Climate Policy and Political Polarization Along Occupational Lines: Evidence from Germany

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January 15, 2024

Abstract

Climate change policies create economic winners and losers. To what extent has the increased importance of climate change and climate change policies resulted in political polarization along occupational lines? We examine this question in the context of Germany, a country that has adopted some of the most far-reaching energy transition policies and that also has substantial employment in heavy emissions ("brown") occupations. We show that since the Paris Agreement, the AfD gained significantly and the Greens lost in communities with larger shares of employment in brown industries. We then use an individual level panel regression to show that after 2015 individuals in brown occupations have become significantly more likely to identify with the far right and less likely to identify with the Greens. These findings are not (fully) attributable to compositional effects in the sample or simultaneous political changes, most notably the 2015 migrant crisis.

1 Introduction

The energy transition, a shift from nonrenewable to renewable energy sources worldwide, is causing notable changes in the labor market. A core consequence of the energy transition is a shift from "brown" jobs, those associated with traditional, non-renewable industries, to "green" jobs related to environmental sustainability. In fact, the energy transition poses an existential challenge for some industries and occupations that need to be "phased out." This change is not without challenges. Workers in brown jobs often face difficulties when transitioning to greener roles and promises of financial compensation may not be credible

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(Bluedorn et al. 2023; Gazmararian and Tingley 2023). Do these labor market changes also have political consequences? In many countries, the far right has been the first, the loudest, and often the only opponent of energy transition policies. Can the far right attract support from workers in brown jobs and communities that depend on brown jobs?

We answer this question in the context of Germany. Germany has long pursued relatively aggressive energy transition policies. Recently, the far right Alternative for Germany (AfD) gained substantially in opinion polls over vocal opposition to a law mandating a transition to electric heatpumps.[1] Yet, the partisan cleavage predates 2023: Since 2016 the AfD party platform has emphasized how transition policies pose existential threats to economic freedom and to key German industries, especially the automotive and chemical industries. We examine whether this has resulted in polarization along occupational lines, with those in brown occupations shifting towards the AfD and away from the Greens, which is the party most strongly associated with a pro-energy transition platform?

Similar to the literature on globalization, we hypothesize that an existential threat to brown occupations may affect communities that depend on these jobs as well as the individuals who are in brown occupations. We first study the effect of the relative importance of brown occupations at the county level. We find that, compared to 2013, the AfD gained significant vote shares in counties with relatively high shares of brown employment in 2017 and 2021. By contrast, the Greens lost in brown counties.

We next use a differences-in-differences design in a German panel survey to analyze changes in political preferences among individuals employed in brown occupations. After the AfD started polarizing climate issues, employees in brown occupations disproportionately shifted towards the far right, although we do not find a significant shift away from the Greens. We find that these shifts in political allegiance cannot be attributed to differences in demographic characteristics or responses to the concurrent refugee crisis in Germany. We

[1]Karl Mathiesen, "How the far right weaponized heat pumps into electoral rocket fuel" Politico, October 4 2023, https://www.politico.eu/article/robert-lambrou-alternative-for-germany-heat-pump-election-climate-change/

do not yet examine the precise mechanisms through which brown occupations have electoral effects. Yet, these preliminary results reinforce the notion that the energy transition and its labor market implications have significant political repercussions.

2 Theory and Literature

2.1 The Labor Market and Electoral Consequences of the Energy Transition

Scholars have attributed the rise of the far right in Europe and the United States to both cultural and economic factors. The political economy literature has identified three plausible economic drivers of support for radical right parties and candidates: deindustrialization due to globalization and automation, austerity following the 2008 financial crisis, and the economic consequences of migration (For recent overviews of the literature, see Colantone and Stanig 2019; Margalit 2019; Rodrik 2021)).

A more recent emerging literature focuses on the energy transition as a fourth potential economic driver. Most of this literature highlights how energy transition policies increase the costs of carbon intensive consumption, which may drive some voters towards parties and candidates that oppose climate policies and away from Green parties or others who take strong pro-climate positions. For example, Milanese voters who were adversely affected by a ban on polluting cars became more likely to vote for the Lega Nord (Colantone, Di Lonardo, et al. 2022). Similarly, a Dutch policy that increased household energy taxes and redistributed the revenues as subsidies for renewable energy led voters who were more exposed to increases in household energy taxes and who did not benefit from the subsidies to become more likely to vote for the radical right and less likely to support the Greens (Voeten 2022). These findings build on a prior literature showing that voters are sensitive to gasoline price increases (e.g. Kim and Yang 2021) and an experimental literature demonstrating that public support for climate policies depends on their cost to individuals and their redistributive

effects (e.g. Beiser-McGrath and Bernauer 2023; M. Bechtel and Liesch 2020; Bernauer and Gampfer 2015; Egan and Mullin 2017; Schaffer 2023; Stokes and Warshaw 2017).

Yet, the energy transition and decarbonization will also have substantial labor market implications. Energy transition policies rely on making carbon intensive production relatively more expensive, for example through emission trading schemes that create carbon prices, carbon taxes, regulations, or through subsidies on less carbon intensive production. Most European countries have adopted environmental taxes and regulations that have increased energy prices. There is substantial evidence that higher energy prices have reduced labor demand in energy intensive industries across Europe in the 2010s, although these price increases were not just due to environmental policies (Bijnens, Konings, and Vanormelingen 2022; Cox et al. 2014; Marin and Vona 2021). Moreover, sociologists have started to examine the increased stigmatization associated with polluting industries and occupations (Beckfield and Evrard 2023), suggesting the possibility that efforts to fight climate change reduce the social status of brown occupations.

What sets the energy transition apart is that the threat to brown industries and occupations is existential: some industries and jobs will disappear altogether if governments follow through on their climate commitments (Colgan, J. F. Green, and Hale 2021). Green and other parties that advocate for more aggressive energy transition policies explicitly call for a phase out of fossil fuels, especially coal. Such policy positions have drastic consequences for individuals with brown occupations and for communities that either produce fossil fuels or have industries that heavily rely on fossil fuels, such as the chemical industry. While the energy transition also creates new greener jobs, individuals rarely move from more carbon-intensive to greener jobs (Bluedorn et al. 2023). Promises of financial compensation or green jobs that might replace brown jobs may not be credible (Gazmararian and Tingley 2023). However, until recently, radical right parties have been the only source of political opposition to energy transition policies in most European countries. It is thus plausible that the labor market consequences of decarbonization may have effects on both support for Green parties

but also the radical right.

There is already a literature on the electoral implications of the decline in coal employment in the United States. The decline of coal in the U.S. is mostly a consequence of increased competition from natural gas rather than climate policies. Yet, parties and politicians have taken visibly different positions about the future of coal. Especially Donald Trump campaigned heavily to defend coal whereas the Obama administration was accused of waging a "war on coal."[2] Districts with a higher share of coal-related job losses have relatively higher shares of the Trump vote (Goetz et al. 2019; Egli, Schmid, and Schmidt 2020) and there is evidence that the drop in coal employment has led to a partisan shift towards Republicans in U.S. coal communities (Gazmararian 2022). There is also evidence that, beyond coal, individuals employed in high emission industries and occupations are less likely to support climate cooperation (M. M. Bechtel, Genovese, and K. F. Scheve 2019). However, we know less about whether the energy transition contributes to broader electoral polarization along occupational lines.

Our study builds on the literature that attributes the rise of the radical right in the United States and Europe at least in part to job losses in import competing industries (e.g. Autor, Dorn, Hanson, and Majlesi 2020; Colantone and Stanig 2018; Dippel et al. 2022). Most manufacturing job losses are likely due to automation (Baldwin 2019) but increased trade exposure to especially China has also contributed to the decline of manufacturing, which long provided stable and relatively well compensated employment for a less educated male dominated labor force. In the United Kingdom, the anti-EU wing of the Conservative party and far right politicians, such as Nigel Farage, managed to attract votes in communities adversely affected by import competition (Colantone and Stanig 2018). In Germany, the far right was similarly successful in communities and among individual voters affected by job losses from import competition (Dippel et al. 2022).

A key theoretical precondition for these economic effects to have electoral effects is that

[2]Grunwald, Michael (1 June 2014). "New Carbon Rules the Next Step in Obama's War on Coal". *Time*. Retrieved 6 January 2016.

candidates or parties take distinct positions on them. For example, in the U.S., Donald Trump departed from longstanding Republican support for trade in the 2016 elections. Scholars therefore identify the effect of manufacturing employment losses on changes in Republican vote shares between 2012, when Romney ran on a traditional Republican platform, and 2016 even if the China shock effect was already visible in manufacturing employment numbers in 2012 (Autor, Dorn, Hanson, and Majlesi 2020). In many European countries, climate policy has long been a near consensus issue among centrist parties. Green parties have typically wanted more aggressive energy transition policies, but there was little active opposition to existing policies until far right parties started to take the issue on around the time of the Paris Agreement (Huber et al. 2021). Identifying when the issue becomes salient and polarized is thus a prerequisite for any study of the electoral effects of the energy transition.

Theories of how globalization affected support for the far right through its effects on labor markets differ across two conceptual dimensions. First, some studies highlight the labor market effects on individuals who are directly affected by deindustrialization whereas others also focus on the effects on communities (e.g. Broz, Frieden, and Weymouth 2021). Second, some studies examine purely economic pathways, such as job or wage losses or changes in housing prices, while others focus on how economic shocks affect the social status and values of individuals and groups (e.g. Baccini and Weymouth 2021; Ballard-Rosa, Jensen, and K. Scheve 2021). The broadest studies argue that industrial decline not only affected workers themselves, but also had broad economic and social effects on communities and affected the relative status of especially less educated white males (Autor, Dorn, and Hanson 2019; Baccini and Weymouth 2021; Pierce and Schott 2020).

We take a similarly broad approach. It is theoretically plausible that the energy transition affects electoral choices because individuals in brown occupations fear that their job opportunities or their social status are adversely affected. It is also plausible that the transition has broader effects on communities. For example, there is evidence that the energy transition creates considerable existential uncertainty in fossil fuel communities (Gazmarar-

ian 2024; Gazmararian and Tingley 2023) and that individuals tend to prefer broad based community approaches to compensation for job losses (Gaikwad, Genovese, and Tingley 2022). Sociologists have also identified the broader social implications of threats to relatively well-paying jobs for a relatively less-educated and male dominated labor force (for an overview, see: Beckfield and Evrard 2023). It is thus entirely plausible that concerns about energy transition policies have both individual and community level effects and that they can work through economic and/or social channels. Our empirical approach is to examine both community and individual effects. We do not yet have an empirical design that allows us to separate purely economic and social mechanisms.

