) on vote shares.  $\delta_m$  are municipality-fixed effects accounting for time-invariant confounders at the municipality level,  $\lambda_t$  are time-fixed effects which control for time-specific variation common to all municipalities and

$\epsilon_{mt}$  identifies the error term.

For the second step of the empirical analysis, I estimate the effect of multiple closures within the same election period conditional on the existence of previous closures on vote shares. Here, the TWFE model is specified as follows:

$$\begin{aligned} \text{VoteShare}_{mt} = & \beta * \text{CoalClosure}_{mt} + \beta_1 * \text{PreviousClosure}_{mt} \\ & + \beta_2 * (\text{CoalClosure}_{mt} * \text{PreviousClosure}_{mt}) + \delta_m + \lambda_t + \epsilon_{mt} \end{aligned} \quad (2)$$

where  $\text{VoteShare}_{mt}$  identifies a municipality  $m$ 's vote share for the specific party at election period  $t$ .  $\text{CoalClosure}_{mt}$  is a count variable which measures the number of coal closures per municipality per election period, while  $\text{PreviousClosure}_{mt}$  is a dummy variable which takes a value of 1 when there has been at least one coal closure in a previous election period in a given municipality.  $\beta_2$  identifies the effect of the main parameter of interest, namely the effect of an additional closure per election period conditional on the existence of a previous closure. Again,  $\delta_m$  are municipality-fixed effects accounting for time-invariant confounders at the municipality level,  $\lambda_t$  are time-fixed effects which control for time-specific variation common to all municipalities, and  $\epsilon_{mt}$  identifies the error term.

However, recent advances in econometrics have highlighted that in the event of staggered treatment timing, conventional TWFE regressions can produce biased estimates.<sup>7</sup> This is why I perform robustness checks of the effect of the first coal closure per municipality by estimating staggered difference-in-differences models (see Section C in the Appendix for more details about the estimation strategy). However, there is to date no difference-in-differences estimator that both corrects for the flaws of TWFE models and at the same time is able to take into account multiple staggered treatments both within the same time period as well as over multiple time periods.

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7. For a summary and discussion of the recent developments in the difference-in-differences literature, see Roth et al. (2022).

This is why I cannot use the staggered difference-in-differences model for robustness checks of the second step of my empirical analysis.

Identification of the TWFE as well as the staggered difference-in-differences estimates relies on the assumption of parallel trends. Due to the counterfactual nature of this assumption, it is not directly testable and its graphical depiction is complicated by the staggered nature of the treatment, but analysing the balance between treated and control municipalities in the year before the earliest possible treatment, 2006, can give an indication of whether this assumption is likely to be met. Table A.1 in the Appendix shows pre-treatment balance on a number of variables related to population and employment characteristics that are potentially related to both the treatment assignment and the dependent variables.<sup>8</sup> It can be seen that treated municipalities are significantly more likely to have at least one operational coal plant or mine before treatment, are more urban and have a higher population density. To mitigate for these variables to influence the results, I conduct coarsened exact matching (CEM) to identify a set of control municipalities that are as similar as possible to those municipalities that become treated (Ho et al. 2007; Iacus, King, and Porro 2012). As Table A.2 and Figure A.1 in the Appendix show, CEM considerably improves balance among treated and control units. I then perform both the TWFE analyses as well as the staggered difference-in-differences estimations with both the full and the matched datasets.

The level of analysis for this paper is the municipality, of which there are 396 in North-Rhine Westphalia. In addition to the theoretical considerations that inform this choice of level of analysis as detailed in the theoretical discussion, methodological considerations also support this choice. Following Toshkov (2016), the level of analysis

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8. The data for these covariates stems from the German Federal Network Agency (2023) (for the existence of coal in 2006), from *Wegweiser Kommune* (2023) (for population density, share of secondary sector employment, share of tertiary sector employment, share of service sector employment) and the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR 2023) (for the urban-rural dummy).

