Meat Substitute Consumption and Political Attitudes - Testing the Left-Right and Environmental Concerns Frameworks

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Abstract:

The promotion of meat substitutes to reduce meat intake is a promising way to reduce the environmental and public health externalities of meat consumption while preserving the important role of taste and texture in meat products. However, the market for meat substitutes is developing more slowly than expected. Therefore, in this article, we analyze the factors associated with the heterogeneity in meat substitute consumption in Germany, a country where meat has an important traditional role. We use data on meat substitute sales from 1,025 individual retailers, sociodemographic data, and election results from 92 regions in Germany over the period 2017-2021, to analyze whether differences in meat substitute consumption are associated with consumers' political orientation (liberal/left or conservative/right). We also investigate whether differences in elected political parties' endorsement of climate protection goals can explain contrasts in meat substitute consumption. Our results show that meat substitute consumption varies significantly across Germany and that this is related to differences in sociodemographic characteristics and voting behavior across regions. Voting for the Green Party and parties with strong climate protection ambitions is positively related to the market share of meat substitutes. In contrast, voting for Germany's most conservative party, which has the lowest ambitions in terms of climate protection targets, is associated with lower meat substitute consumption. Therefore, to increase the market share of meat substitutes manufacturers could develop more tailored marketing strategies that better target these socio-demographic voter groups to increase the market share of meat substitutes as alternatives to meat products.

Keywords: meat; meat substitute consumption; sustainability; political preferences; green consumption

1 Introduction

Policymakers should attach great importance to reducing meat consumption, particularly red meat such as pork and beef, due to the adverse external effects of livestock farming and meat consumption on the environment and public health (IPCC, 2022). Accordingly, the 'EAT-Lancet Commission'[1] suggests a drastic reduction in meat consumption and an increase in the intake of plant-based foods (Willett et al., 2019). One way to reduce meat consumption is to increase green choices in meal settings (Meier et al., 2022). Another option which could discourage meat consumption would be to adopt policy measures to internalize the external effects of meat via its market price (Funke et al., 2022; Roosen et al., 2022). Meat consumption could also be reduced by promoting the consumption of meat substitutes (IPCC, 2022; Siegrist and Hartmann, 2023). These products imitate meat in taste and appearance and/or replace it in a meal context[2] (Petersen et al., 2021). Meat substitutes tend to have lower carbon footprints than meat products (Bryant, 2022; Clark et al., 2022; Saget et al., 2021) and despite being ultra-processed products (Wickramasinghe et al., 2021), they can have beneficial nutritional compositions (Petersen et al., 2021; Petersen and Hirsch, 2023). Another advantage of meat substitutes is that their uses and preparation resemble that of traditional meat products, which can simplify the transition from traditional meat recipes (Siegrist and Hartmann, 2023). However, despite high anticipated growth rates for meat substitutes (Barclays, 2019), their current market shares are relatively low in most Western countries (Siegrist and Hartmann, 2023). Given the environmental and health concerns connected to meat consumption, it is therefore crucial to understand the factors related to meat substitute demand.

[1] "*The EAT-Lancet Commission consists of 37 world-leading scientists from 16 countries from various scientific disciplines. The goal of the Commission was to reach a scientific consensus by defining targets for healthy diets and sustainable food production. The findings of the Commission provide the first ever scientific targets for a healthy diet and sustainable food production within planetary boundaries that will allow us to feed up to 10 billion people by 2050.",* https://eatforum.org/eat-lancet-commission/.

[2] We do not consider other meat alternatives like cultured meats or insect-based products as these types of meat substitutes are not yet established on the market.

When investigating these factors, it is important to consider how the characteristics of different segments and consumer groups might be associated with varying levels of adoption. Factors, such as young age, high education level and income are most likely to be positively related to the consumption of meat substitutes, although the relevant literature has not yet provided conclusive results in this regard (Onwezen et al., 2021). Furthermore, no adequate research has yet been carried out regarding factors such as the social and political environment of consumers (Onwezen et al., 2021). In this context, Jost (2017) highlights the relevance of consumers' political attitudes in explaining different consumption patterns. Based on a study with 995 participants from the US, Wolf et al., (2020) suggest that more liberal households exhibit a greater likelihood to consume plant-based milk. In contrast, the study by Li et al. (2023) showed that there is no relationship between political beliefs and the purchase intention of plant-based meat substitutes. In addition, when applying the theory of planned behavior Marcus et al. (2022) found that the environmental and animal welfare concerns expressed by German consumers do not explain their attitude towards meat substitutes or their behavioral intention to consume these products. Hence, given the potential benefits of meat substitutes, their low acceptance and the inconclusive results on the factors associated with their intake, this study aims to determine the consumer characteristics linked with the consumption of meat substitutes both from a demographic perspective and with regard to the political attitudes of consumers in Germany.