2.2 The German Case

Germany is a good case to study this question because it has a relatively advanced energy transition policy and a relatively large share of the population working in polluting industries. The 2000 Renewable Energy Act adopted a feed-in tariff and grid priority for renewables. In 2010 the German government formally endorsed the "Energiewende," a planned transition towards a low carbon (and nuclear free) economy. These policies were supported by various coalition governments led by the centrist Christian Democrats (CDU) joined by the right of center FDP and the left of center Social Democrats (SPD).

The policies helped make Germany a leader in renewable energy industries (Nahm 2017). However, Germany also remains a traditional industrial powerhouse. For example, about 20 percent of Germany's workforce is in manufacturing, compared to just 10 percent for the United States and 12 percent in France. The car manufacturing industry is only just beginning to transition, resulting in significant job losses as electric vehicles are easier to build. The chemical industry cannot easily transition away from fossil fuel combustion. For example, BASF, which has more than 50,000 employees in Germany, has announced that it will permanently cut operations in Germany in response to "high energy prices and

overregulation."[3]

There is evidence that higher electricity prices have resulted in lower demand for labor in German industries with high electricity demand and that the effect is greater among low-skilled workers (Cox et al. 2014). A European study found that the regions with the greatest potential negative labor impact of rising electricity prices are located in Belgium, Germany, the Netherlands, Northern Italy, and Sweden (Bijnens, Konings, and Vanormelingen 2022). We do not yet know what, if any, the political consequences of these labor market changes are. Evidence from Spain suggests that an effective just transition policy that offers generous compensation to coal miners and coal mining communities gave an electoral boost to the party that implemented a coal phase-out (Bolet, F. Green, and González-Eguino 2023). Survey experimental evidence from the United States also supports this general insight (Gazmararian 2024). This matters in our context, as Germany has quite generous compensation policies for individuals who lose employment, including retraining programs. For example, in 2020, the German parliament passed the Structural Strengthening Act for Coal Regions ("Strukturstärkungsgesetz Kohleregionen") which aims to mitigate the impact of phasing out coal power by providing up to 40 billion euros until 2038 for significant investments and various support measures in coal regions, including active labor market policies, promoting their development post-coal era.[4]

For job concerns to translate into voting behavior, there must be salient distinctions between parties or candidates. Other than the AfD, German parties have not campaigned on climate change opposition during our timeframe. We determine the timing of the AfD's shift to climate opposition using three data sources: party manifestos, media reports, and election surveys. The AfD party program for the 2013 Federal elections remained silent on climate change.[5] The 2014 program for the European elections claims that scientific

[3]https://www.reuters.com/markets/europe/basf-says-european-operations-need-be-cut-size-permanently-2022-10-26/

[4]https://www.bmwk.de/Redaktion/DE/Textsammlungen/Wirtschaft/strukturstaerkungsgesetz-kohleregionen.html.

[5]https://www.abgeordnetenwatch.de/sites/default/files/election-program-files/afd_1.pdf

evidence for anthropogenic climate change is uncertain. However, the program still supports international climate mitigation efforts, claiming that: "In order to take the precautionary principle into account, a gradual reduction in CO2 emissions can be agreed within the framework of international agreements." [6]

This changes completely with the AfD's 2016 party Grundsatz ("basic principles") program, which attacks both climate science and climate policies. The document claims that "Carbon dioxide (CO^2) is not a pollutant, but an indispensable component of all life." The program also tackles the Energiewende and its existential threat to industry and Germany ways of life. The program states that: "[..] the German government is abusing the increasing CO2 concentration for the "great transformation" of society, with the result that personal and economic freedom is massively restricted."[7] Since then, the AfD has only increased its attention to this issue. Its 2021 program again challenges climate science and the "radical restructuring of industry and society" that "threatens our freedom on an increasingly frightening scale."[8]. The AfD has also consistently voted against climate legislation in the Bundestag and the European Parliament, where it was one of only three national party groups to vote against all major climate proposals (Schaller and Carius 2019).[9]

The media search examines whether the AfD's shift was noticed in public debates. We did a Factiva search on articles on the topic climate change that also mention the AfD for Germany's four largest newspapers: Bild, Süddeutsche Zeitung, Franfurter Allgemeine, and Die Welt. This yields 997 articles, but only one that appeared before 2016. The 2016 articles focus on the AfD's new election program, which was discussed in all newspapers and invited numerous critical opinion pieces. The jobs angle is also apparent. For example, newspaper stories report that AfD top candidate Alice Weidel in Berlin accuses Chancellor Angela Merkel (CDU) of endangering jobs in the automotive industry and unnecessarily pursuing

[6] https://www.abgeordnetenwatch.de/sites/default/files/election-program-files/afd-europawahl-2014.pdf

[7] https://www.afd.de/wp-content/uploads/2016/03/Leitantrag-Grundsatzprogramm-AfD.pdf

[8] https://www.afd.de/wp-content/uploads/2021/06/20210611_AfD_Programm_2021.pdf

[9] The others were the PVV (The Netherlands) and UKIP (the United Kingdom).

the "de-industrialization of Germany." [10] By far the most stories on the AfD and climate appear in 2019. Most of these relate to the Friday for future protests and reflect a broader jump in attention for the climate issue in Germany that year. More generally, the salience of climate issues increased considerably. We did a Factiva search on German media on the subjects "climate" and "elections". In 2013, this subset includes only 86 stories, but in 2017 it has 1358 stories and in 2021 9008. There are 226 stories in 2016, despite the absence of Federal elections that year. This suggests that the issue became a salient electoral issue only after 2015.

Data from election surveys confirm the timing of climate change polarization. Figure 1 shows how voters for different parties place themselves on the climate change issue based on the German Longitudinal Election Study (GLES). The figure plots regression coefficients and their 95 percent confidence intervals relative to CDU/CSU voters. In 2013, AfD voters are not significantly different from CDU and FDP voters. In contrast, in 2017 and even more so in 2021, the AfD voters stand out in terms of their views that the government should prioritize the economy over climate change (in 2017) [11] and that the government has already done too much to fight climate change.[12] The AfD is the only party that is substantively and statistically significantly to the right of the mainstream center right parties on this issue.[13]

We thus test the following hypotheses:

- **H1a:** Communities with a larger share of voters in brown occupations become more likely to vote for the far right in 2017 and 2021 compared to 2013.

- **H1b:** Communities with a larger share of voters in brown occupations become less likely to vote for the Greens in 2017 and 2021 compared to 2013.

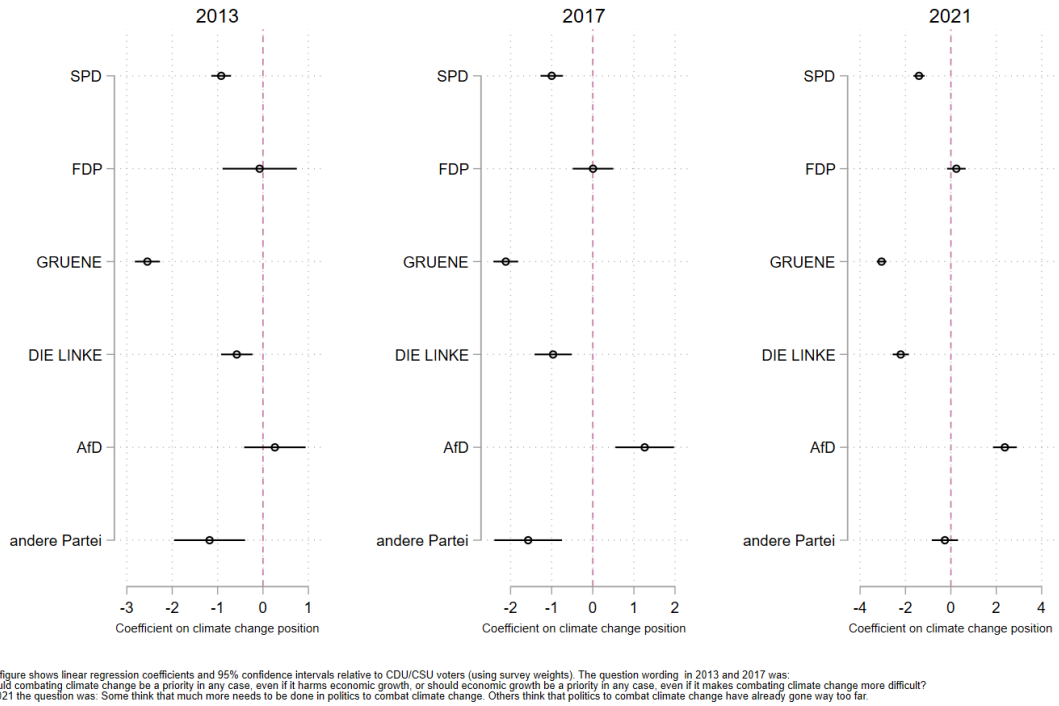
[10] "AfD bestreitet Klimawandel", Süddeutsche Zeitung, 5 September 2017

[11] The 2017 question asks: "Should combating climate change be a priority in any case, even if it harms economic growth"

[12] The 2021 question is: "Some think that much more needs to be done in politics to combat climate change. Others think that politics to combat climate change have already gone way too far."

[13] Voters were also asked to place parties on this scale, although they were not asked about the AfD in 2013. In 2017 and especially 2021, voters recognized the AfD as being significantly "to the right" on climate from the other parties.

Figure 1: Voter views on climate change by party choice in 2013, 2017, and 2021 (Regression coefficients with CDU/CSU as the reference category, based on GLES surveys)



And the equivalent at the individual level, where we have annual panel data.

- **H2a:** Individuals in brown occupations become more likely to vote for the far right after 2015
- **H2b:** Individuals in brown occupations become less likely to vote for the Greens after 2015

3 Data

We compile both county-level and individual-level data to study political polarization between brown and non-brown occupations. At the county level, we combine administrative employment data and federal election results. At the individual level, we use the German Socioeconomic Panel (SOEP), a longitudinal survey of private households established in 1984

and carried out annually. For the period 1990-2020 the panel consists of 34 757 observations on average (18 643 in 1990, 59 852 in 2020). In addition to demographics, the survey contains several items on labor market indicators, economic perceptions, and political preferences.

3.1 Brown occupations

To test our theoretical expectations, we need to identify people who work in brown occupations. Therefore, we use brownness scores for occupations provided by (Vona et al. 2018). They first define the most polluting industries as those in the 95th percentile of pollution intensity for at least three pollutants among CO2, CO, VOC, NOx, SO2, PM10, PM2.5, and lead, and then define as brown all occupations relatively prevalent in these polluting industries, that is, those with probability of employment in these industries at least 7 times higher than employment in any other industry. As these measures are from the US context, we use crosswalks provided by (Cavallotti et al.,2023) to adapt them to the European context. This mapping results in a continuous measure of the Brownness of occupations in the ISCO classification. This continuous brownness score for occupations fundamentally represents the unweighted likelihood of being predominantly employed in a polluting sector, drawing on the dynamics of the US labor market. It is predicated on the belief that these dynamics are a close mirror of those in Germany, particularly in how occupations are distributed across different industries, suggesting a similar concentration of occupations in identical industries in both regions. Furthermore, it is assumed that the specific pollution patterns for each industry are consistent across continents. However, these assumptions are deemed fairly reasonable, especially in light of the parallel production technologies and industrial trends observed in both the US and Germany.