should be chosen according to the level at which the treatment can be isolated. In the case of coal closures, the most fine-grained administrative level at which this effect can be isolated is the municipality level. Moreover, while individual-level survey data would offer the possibility to get a better understanding of the mechanisms at play, survey data on voting behaviour suffers from issues of representativeness, which make observational data at the municipality level the preferred data source. First of all, marginalised social groups tend to be underrepresented in survey data in the sense that they have a lower probability of participating in surveys, which might arguably be the case for disappointed voters. Second, survey responses regarding vote choice of an extreme party or vote abstention might be biased due to social desirability as respondents tend to under-report this kind of behaviour. This speaks strongly in favour of relying on observational data in the form of actual election results in order to gauge the effect of coal closures on voting behaviour.

## Results

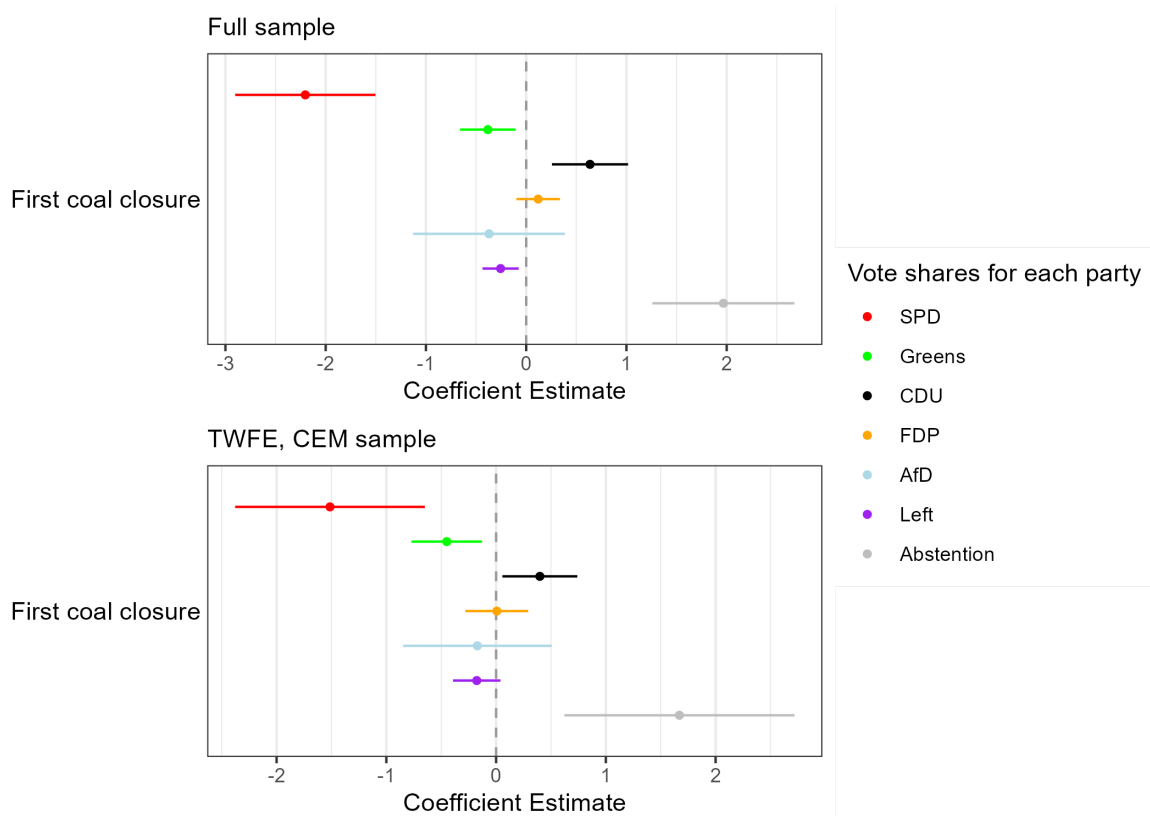
To get an encompassing picture of how coal closures affect voting behaviour, in the first part of this section I estimate the effect of the first coal closure in a given municipality on vote shares for each party. The second part then presents the results for multiple coal closures conditional on the occurrence of a previous closure. Lastly, the third part briefly presents results for an alternative explanation for the changes in voting behaviour, namely that the effect is driven solely by the announcement and implementation of the 2007 phase-out law itself and not by the actual coal closures.