The per capita consumption of meat in Germany was 52 kg in 2022 and follows a downward trend (60 kg in 2017 and 62.4kg in 2007) (BMEL, 2023). On the other hand, the production volume of plant-based meat substitutes increased from 0.73 kg per capita in 2019 to 1.24 kg per capita in 2022 (DESTATIS, 2023b, 2022). Although the per capita consumption of meat is still forty times higher than that of meat substitutes, the trend towards declining meat intake and increasing meat substitute consumption makes Germany an interesting case study for the analysis of the factors related to the market shares of meat substitute products.

1.1 Acceptance of meat substitutes

There is a large body of research on the product attributes that influence the demand for meat substitutes, for example, the willingness to pay (Apostolidis and McLeay, 2019, 2016), the barriers inhibiting a switch to these products (Carlsson et al., 2022), or ingrained consumer characteristics and attitudes (Bryant and Sanctorum, 2021; Heijnk et al., 2023). Onwezen et al. (2021) review the recent literature on the acceptance of meat substitutes and find that the differences in the acceptance of plant-based meat substitutes between consumer groups can be explained not only by motives like taste but also by attitudes and norms (Onwezen et al., 2021). In turn, studies on demographic consumer characteristics yield mixed results as some report insignificant relationships while others report relationships that can explain the variation in preferences. Still, previous findings tend to show that young, educated people in urban areas prefer meat alternatives (Onwezen et al., 2021). Moreover, Meier et al. (2022) highlight the importance of social desirability in sustainable food choices.

Previous literature on plant-based meat substitute acceptance and consumption is based mainly on stated-preference methods with the disadvantage that results are potentially affected by social desirability bias (Cerri et al., 2019). Therefore, our study aims to address this problem by using revealed preference data to explore the relationship between consumer characteristics, like age or income, as well as political orientation and meat substitute consumption.

1.2 Political orientation and sustainable consumption

In their review of political ideology and consumers, Jung and Mittal (2020) conclude that political ideology is playing an increasingly important role in daily life choices and consumer behavior. Studies which focus on assigning consumers to political groups tend to use the terms liberal (left-wing) and conservative (right-wing) (Adaval and Wyer, 2022; Carney et al., 2008). Conservatism and right-wing can be described as "the tendency to prefer safe, traditional, and conventional forms of institutions and behavior" (Wilson, 1973, p. 4). In contrast, liberal and

left-wing consumers are characterized by their openness to change, fairness and diversity (Adaval and Wyer, 2022).

This segmentation into liberal vs. conservative reveals differences in consumer behavior. For example, Gromet et al., (2013) show more conservative consumers are less likely to purchase light bulbs bearing labels with environmentally friendly claims in spite of the fact that they had previously purchased very similar versions of these products without the environmentally friendly label. Usslepp et al. (2022) find a negative relationship between conservatism and fair trade adoption, which is influenced by age and income. Furthermore, Irmak et al. (2020) suggest that compared to liberals, conservatives tend to disregard governmental food labeling pertaining to the healthiness of products as they feel these labels represent a threat to their freedom of choice. In addition, Fernandes and Mandel (2014) find that conservatism is related to more variety-seeking. They assume that this is due to social norms in the Western world regarding choice searches, which could point towards more openness towards new products.