To create a county-level measure of brown employment, we acquire administrative labor market data from the German Federal Employment Agency (*Bundesagentur für Arbeit*) on the number of workers who are employed in these brown occupations in each county for the period 1996-2022. In particular, we construct the share of people working in brown

occupations for the election year 2013 (pretreatment).

$$\text{Share brown employment}_{c,2013} = \frac{\sum_{j=1}^{J} N_{c,2013}^{j} \times \text{brownness}^{j}}{\sum_{j=1}^{J} N_{c,2013}^{j}} \tag{1}$$

where $N_{c,2013}^{j}$ measures the number of people working in a particular occupation j (ISCO08) in a county c in 2013 and brownness^{j} measures the particular brownness score of that occupation.

As county-level employment data before 2012 is only available for three-digit German Classifications of Occupations 1988 (*Klassifikationen der Berufe; KldB 88*), we crosswalk the brownness scores of ISCO08 occupations to KldB 88. Moreover, for the years 1996-1998, we only obtain data with county boundaries set at the respective year (1996-1998). Some counties have experienced boundary changes and mergers since then. To obtain a balanced panel of comparable counties, we map all counties that experience boundary changes to their 2021 boundaries using population-weighted crosswalk files provided by the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR; see section A.2.1 for more details). We present the distribution of brown jobs across counties in 2013 in figure 2.

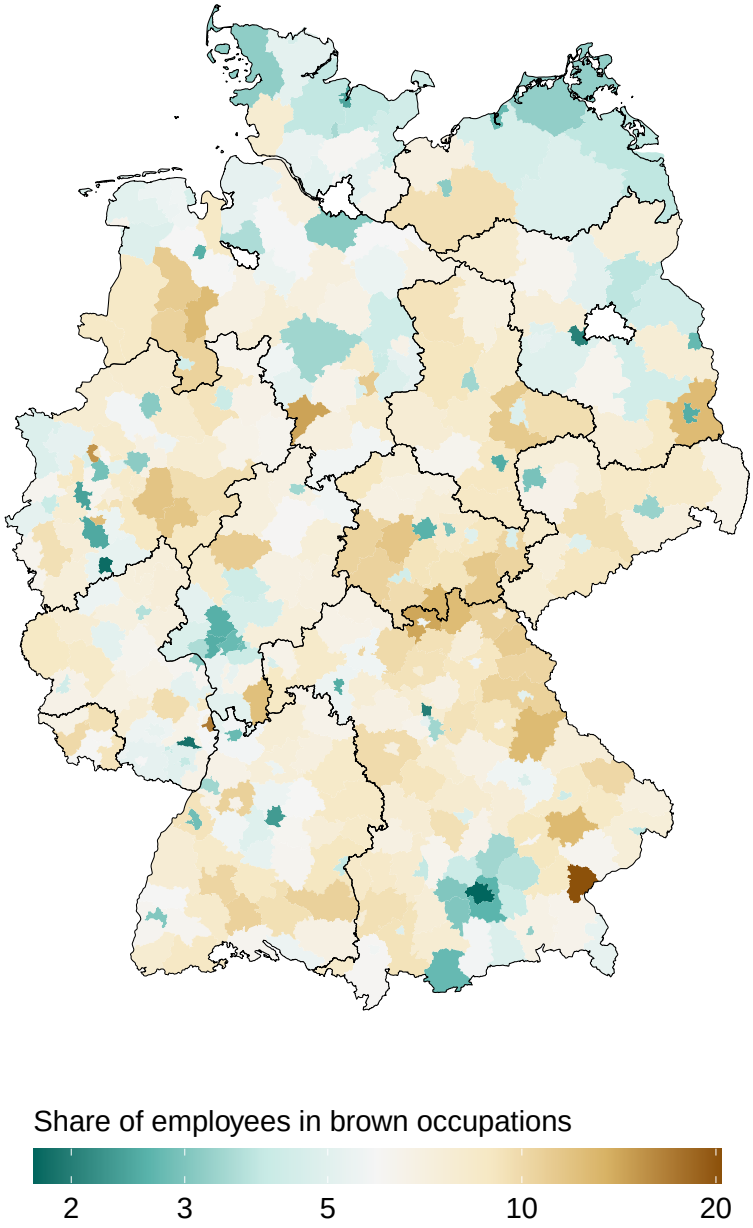
When analyzing individual-level panel data, we obtain individual-level brownness scores using the ISCO-88 and ISCO-08 indicators in the SOEP panel data.[14] We create a binary indicator for brown occupation (brownness > 0.3) following (Cavallotti et al 2023).

3.2 Political outcomes

For the county-level analyses, we compile data on German federal election results at the county level between 1980 and 2021. Some counties have experienced boundary changes

[14]ISCO-88 codes are only available until 2017, ISCO-08 only since 2013. We use ISCO-08 codes to merge with brownness scores since 2013. For previous years, we cross-walk the ISCO-88 indicator with the ISCO-08 codes using the official correspondence table of the International Labor Organization (`https://www.ilo.org/public/english/bureau/stat/isco/docs/corrtab08-88.xls`). In some cases, multiple ISCO-08 codes are merged into a respective ISCO-88 code. In such cases, we calculate the mean brownness score across all the merged ISCO-08 codes.

Figure 2: Geographic distribution of brown jobs in Germany



Notes: the figure shows the share of brown jobs in each county in 2013.

and mergers during this period of time. To obtain a balanced panel of comparable counties, we map all counties that experience boundary changes to their 2021 boundaries using population-weighted crosswalk files provided by the Federal Institute for Research on Build-

ing, Urban Affairs, and Spatial Development (BBSR; see section A.2 for more details). Our data include party vote shares and voter turnout.

When analyzing individual-level panel data, we focus on outcome variables that measure individuals' voting intention. In particular, participants are asked "Which party do you lean toward?". We construct binary variables for each party that take the value 1 for a respective party if the respondents indicate that they lean toward that party, and 0 otherwise.

3.3 Covariates

At the county level, we collect data for several potential confounders that affect both the share of brown jobs in a county and election outcomes that vary between counties and election years. In particular, we collect data on the total county population and population density obtained from BBSR. In addition, data on the share of manufacturing workers and the unemploment rate, average gross income, and average household income are obtained from the Federal Statistical Office of Germany.

Table 1: Summary statistics for county-level variables in 2013

	Mean	Median	SD	N	Min	Max
Employees in brown occupations (%)	6.77	6.66	2.62	399	1.75	20.30
Unemployment rate (%)	0.06	0.06	0.03	397	0.02	0.17
Gross income	29148.92	28402.00	4430.15	397	21920.00	52480.00
Household income	20159.53	20035.00	2455.12	397	15186.00	33310.00
Share manufacturing (%)	19.79	18.58	8.53	397	1.65	49.38
Population density	509.45	193.61	657.45	399	36.47	4530.48
Population	193.85	149.70	165.81	399	34.10	1746.30
AfD	4.90	4.73	1.11	399	2.38	9.01
Far right parties	6.55	6.16	1.80	399	2.93	13.39
FDP	4.35	4.34	1.35	399	1.52	10.42
CDU/CSU	42.36	41.95	7.35	399	25.18	62.59
SPD	25.44	24.42	7.38	399	11.39	49.86
Green Party	7.57	7.28	3.11	399	2.45	21.73
Left Party	8.91	5.70	7.15	399	2.58	29.45

Notes: The table shows summary statistics for aggregate-level data in 2013.

4 Research design

4.1 County-level data

To estimate the aggregate effects of the energy transition on voting, we estimate a specification of the following form:

$$Y_{cjt} = \gamma_c + \delta_{jt} + \sum_{k=-3}^{1} \theta_k \big(D_c \times \mathbf{1}_{t=k}\big) + \beta' X_{ct} + \varepsilon_{cjt} \tag{2}$$

Here, c indexes counties, t indexes years and j indexes federal states. The outcome Y_{ijt} is the vote share for a given party in county c and election t. The main treatment D_c is the share of people working in brown occupations in county c in 2013 (i.e., prior to the treatment). We are interested in the parameters θ_k, which are the difference-in-differences estimates for the k^{th} election before or after treatment. Here, k indexes elections relative to 2017, with $k = 0$ indicating the 2017 election, $k = -1$ indicating the 2013 election, etc. The term γ_i is a county fixed effect, and the term δ_{jt} is a state-specific election fixed effect. The latter accounts for time-varying confounding at the state level. As is standard practice in event study analyses, we omit the interaction between D_c and the last pre-treatment period election (2013, which corresponds to $k = -1$), which serves as the baseline for all estimated treatment effects. Standard errors are clustered by county.

The matrix X_{ct} contains the following control variables, all measured at the county level: average household income, county-level gross income, the share of workers employed in the manufacturing sector, population density, total population and unemployment rate. Descriptive evidence suggests that counties with many brown jobs tend to be more rural, have higher shares of manufacturing employment, slightly lower incomes and are more supportive of the CDU/CSU. As a further pre-processing step, we therefore use a weighting approach to ensure that counties with high and low shares of brown jobs are as comparable as possible. Since we have a continuous treatment, we rely on the covariate-balancing propensity score

approach (CBPS). As we show in figure 7, weighting considerably improves balance. All results are derived from specifications that use these weights.

4.2 Individual-level data

In a second step, we assess whether (i) party preferences differ between individuals in brown and non-brown occupations and (ii) whether this relationship varies over time. To do so, we estimate a specification of the following form:

$$y_{it} = \tau D_{it} + \theta(D_{it} \times I_{2015+}) + \beta' X_{it} + \gamma_i + \delta_t + \varepsilon_{it} \tag{3}$$

Here, y_{it} is the reported party preference for individual i in year t. Our main independent variable is D_{it}, the indicator of having a brown job. We include individual fixed effects i and year-fixed effects t. We estimate the effect of holding a brown job prior to 2015 (τ) as well as the change in the brown / non-brown difference in political attitudes after 2015 (θ). In particular, the inclusion of the term $D_{it} \times I_{2015+}$ allows us to examine whether the political attitudes of those in brown occupations change as the viability of their jobs decreases. The vector of control variables X_{it} includes age, education levels, income, migration background, and concerns about immigration.