### Main Analyses: First Coal Closure

Figure 3 presents coefficient plots of the results from the TWFE models for the full sample as well as for the matched sample (see Tables A.3 and A.4 in the Appendix

for the corresponding regression tables). It shows that the first coal closure leads to a significant decrease in the vote share for the Social Democrats in the subsequent regional election by 2.2 percentage points. Moreover, the first coal closure leads to a significant increase in the abstention rate in the affected municipality by 1.97 percentage points. In addition to these two effects of considerable magnitude, the first coal closure is also associated with a small increase in support for the Christian Democrats and a small decrease in support for the Greens and the Left Party. When estimating these effects based on the matched sample, all of the effects hold except for the decrease in vote shares for the Left Party, with the effect sizes being slightly smaller. This first analysis provides indicative support for hypotheses 1 and 3.

Figure 3: *TWFE estimates of first coal closure on vote shares*



As a robustness check, I perform these analyses of the effect of the first coal closure on vote shares for each party using staggered difference-in-differences models



(see Figure A.2 as well as Table A.6 and A.7 in the Appendix). These models replicate the results of the TWFE models in terms of the direction of the effects with slightly larger confidence intervals, which turns the positive effect on vote shares for the Conservatives insignificant.

Overall, the analysis of the effect of the first coal closures for a municipality reveals strong support for a positive effect of coal closures on abstention rates (hypothesis 1) and for a negative effect on vote shares for the Social Democrats (hypothesis 3). However, these initial results do not support the hypotheses that coal closures lead to higher vote shares for the far left and far right (hypotheses 2a and 2b).

## **Main Analyses: Multiple Coal Closures**

Moving beyond the impact of the first coal closure per municipality, I look at how multiple coal closures within the same election period affect aggregate voting behaviour conditional on the occurrence of previous closures. While the estimates based on the full sample are depicted in Table A.5 in the Appendix, Table 1 presents the results of the models based on the matched sample. For municipalities that only experienced coal closures in one election period (which is the case for 14 out of the 20 treated municipalities), only the coal closure variable is relevant, which shows that with each additional coal closure per election period, the negative effect on the vote shares of the Social Democrats decreases while the abstention rate increases. For municipalities that experienced closures in several election periods, the point estimates of the previous closure dummy are very similar to those of the first coal closure in these municipalities, indicating that these results are mainly driven by municipalities with closures in multiple election periods.

Turning toward the main effect of interest here, namely the interaction of previous coal closure with the number of coal closures per election period, it can be seen that conditional on having already experienced a coal closure in a previous election period,

Table 1: TWFE multiple coal closures, matched sample (CEM)

	SPD	Greens	CDU	FDP	AfD	Left	Abs.
Coal closure	-0.749** (0.228)	0.003 (0.152)	0.158+ (0.095)	-0.085 (0.154)	0.160 (0.131)	0.012 (0.063)	0.523* (0.255)
Previous closure	-1.880*** (0.491)	-1.486*** (0.374)	1.097* (0.473)	0.549 (0.397)	-1.460*** (0.393)	-0.331* (0.148)	3.089*** (0.560)
Coal closure:Previous closure	0.442+ (0.229)	0.497** (0.159)	-0.507*** (0.118)	-0.235 (0.159)	0.508*** (0.133)	-0.006 (0.065)	-1.131*** (0.260)
FE: time	X	X	X	X	X	X	X
FE: AGS	X	X	X	X	X	X	X
Num.Obs.	775	775	775	775	310	620	775
Num.Munic.	155	155	155	155	155	155	155

*Note: Two-way fixed effects estimation of the effect of multiple coal closures conditional on the existence of previous closures on vote shares at the municipality level. Estimates based on matched sample following coarsened exact matching. AfD model is based on years 2015-2022 only, Left model is based on years 2010-2022 only. Robust standard errors clustered by municipality in parentheses. Abs. = Abstention, AGS = municipality (Amtlicher Gemeindegchlüssel). Signif. Codes: +  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .*

each additional coal closure per election period significantly increases the vote shares of the Greens and the AfD and decreases the abstention rate and the vote shares of the Conservatives.