In the context of meat consumption, conservative consumers tend to include higher shares of meat in their diets (Ruby, 2012) while Yule and Cummings (2023) highlight the disinterest of these consumers in meat substitutes. According to Nezlek and Forestell (2019), college students in the USA who strongly support the conservative party are more likely to be omnivores. Similarly, a longitudinal study of adults in New Zealand finds that political conservatism is linked to a lower probability of adopting plant-based diets and lower environmental efficacy, due to doubts that personal actions influence climate change (Milfont et al., 2021). As there is little support for the change to plant-based diets in conservative environments, consumers are more likely to shift back to omnivorous eating habits after trying plant-based diets (Hodson and Earle, 2018). A possible explanation is that these consumers consider meat consumption as a part of their cultural identity, and thus regard vegetarian or vegan diets as a threat (Dhont and Hodson, 2014). Additionally, Wilks et al., (2019) find that conservatives have a greater aversion

to cultured meat, which they justify by stating that conservatism seeks to support the established meat industry and traditional culinary culture. However, the reported results are often based on stated self-evaluations regarding political attitudes, for example, on a scale from 1 (liberal) to 9 (conservative) (Wilks et al., 2019), and on revealed voting data. Therefore, this study aims to explain meat substitute consumption in relation to political ideology based on individual party outcomes.

Some studies not only analyze the liberal-conservative aspect but also the relationship between consumers' sustainability attitudes and their sustainable behavior. Haws et al. (2014) show that high scores on a green preferences scale indicate that consumers react positively to (green) product attributes. However, in general, there is an attitude-behavior gap between consumers' statements on environmental concerns and the actual greenness of their behavior. This can be explained by the prices of the products (Gleim and J. Lawson, 2014) as meat substitutes in particular tend to be more expensive than traditional meat products (Petersen et al., 2023). In this regard, Marcus et al. (2022) find that consumers who express concern for the environment generally have no immediate intention to adopt and consume meat substitutes. This study aims to contribute to the literature and investigates the discrepancy between attitude and actual behavior in relation to sustainable behavior by linking meat substitute consumption to the electoral outcomes of parties with strong or weak environmental objectives in their election programs.

1.3 Research objectives

A revealed preference dataset serves as the basis for the following three contributions to the literature:

1. we use a sample for the German meat market for the period 2017-2021 to test whether sociodemographic and economic factors are related to sustainable food choices in Germany;

2. we investigate whether the findings on the relationship between liberalism/conservatism and the adoption of vegan/vegetarian diets suggested in previous literature are transferable to meat substitute consumption;
3. we further advance the literature by testing the relationship between green/ecological sustainability voting in a region and meat substitute consumption on an aggregated scale.

Our analysis is based on a sample of sales data from IRI (2023) for meat and meat substitute products merged with data on demographic and political characteristics of 95 different regions in Germany, over the period 2017-2021. While early studies forecast significant growth in the market for plant-based alternatives, the sector's sales and revenue are currently stagnating (Siegrist and Hartmann, 2023). Hence, our study may be of particular interest for the marketing strategies of food producers and retailers who aim to encourage the demand for plant-based alternatives. Moreover, the results may be relevant to policymakers who are interested in implementing measures that increase the share of meat substitutes to tackle both public health and environmental issues arising from meat consumption.

The remainder of this article is structured as follows: The six major German political parties are presented in the next chapter. The data and method are described in chapter three, which is followed by the results and a discussion chapter with concluding remarks.

2 Background on the political parties in Germany and research hypotheses

In Germany, six parties are relevant at the federal level (Schmitt-Beck et al., 2022). These include the Alternative for Germany (AfD), the Christian Democratic Union-Christian Social Union (CDU/CSU), the Free Democratic Party (FDP), Alliance 90/Die Grünen (Greens), Die Linke (The Left) and the Social Democratic Party of Germany (SPD) (Schmitt-Beck et al., 2022). The main information about these parties and their position regarding meat consumption and meat substitutes is summarized in Table 1. The AfD can be described as a populistic right-

wing party that is most successful in the eastern regions of Germany (Weisskircher, 2020). The CDU/CSU is a block consisting of two separate parties that act as one in the federal parliament (Bawn, 1999) and can be classified as conservative on the center-right of the political spectrum (Weisskircher, 2020). The FDP defines itself as a liberal party with a center-right position and having a strong belief in the economic market (Schmitt-Beck et al., 2022). The focus of the Greens, in contrast, is on issues associated with sustainability and climate change and they can be classified on the left of the political spectrum (Schmitt-Beck et al., 2022). Finally, the SPD is positioned on the center-left and The Left on the left wing of the political spectrum (Schmitt-Beck et al., 2022). Lo et al., (2014a) present a general left-right score for political parties in Europe; the corresponding results for Germany are presented in Table 1. Note that the political scale presented in Lo et al. (2014a) dates from a time when the AfD was just emerging and, therefore it is not considered. To account for this, we use the result of the AfD's Austrian sister party, which can be considered comparable in terms of political opinions and ideology (Heinisch and Werner, 2019).