We note that the interpretation of the coefficient θ is not straightforward, since, for some individuals, $D_{it} \neq D_{it'}$ for $t \neq t'$. Put differently, individuals can switch in and out of brown jobs over time, with the latter being more common. As a result, changes in political attitudes among individuals in brown occupations can stem from either (i) actual changes in attitudes within those individuals over time or (ii) compositional differences, which occur if there is a correlation between political attitudes and the propensity to select out of brown occupations.

To assess whether compositional differences account for the over-time changes in political preferences of employees in brown occupations, we rely on two strategies: first, we include

several time-varying covariates X_{it}, chiefly income and worries about immigration. We note that individual-level time-invariant characteristics, such as gender, education, and migration background, are already taken into account by including individual-level fixed effects γ_i. Second, we use a weighting approach, in which we seek to keep the composition of the groups defined by D_{it} constant. We provide more details on this approach in Section A.3 of the SI, where we also assess the resulting improvement in balance through a comparison of covariate means over time in Figure 6. While some imbalance remains, this approach significantly improves balance between the brown and nonbrown groups over time.

5 Results

5.1 Aggregate-level results

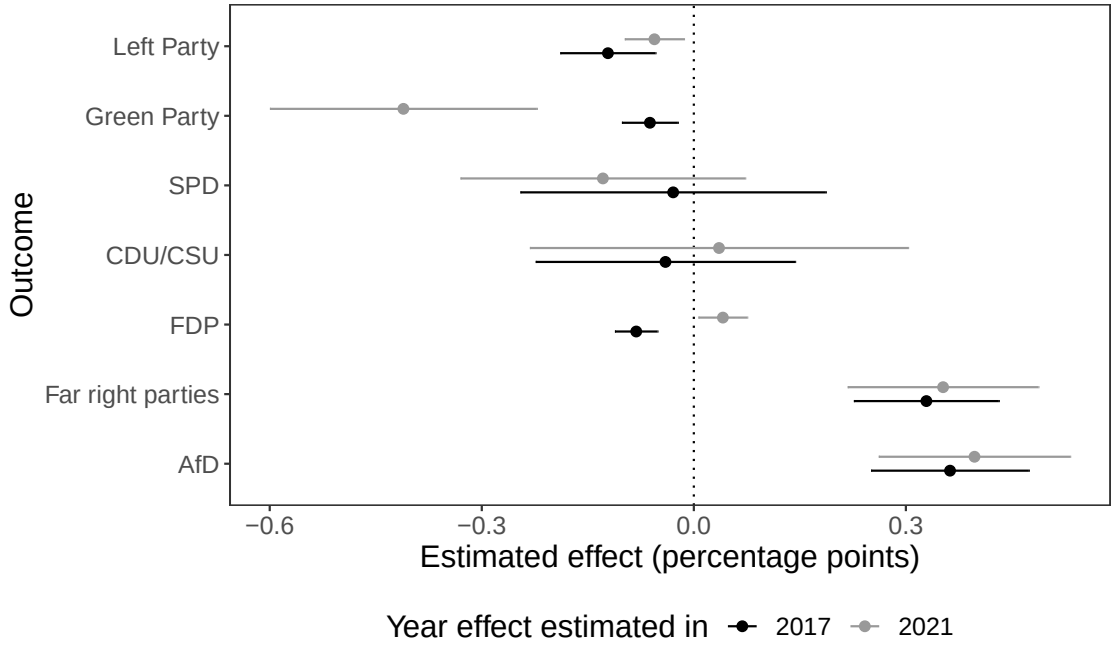
We begin by assessing whether counties with a higher share of brown jobs have experienced a change in party support after 2015. We present the results in figure 3.

The figure shows the relationship between the share of brown jobs in 2013 and the change in vote shares between 2013–2017 as well as 2013–2021, at the county level. This means that we present the estimated coefficients θ_0 and θ_1 from equation 2.

As discussed above, we argue that, subject to typical assumptions, this relationship can be interpreted as a causal effect. In 2017, we find that counties with a higher share of brown jobs have experienced an increase in support for the AfD and a decrease in support for the Left party, Greens and the FPD. In 2021, these patterns are similar, with the main differences being that losses for the Green party are considerably larger, while gains for the AfD are comparable to 2017. The estimates we present in figure 3 are consistent with descriptive assessments of the underlying data, which we present in figures 8 and 9 in the SI.

In the appendix, we further present lags and leads estimates in figure 10. Here, we show all estimated coefficients θ_k from equation 2. As is standard in difference-in-differences designs, we use the estimated coefficients for the leads of the treatment to assess the validity

Figure 3: Aggregate results



Notes: The figure presents the results from the main specification.

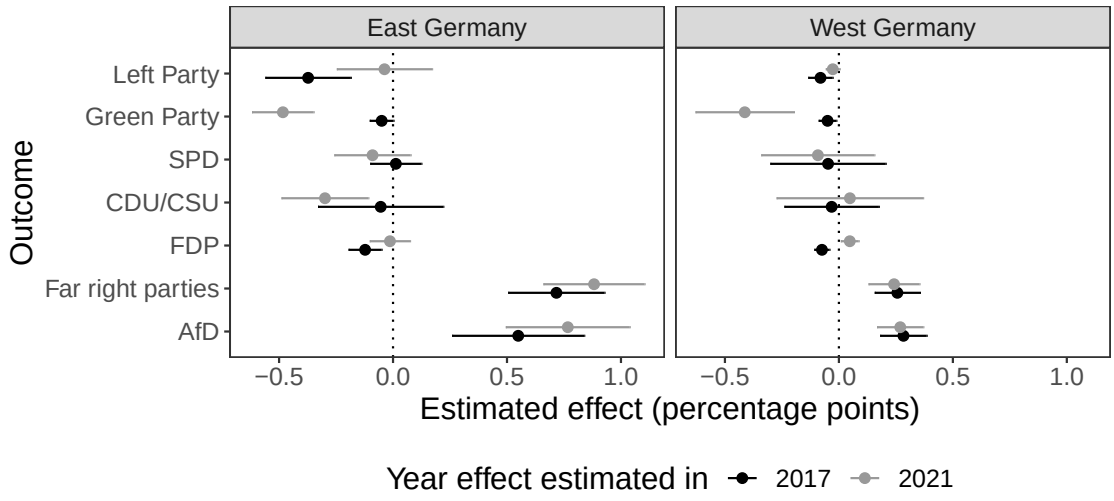
if the parallel trends assumption. With regard to our main outcome – voting for the AfD party –, we cannot directly assess trends prior to 2013, since the AfD did not compete in earlier elections. We can, however, use the combined vote share of far right parties instead, since other far-right parties competed before 2013. Here, we observe coefficients that are close to zero, which suggests that, with respect to radical-right voting, counties with many brown jobs were not on a different trend prior to 2013. We similarly find no evidence for diverging trends when examining voting for the FDP, CDU/CSU, and the SPD. For the Greens and the Left Party, however, there is some evidence that counties with a higher share of brown occupations did not follow the same trends as counties with a lower share prior to 2013. We therefore advise caution when interpreting the main results for these parties.

Notably, our main results are similar when comparing East and West Germany, as we show in figure 4. Put differently, our main results do not appear to be driven by the fact that brown jobs are more prevalent in East Germany, and that the AfD is more popular in East Germany. We find the that the sign and significance of the coefficients for each party is

similar in East and West Germany. Effect sizes are generally larger in East Germany, which is likely due to the fact that vote shares for the AfD are generally higher in East Germany.

Finally, we verify that our measure of brown jobs does not merely pick up on urban-rural differences. As shown in figure 2, it appears that urban areas tend to have fewer brown jobs. We observe the same result when assessing the relationship between brown jobs and population density in figure 7 in the SI. We note that our main specification already includes population density as a control. To further address urban-rural differences we add an additional term to our main specification, which allows for time-varying effects of pre-treatment population density on the party vote share outcomes. We present the results in figure 13 in the SI, and find that the results are robust to the inclusion of this additional term.

Figure 4: Aggregate results – comparing East and West Germany



Notes: The figure presents the results from the main specification, separately for East and West Germany.

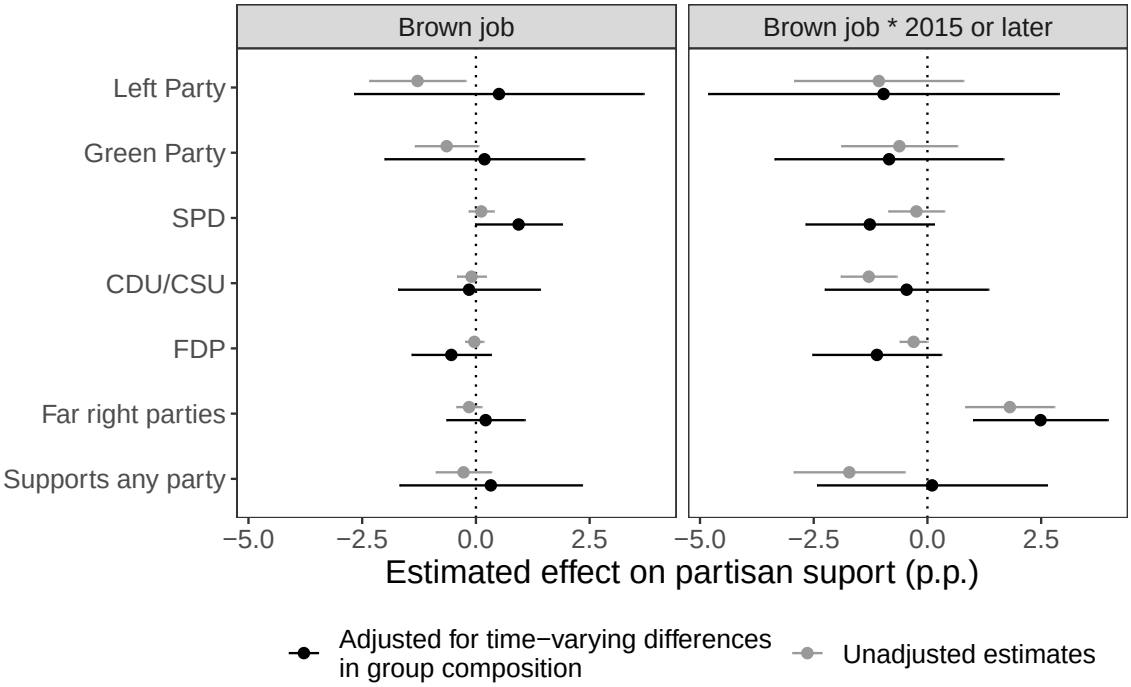
5.2 Individual-level results

In the previous section, we have established that counties with a higher share of workers in brown jobs experience larger swings towards the AfD than counties with a lower share of

brown occupations. We now draw on individual-level panel data to examine whether we see similar effects when comparing individuals in brown vs. non-brown occupations.