Tying these results back to the hypotheses, I find strong support for two of the hypotheses and only weak to no support for the third. The findings suggest that the first coal closure has a strong positive effect on the abstention rate of the affected municipality, which—in municipalities with multiple coal closures—is partly offset by each additional coal closure. This strong support for hypothesis 1 suggests that economic grievances triggered by coal closures lead to the political disengagement of individuals in affected municipalities. Moreover, the first coal closure per municipality has a strong negative effect on vote shares for the Social Democrats, which is then not significantly (only at the 10 per cent significance level) affected by additional coal closures within the same election period. This provides evidence in support of hypothesis 3, suggesting that affected municipalities indeed punish the former issue owner and their long-term political ally, the Social Democrats. Furthermore, the first coal closure in a municipality does not significantly affect the vote share of the

AfD. However, each additional coal closure has a positive effect on AfD vote shares, which provides only some support for hypothesis 2a. Lastly, the effects on vote shares for the Left Party are largely insignificant, which goes against hypothesis 2b. This suggests that issues of positional deprivation and social status only played a minor role in influencing voting behaviour in affected communities.

As a robustness check, I performed all analyses with the complete sample of 396 municipalities of North Rhine-Westphalia which also includes the four municipalities in which additional coal plants were constructed during the time period of observation (see Tables A.8 to A.13 in the Appendix for the regression tables). These estimations lend support to my main findings which are consistently robust to this alternative specification of the sample.

## **Alternative Explanation**

So far, I have argued that the effects on vote shares in treated municipalities after 2007 are driven by coal closures. However, it could also be the case that not the closures themselves but rather the announcement of the closures through the hard coal phase-out law that was adopted in 2007 influenced voting behaviour in municipalities which had operating coal plants or mines in that year and which then experienced a closure later. This might be driven by fears of economic hardship or status decline rather than by the actual experience thereof (Kurer 2020).

To test this possible alternative explanation, I estimate standard difference-in-differences models to compare the vote shares for the regional elections before and after 2007 (i.e. in 2005 and 2010) for treated and untreated municipalities. I use two different conceptualisations of the treatment: first, treatment is defined as experiencing at least one coal closure after 2007. In a second step, those municipalities that had at least one operating coal plant or mine before the entry into force of the 2007 phase-out law are considered as treated (regardless of whether they experienced a

coal closure between 2007 and 2022 or not). Similar to the main analyses, I perform these analyses both for the full dataset as well as the dataset based on coarsened exact matching. The difference-in-differences models are specified as follows:

$$VoteShare_{mt} = \beta * Treated_{mt} + \epsilon_{mt} \quad (3)$$

where  $VoteShare_{mt}$  identifies a municipality  $m$ 's vote share for the specific party in year  $t$  and  $\beta$  identifies the parameter of interest, namely the effect of the treatment indicator ( $Treated_{mg}$ ), which is a dummy variable either indicating whether a municipality experienced a closure between 2007 and 2022 or whether a municipality had an operating coal plant or mine before the entry into force of the 2007 phase-out law. Again,  $\epsilon_{mt}$  identifies the error term. As the AfD and the Left Party were only founded in 2013 and 2007 respectively, these analyses cannot be performed for the two parties.

The results of these difference-in-differences regressions are displayed in Tables A.14 to A.17 in the Appendix. They show that while the estimations based on the full sample show a significantly positive effect on vote shares for the Christian Democrats and a partly significant negative effect on vote shares for the Greens, all effects except for the negative effect on vote shares for the Greens disappear when estimating the same regressions using only the matched sample. Since my main theoretical interest is not in the effect of coal closures on vote shares of the Greens, this allows me to rule out the possibility that the results that refer to my hypotheses are driven by the immediate reaction to the entry into force of the hard coal phase-out law in 2007 and not to the coal closures themselves.