In figure 5, we show that radical-right support is initially similar among respondents in brown and nonbrown occupations. However, after 2015, individuals in brown jobs become disproportionately more supportive of radical right parties, primarily the AfD.

Figure 5: Brown occupations and partisan support, before and after 2015



Notes: The figure presents results from the specification described in section 4, with an additional interaction for responses recorded 2015 or later. The sample is all responses between 1990 and 2020. The left-hand side contains coefficients that are based on the period of 1990-2014, while the right-hand-side panel contains the coefficients for the interaction term between D_{it} and the indicator variable for responses recorded 2015 or later. Models include year and individual-level fixed effects.

As discussed previously, the fact that individuals can and do switch out of brown occupations is an issue for our analysis. To address this, we use (i) individual-level fixed effects to account for time-invariant differences between individuals, (ii) time-varying covariates and (iii) weighting to account for compositional differences between the groups defined by D_{it}. In figure 5, the estimates labelled "adjusted" are based on specifications that rely on these three approaches. While this approach increases uncertainty, our main results – a relative increase

in radical-right support among respondents in brown occupations after 2015 – remains the same.

5.3 Robustness

Finally, we conduct a number of robustness checks for the aggregate as well as the individual-level analyses.

Aggregate-level results: First, we show that our results are robust to alternative definitions of the aggregate-level treatment in figure 11 in the SI. Second, we show that are results are not driven by one specific state – excluding states one-by-one does not change our main conclusions (see figure 14 in the SI).

Individual-level results: Third, in figure 14, we assess whether regional differences can account for the observed relationship between brown occupations and radical-right support. We do so by including state fixed effects and state-specific time trends. We find that our main results are robust to the inclusion of these controls.

6 Conclusion

The transition to sustainable energy sources is crucial to combating climate change. However, the shift from non-renewable to renewable energy sources is not only an environmental and economic shift, but also a profound social and political transformation. We argue that workers in traditional, non-renewable industries and occupations face economic and social difficulties, as transitioning to greener jobs is often challenging. We expect that workers in "brown" jobs will favor political actors that oppose energy transition policies.

We provide evidence for our argument from Germany, a country that has long pursued extensive energy transition policies, and where the far right AfD has been the sole vocal opponent of these policies. Using a difference-in-differences design and county-level and

individual-level panel data, we show that workers in brown occupations disproportionately shifted towards the far right after the 2015 Paris Agreement and the subsequent opposition of the AfD to energy transition policies.

Based on our findings, we propose several implications and potential avenues for future research. First, our study highlights the need for policymakers to consider the broader socio-political impacts of energy transition policies, particularly on workers in affected industries. This calls for comprehensive strategies that not only promote environmental sustainability, but also address the economic and social challenges faced by these workers. Recent scholarship shows that compensatory policies in the Spanish coal country can alleviate economic and political grievances (Bolet, F. Green, and González-Eguino 2023). Future research could test similar programs more broadly focusing on other occupations and industries. This could include examining the role of retraining programs, economic incentives, and community engagement initiatives in mitigating the adverse effects of this transition.

Second, our research underscores the importance of understanding the dynamics of political allegiance shifts in the context of major policy changes. The pronounced movement toward the far right observed among workers in 'brown' occupations suggests a deeper, underlying narrative of perceived economic vulnerability and identity threat. Future studies could investigate the psychological and cultural factors driving these political changes, providing information on how to effectively communicate and implement policy changes in a way that resonates positively with affected communities (Gazmararian and Tingley 2023). Investigating the role of political discourse, media influence, and grassroots movements in shaping public perception during energy transitions could provide valuable lessons for fostering more inclusive and politically stable environmental policies.

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A Supplementary Materials

A.1 Additional information on brownness data

A.1.1 County mergers

The counties for 1996-1998 have territorial boundaries set at the respective cut-off date (30 June 1996, 30 June 1997, 30 June 1998). Because crosswalk files are only available for December 31 of the respective year, we crosswalk the occupation data with county territorial boundaries set at the year before (31 December 1995 for year 1996, 31 December 1996 for year 1997, 31 December 1997 for year 1998). We map the boundary of each county in the years prior to 2021 to its 2021 boundaries using crosswalk files from the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR). For a detailed account of this process, see section A.2.1.

A.2 Additional information on election data

A.2.1 County mergers

During the period of time we study, the county borders change. To create a balanced panel where the number of counties remains constant over time, we map the boundary of each county in the years before 2021 to its 2021 boundaries using crosswalk files from the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR). Specifically, for all counties that were subject to change, we calculate a weighted average of each variable that we use in the analyses using a population-weighted key. For example, if counties a and b merge into a new county c, the value of a variable X_c^{merged} for county c after merging is the population-weighted average of the values X_a and X_b, that is, $X_c^{merged} = \frac{w_a}{w_a+w_b}X_a + \frac{w_b}{w_a+w_b}X_b$, where w_a and w_b are the population sizes of counties a and b. The units of analysis are counties in their 2021 boundaries. This procedure may introduce some measurement error in our models.

A.3 Weighting

Compositional differences: As described in section 4, the composition of the group of respondents in brown occupations changes over time. In particular, the share of respondents in brown occupations decreases over time. Formally, for some covariate X, we can write the

mean of this variable for respondents in brown and non-brown occupations in year t as:

$$\mu_{X,\text{brown},t} = \frac{\sum_{i=1}^{N} X_{it} D_{it}}{\sum_{i=1}^{N} D_{it}}$$
$$\mu_{X,\text{non-brown},t} = \frac{\sum_{i=1}^{N} X_{it}(1 - D_{it})}{\sum_{i=1}^{N} (1 - D_{it})}$$

We can call the difference between these two means $\Delta\mu_{X,t} = \mu_{X,\text{brown},t} - \mu_{X,\text{non-brown},t}$. As stated above, $\Delta\mu_{X,t}$ is not constant across t. In designs where D_{it} is fixed across all t, the variance of $\Delta\mu_{X,t}$ across t can only stem from changes in X_{it}, i.e. from time-varying covariates – in our design, variance in $\Delta\mu_{X,t}$ can also stem from changes in the composition of the group defined by D_{it}.

Calculating weights: To calculate weights, we proceed as follows:

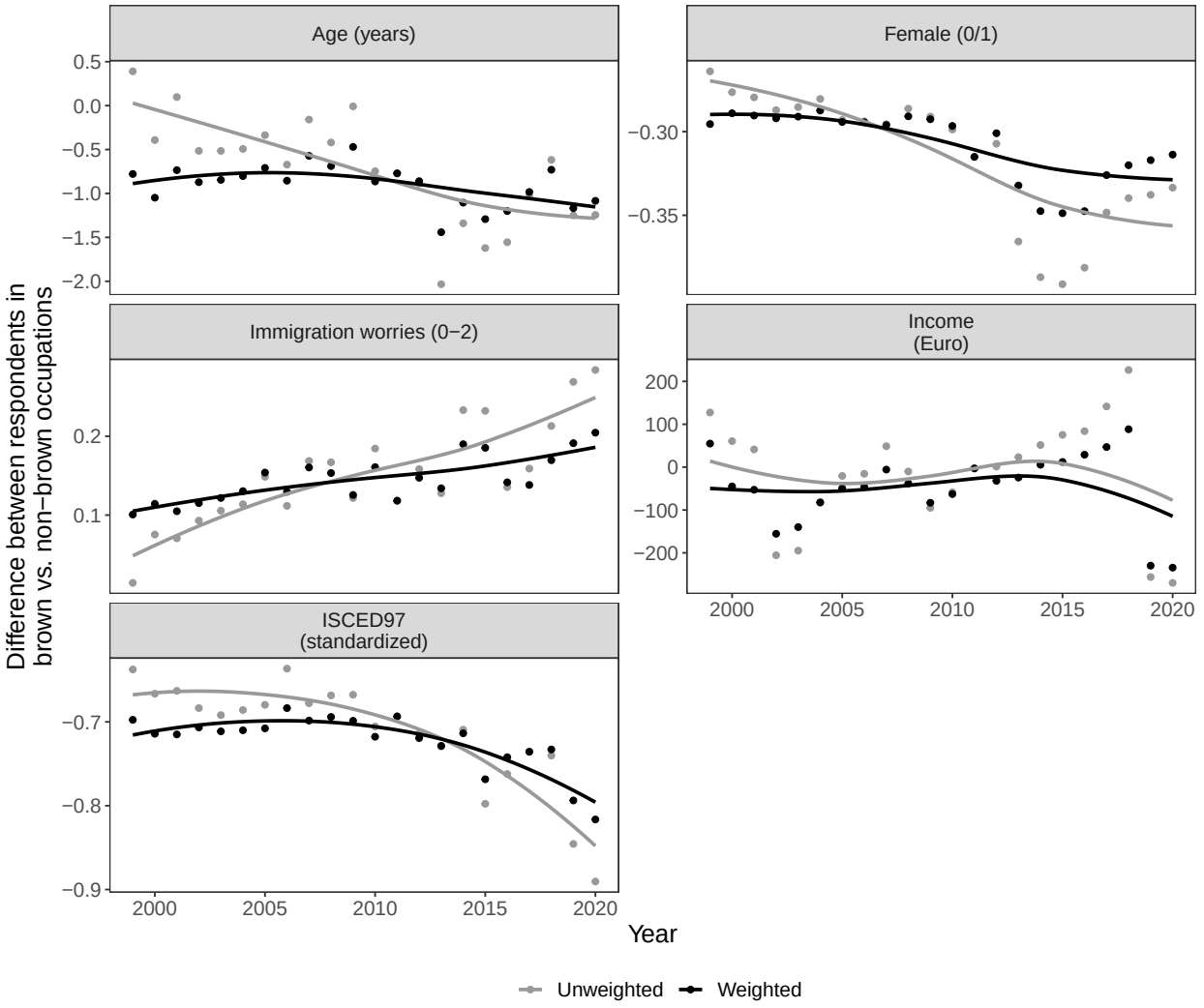
- We select 2011 as the reference year. We then select all observations that are either observed in 2011 or in a year t' such that $t \in \{2011, t'\}$ with $t' \neq 2011$. We further restrict the set of observations to $D_{it} = 1$, which means we end up with the set $\{(i,t) \mid t \in \{2011, t'\} \text{ and } D_{i,t} = 1\}$.[15]
- We then define a simple indicator variable T_{it} that tells us whether $t = 2011$ or $t = t'$, i.e $T_{it} = \mathbb{1}\{t = 2011\}$. Next, we estimate the propensity of an individual i being observed in 2011 as a function of all covariates. We call this propensity score $\hat{\pi}_{it'}(X_{it})$, which measures the probability of $T_{it} = 1$.
- For observations with $t = t'$, we then obtain weights $w_{it'} = 1/(1 - \hat{\pi}_{it})$.
- We repeat the previous steps for the set of observations that are in non-brown jobs, i.e. for the set $\{(i,t) \mid t \in \{2011, t'\} \text{ and } D_{it} = 0\}$. This gives us weights $w_{it'}$ such that $t' \neq t$. For individual observed in $t = 2011$, we set $w_{it} = 1$ for all i.

Intuitively, this approach selects a target sample (either individuals in brown jobs or individuals in non-brown jobs in 2011), and then weights individuals observed in all other years to reduce the change in the composition of the brown and non-brown groups over time.

Compositional differences in the weighted sample: Given the procedure described above, we obtain weights w_{it}. We can then calculate weighted versions of $\mu_{X,\text{brown},t}$ and $\mu_{X,\text{non-brown},t}$, and then obtain the difference in weighted means $\Delta\mu_{X,t}^{\text{weighted}}$.

[15] For clarity, we can also write this set as $\{(i,t) \mid t = 2011 \text{ and } D_{i,2011} = 1\} \cup \{(i,t) \mid t = t' \text{ and } D_{i,t'} = 1\}$

Figure 6: Differences between respondents in brown and non-brown occupations over time

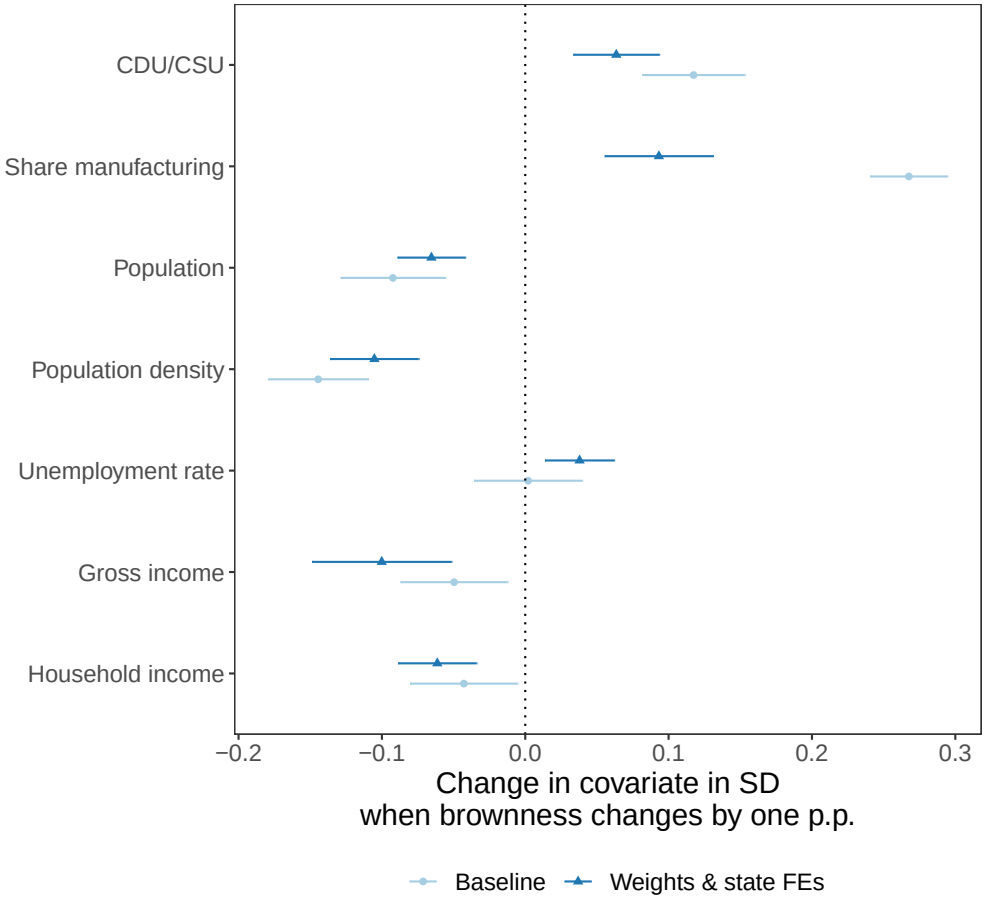


Note: The figure shows the average difference between individuals in brown and non-brown occupations over time, for five covariates. We present weighted and unweighted differences. For more information, see A.3.

In figure 6, we present both $\Delta\mu_{X,t}$ and $\Delta\mu_{X,t}^{\text{weighted}}$. The relevant metric is whether the differences between brown and non-brown groups are changing over time. Put differently, if the slope of the relationship between year and the mean covariate difference between groups $D_{it} = 1$ and $D_{it} = 0$ is different from 0, this indicates that the composition of brown occupations changes relative to non-brown occupations. We find evidence for changes in composition for all covariates. After weighting, these changes are noticeably less pronounced, but not absent.

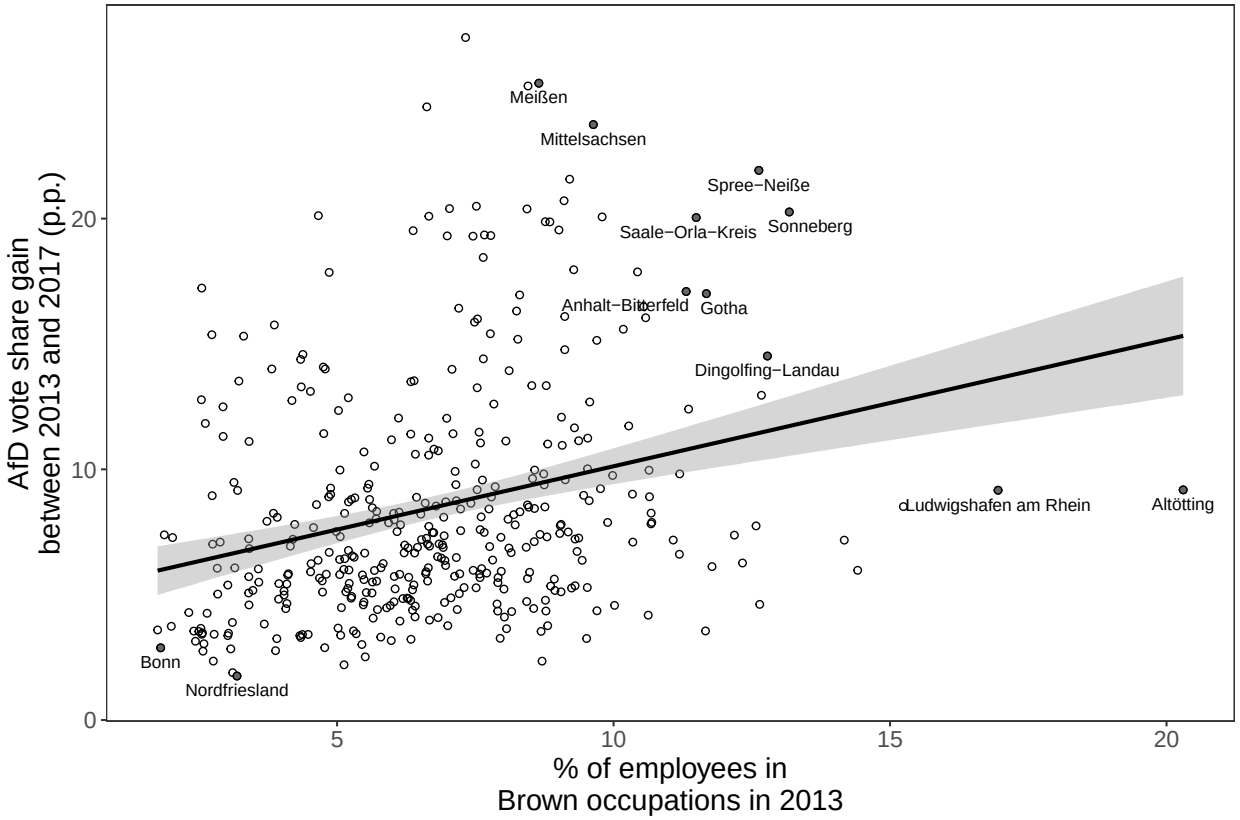
A.4 Descriptives

Figure 7: Pre-treatment balance



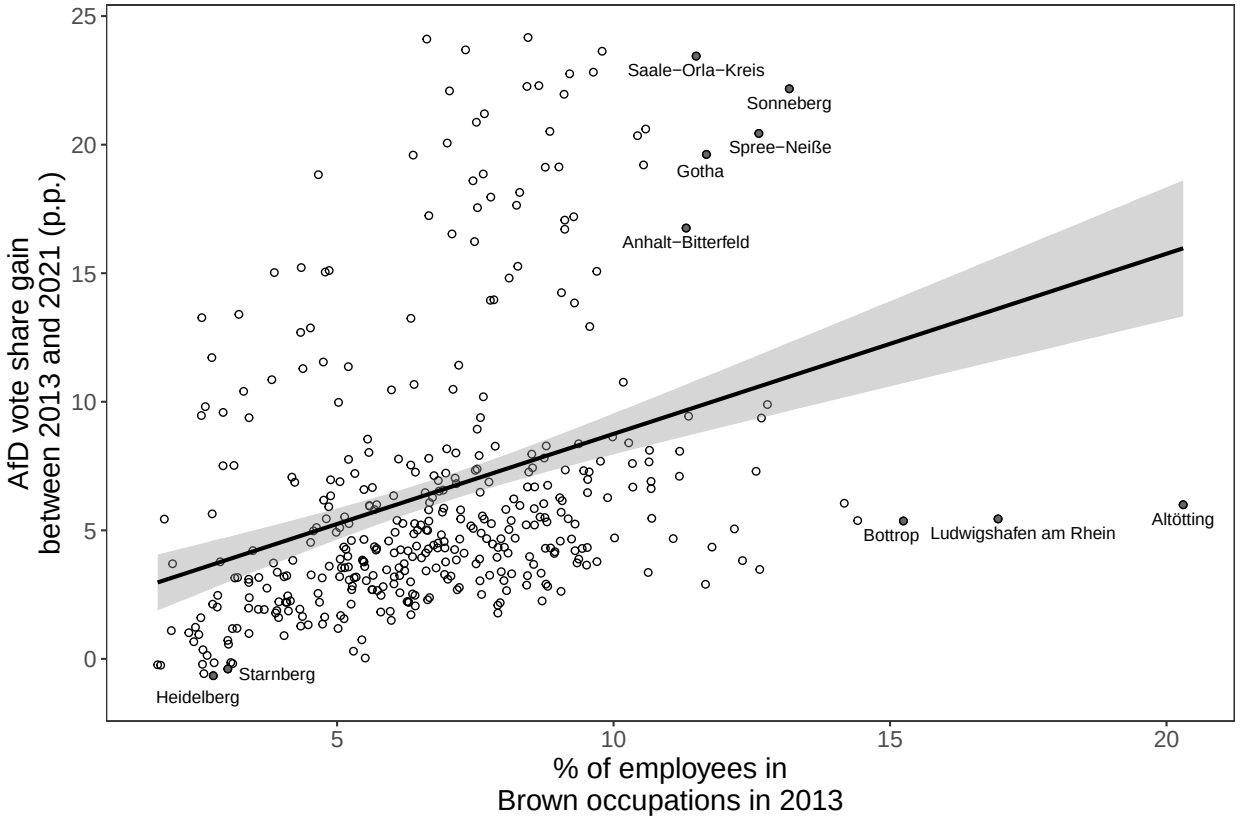
Notes: The figure shows the relationship between the share of brown jobs and a number of pre-treatment variables. We standardize each pre-treatment variable, and then regress is on the county-level share of brown jobs, in percent, for a cross-section of counties in 2013. We further show specifications that use the weights described in section XX, as well as state FEs, since our main specifications include state-specific time trends.