## Discussion and Conclusion

In sum, I have provided evidence for an asymmetric backlash to the closure of coal plants and mines since 2007 which has expressed itself through a significantly negative effect on vote shares for the Social Democrats as well as a positive effect on abstention rates in treated municipalities compared to non-treated municipalities. However, I only found limited support for a positive effect of coal closures on vote shares for the AfD and no evidence of electoral consequences of the closures for support for the Left Party. Moreover, I have shown that these results are not driven by an immediate reaction to the announcement and entry into force of the 2007 phase-out law but rather by the coal closures themselves.

These findings point to the considerable disappointment of coal communities with the long-time issue owner of this topic, the Social Democrats, and could also be interpreted as another manifestation of the alienation of the Social Democrats with a prime example of their former core constituency. This disappointment is then primarily channelled into higher abstention rates in affected municipalities. While this political disengagement can be seen as a form of coal communities voicing protest against the coal phase-out, it might also be driven by economic grievances induced by a net loss of income relative to other municipalities. In the light of the contribution by Kurer et al. (2019), who show that the level of political mobilisation acts as a moderator for the effect of economic grievances on political engagement, these findings could also be interpreted as dissatisfaction of coal communities with trade unions, which should act as political mobilisers in this context. Taken together with the punishment of the Social Democrats, even though they were the only political party that fought for a later coal phase-out (and eventually succeeded), this speaks for a general dissatisfaction of affected communities with the performance of the two actors that were meant to represent their interests in the negotiations of the phase-out.

These findings provide the first empirical analysis of electoral backlash of a green

transition policy in an explicitly least-likely context, which makes these findings even more noteworthy. Even though the German corporatist system of interest representation foresees an active involvement of unions in the policy-making process, which was also the case for the coal phase-out policy, and even though there was targeted compensation for affected workers with the goal of alleviating economic grievances, these circumstances did not succeed in preventing local electoral backlash. This paints a rather pessimistic picture of the difficulty of preventing such backlash for the coal phase-outs that are yet to come in other countries.

While I provided some evidence that exposure to multiple coal closures increases vote shares of the AfD in affected municipalities, the empirical analysis of this hypothesis is weakened by the fact that the AfD was only founded in 2013 and thus only participated in the last two elections in North Rhine-Westphalia. These findings, therefore, only offer first insights. Replicating this analysis in another country with a longer existence of a far-right party might yield a better understanding of the consequences of coal closures for far-right voting behaviour. Generally, the role of social status loss in influencing voting behaviour among communities with a formerly high social status merits further investigation.

Relatedly, another limitation of the data stems from the fact that aggregate data can only offer limited insights into the mechanisms at play. While the reliance on actual voting records instead of survey data which might suffer from biases of representativeness and social desirability lends more credibility to the findings, it is not possible to directly test the assumed mechanisms behind the effect of coal closures on voting behaviour. However, a lack of individual-level data that is representative at the municipality level in North Rhine-Westphalia adds to this difficulty. Yet, further research to clarify the role that both social status and compensation for affected coal communities play in influencing vote choice might yield interesting insights with respect to the conditions under which electoral backlash against coal closures might

be attenuated.

All in all, the findings provide a first glance into the electoral implications of a transformation that is still ongoing in Germany and is yet faced by many countries around the world. In North Rhine-Westphalia alone, as of 2023, 68 coal-fired power plants as well as three lignite open-cast mines still remain in operation, all of which will be shut down until 2038 at the latest (Bundesnetzagentur [2023](#)). With the high level of politicisation around the topic of coal phase-outs and the high salience of the issue of fossil fuel generation, the asymmetric backlash to coal closures in North Rhine-Westphalia increases the importance of understanding the conditions under which such a backlash can be mitigated in order for other countries to adopt adequate policies.

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