Figure 8: Change in AfD support 2013–2017 and brown occupations in 2013



Notes: The figure shows the county-level shares of brown occupations in 2013 and the change in AfD support between 2013 and 2017. We highlight select counties.

Figure 9: Change in AfD support 2013–2021 and brown occupations in 2013

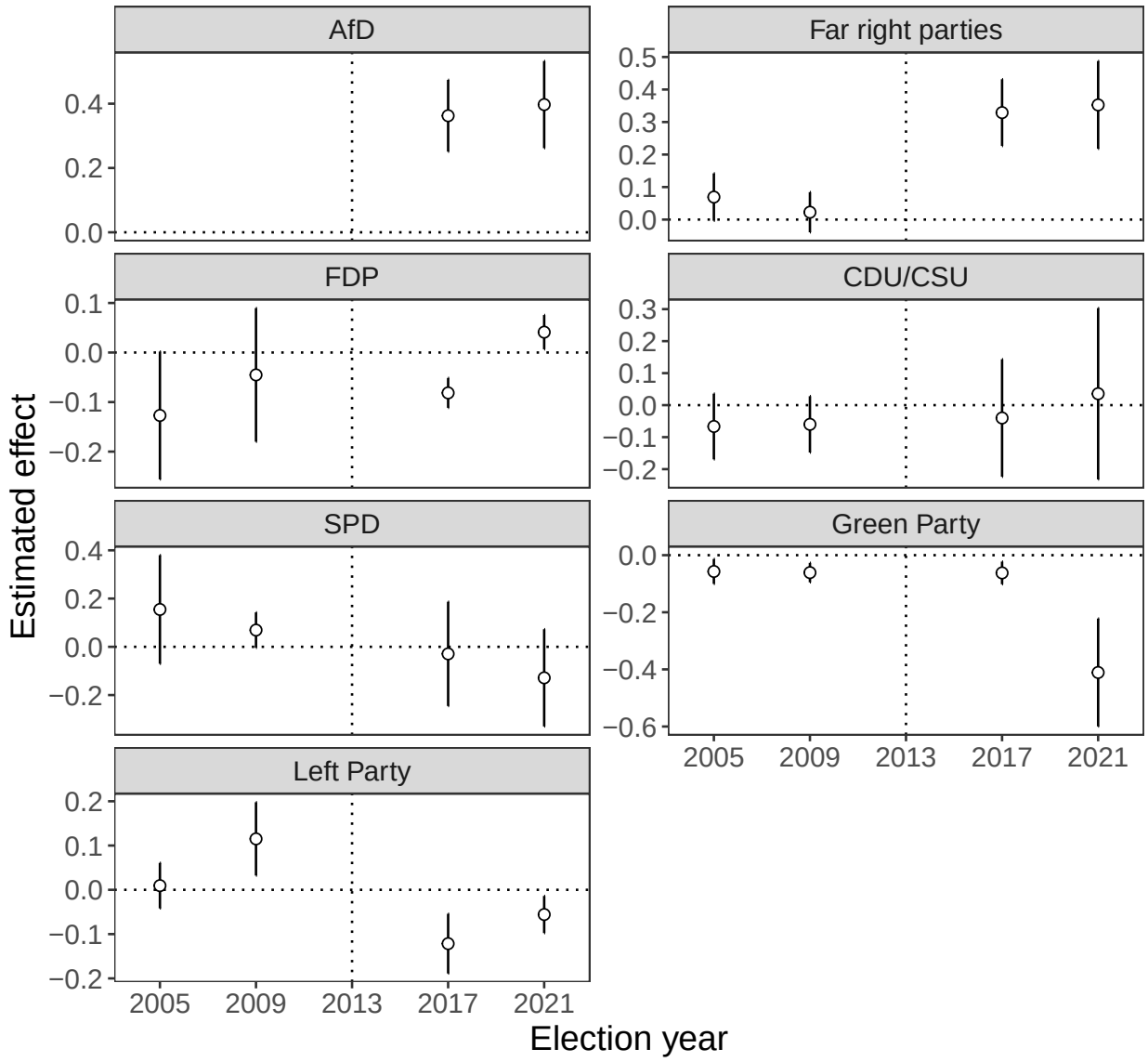


Notes: The figure shows the county-level shares of brown occupations in 2013 and the change in AfD support between 2013 and 2021. We highlight select counties.

A.5 Additional results

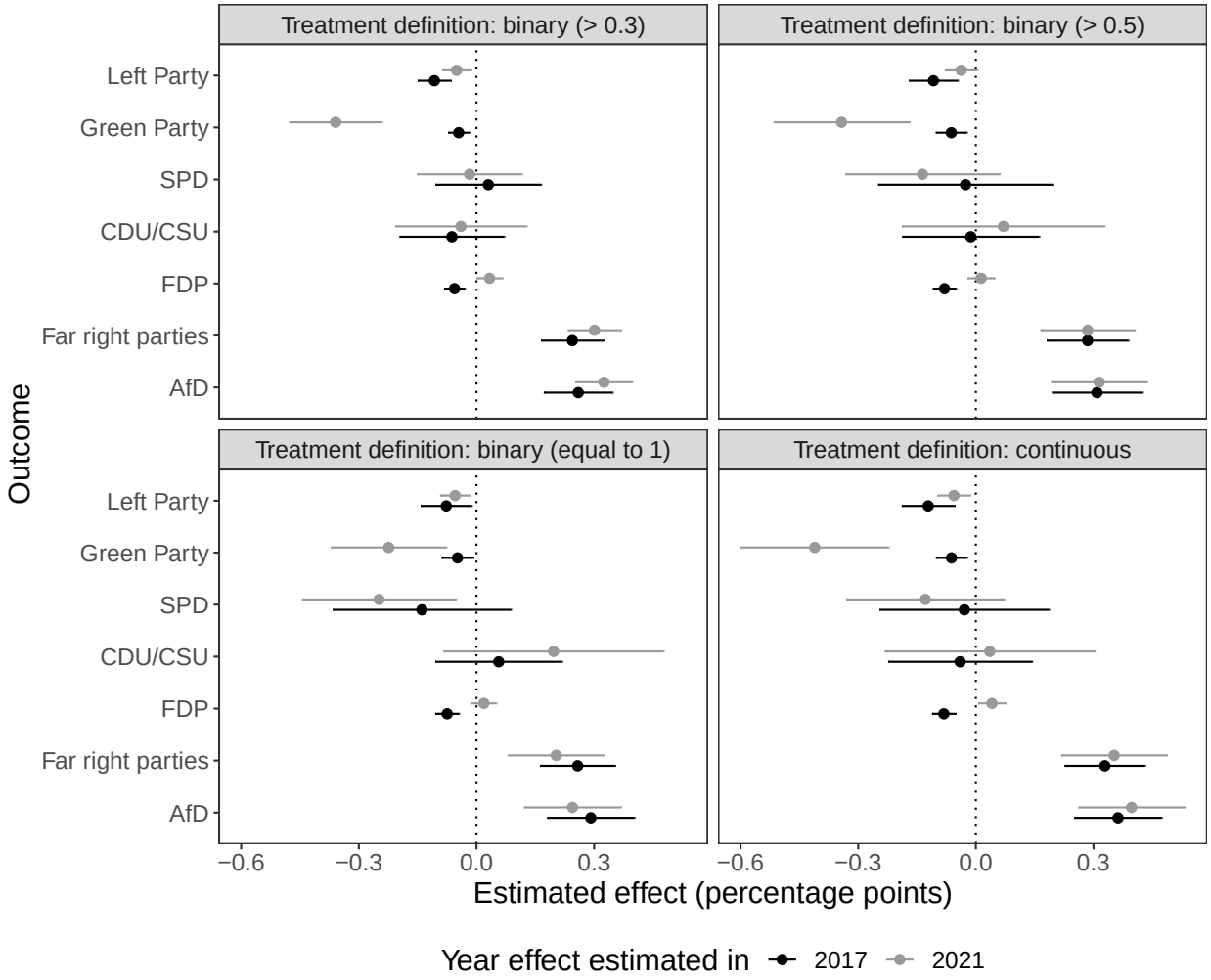
A.5.1 County-level results

Figure 10: Estimated coefficients before and after 2013



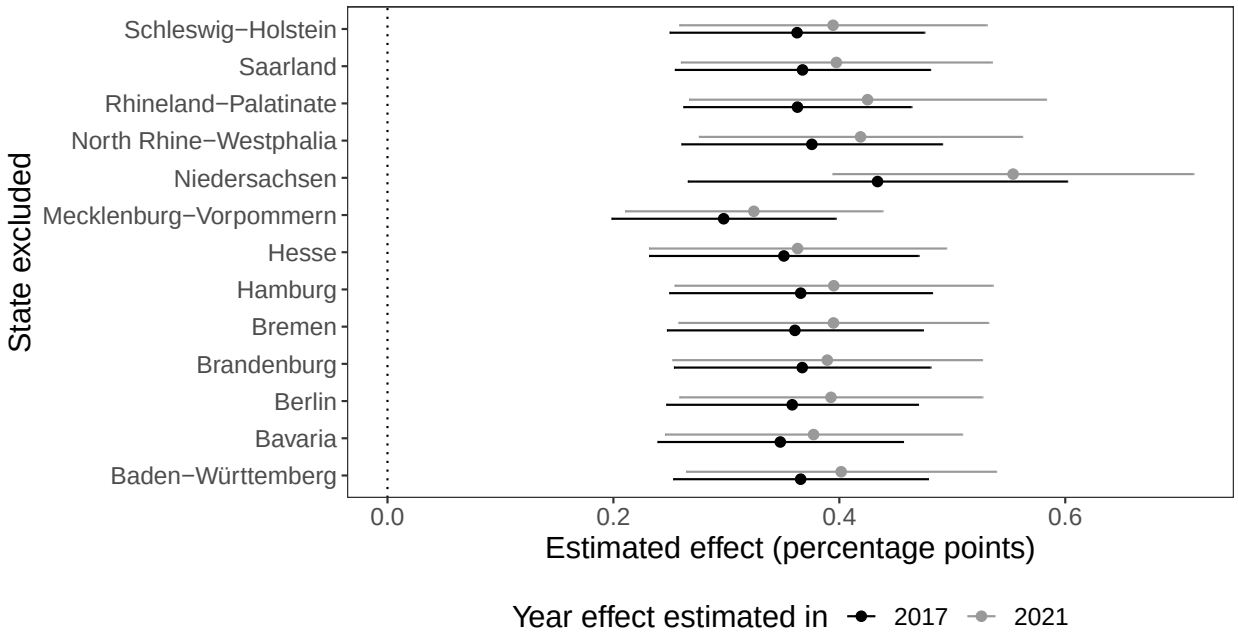
Notes: The figure presents the results from the main specification. As opposed to figure 3, where we only show θ_0 and θ_1, this figures also contains the pre-treatment estimates θ_{-2} and θ_{-3}.

Figure 11: Aggregate results, for different treatment definitions



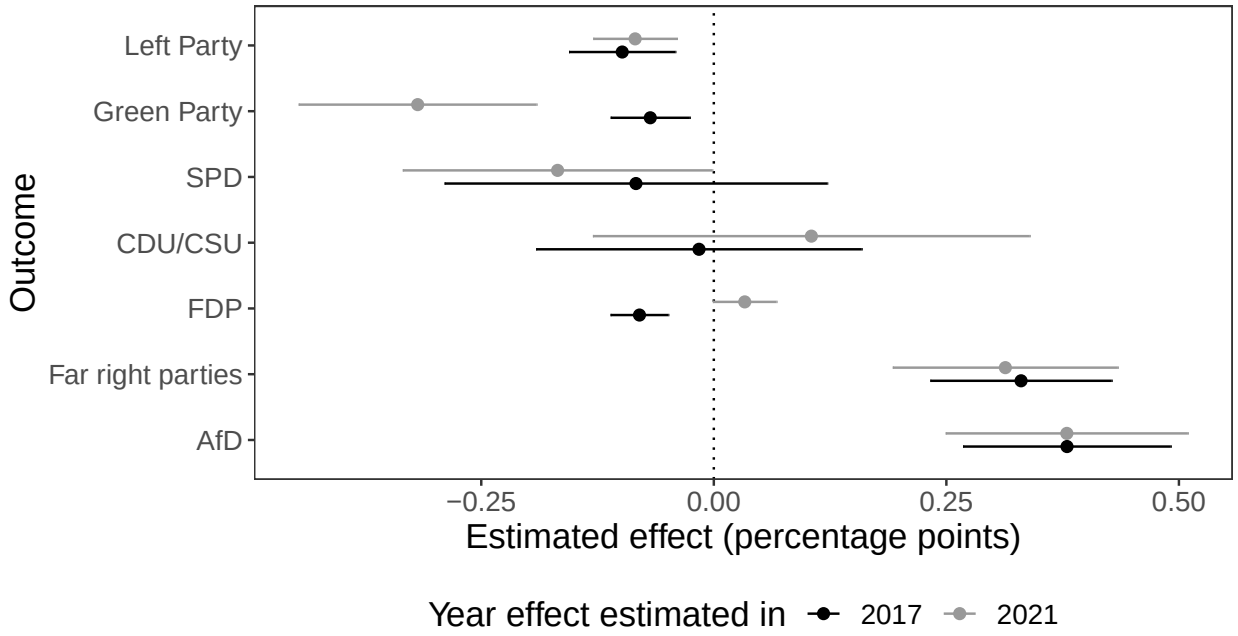
Notes: The figure presents the results from the main specification,for different treatment definitions.

Figure 12: Aggregate results, excluding states one-by-one



Notes: The figure presents the results from the main specification, excluding states one-by-one. We only present results for the AfD.

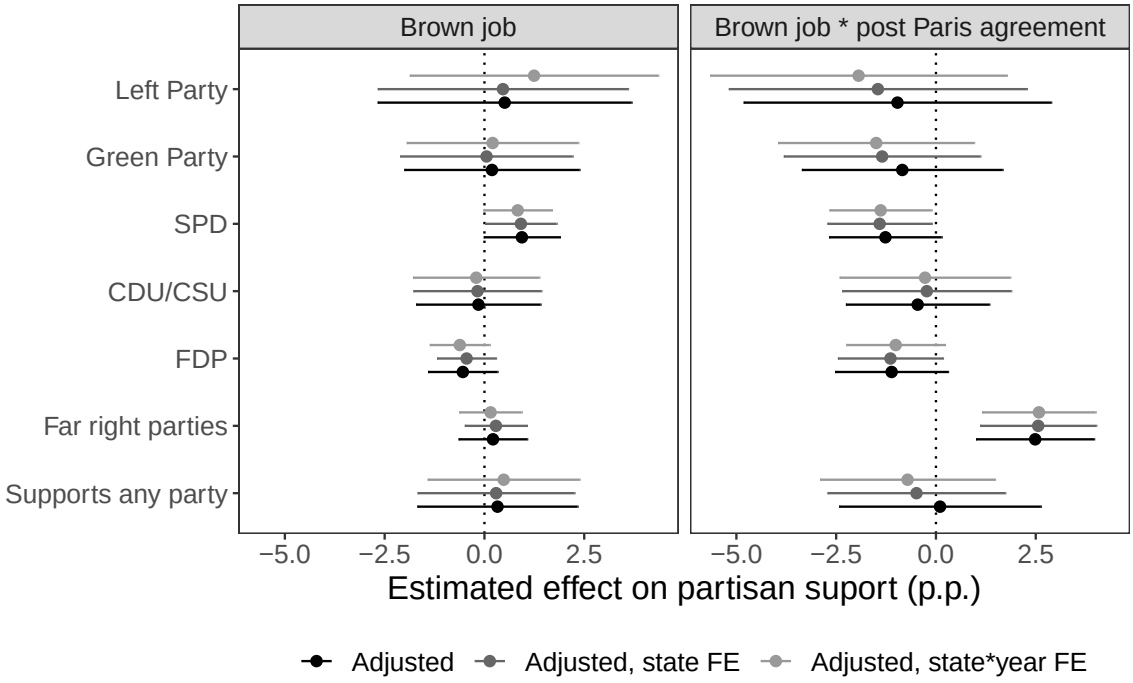
Figure 13: Aggregate results, allowing for time-varying effects of population density



Notes: The figure presents the results from the main specification, with an additional term that interacts pre-treatment population density with election year dummies.

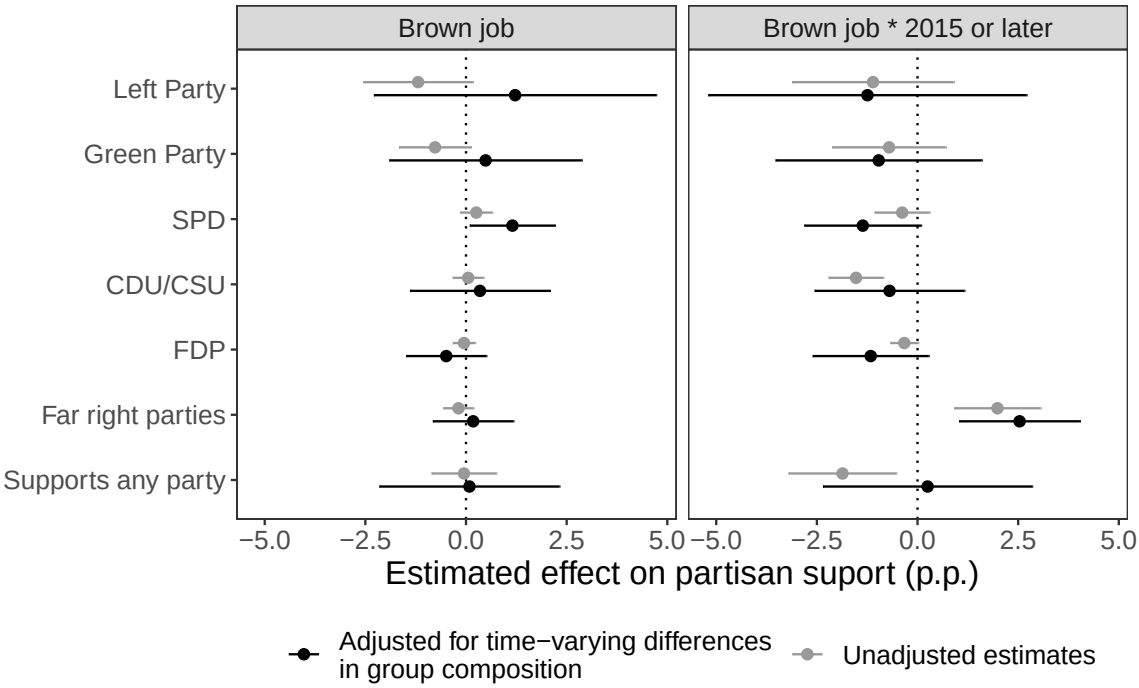
A.5.2 Individual-level results

Figure 14: Brown occupations and partisan support, accounting for regional differences



Notes: The figure presents results from the specification described in section 4, with an additional interaction for responses recorded 2015 or later ("post Paris agreement". The sample is all responses between 1990 and 2020. The left-hand side contains coefficients that are based on the period of 1990-2014, while the right-hand-side panel contains the coefficients for the interaction term between $D_i t$ and the indicator variable for responses recorded 2015 or later. We present (i) adjusted estimates (which are the same as in figure 5), (ii) estimates that additionally control for state fixed effects and (iii) estimates that control for state fixed effects and state-specific time trends. All models individual-level fixed effects.

Figure 15: Brown occupations and partisan support, subsetting the respondents already observed in 2014



Notes: The figure presents results from the specification described in section 4, with an additional interaction for responses recorded 2015 or later. The sample is all responses between 1990 and 2020. The left-hand side contains coefficients that are based on the period of 1990-2014, while the right-hand-side panel contains the coefficients for the interaction term between $D_i t$ and the indicator variable for responses recorded 2015 or later. We subset to respondents who were already observed in 2014, i.e. this excludes respondents who entered the panel in 2015 or later. All models individual-level fixed effects.