These parties differ in their views on the importance of adopting measures to tackle anthropogenic climate change and in the action they want to take to protect the climate. A study from the German Institute for Economic Research (DIW Econ GmbH) analyzed the importance of climate protection measures among the different parties (Handrich, 2021). They assessed the 2021 federal election programs based on the six sectors: industry, energy, traffic, housing, agriculture and carbon sinks. An ordinal score from 0 to 4 was used to evaluate whether a program has the potential to reduce Germany's emissions to a level of 65% below the 1990 emissions by 2030. The results can be ranked from bottom to top in terms of the ability of party programs to reduce emissions as follows: FDP, CDU/CSU, SPD, Left Party, and Green Party. The AfD was not included in the analysis because the party denies human influence on climate change (Handrich, 2021). Therefore, it obtained the lowest ranking for its position on climate

protection. To summarize, there are considerable differences in the political parties' programs regarding measures to tackle climate change.

Finally, the political parties have different recommendations and ideas for meat consumption in Germany. The AfD and the CDU/CSU support traditional diets (CDU/CSU, 2021), and the AfD is strictly against political interference, particularly in the form of a tax on meat products (AfD, 2021). Apart from food affordability in general, The Left's (Die Linke, 2021) program makes no reference to meat consumption. On the other hand, the SPD supports the dietary recommendations of the German Nutrition Society (SPD, 2021), which recommends a daily meat intake of 300 to 600 grams (DGE, 2023). This recommendation would imply a reduction of about 50% of current consumption. The Greens and the FDP are the only parties that refer to meat alternatives in their programs. While the FDP supports the introduction of in vitro meat in the EU (FDP, 2021), the Greens want to actively support plant-based meat alternatives and take measures to improve their market position by adjusting taxes on substitutes compared to conventional meat products (BÜNDNIS 90/DIE GRÜNEN, 2021).

Table 1 Political Parties in Germany

Party	Founding year	Members in 2021 in thousand[1]	Position[2]	Share of (second) votes 2021[3]	Position on meat consumption[4]	Position on meat alternatives[4]	Scaled left - right position γ [5]	CPA-score ω [6]
Bündnis 90/ Die Grünen (Greens)	1980	125.3	Left	14.8%	Fewer animal-based products	Support plant-based meat substitutes; improve tax efficiency of meat substitutes	-0.66 [2]	3.62 [6]
Die Linke (The Left)	2007	60.7	Left-wing	4.9%	None	None	-1.91 [1]	2.6 [5]
CDU /CSU[2]	1950	514.6	Center-right	24.1%	Informed consumer	None	0.60 [5]	1.81 [4]
SPD	1863	393.7	Center-left	25.7%	Support diet recommendations of the DGE with 300-600g per week	None	-0.46 [3]	1.79 [3]

FDP	1948	77.3	Center-right	11.5%	None	Support the approval of in vitro meat in the EU	0.21 [4]	1.24 [2]
AfD	2013	30.1	Right-wing	10.3%	No interference via legislation; no meat tax	None	Not evaluated FPÖ: 2.1 [6]	Not evaluated 0 [1]

Note:[1] Source: Statista (2023); [2]Source: Schmitt-Beck et al. (2022); [3] Source: The Federal Returning Officer (2023); [4]Sources: The electoral programs of the individual parties (AfD, 2021; BÜNDNIS 90/DIE GRÜNEN, 2021; CDU/CSU, 2021; Die Linke, 2021; FDP, 2021; SPD, 2021); [5] Score indicates the position of the political party from negative (left) to positive (right). Source: (Lo et al., 2014a, 2014b);[6] Source: Handrich (2021). CPA: Climate protection ambitions. The numbers in square brackets indicate the alternative ordered scores presented in Chapter 3.1.

3 Data & Method

3.1 Data

We created our dataset by merging data from three different sources. Firstly, we used retail scanner data on sausage, burger, and meat sales from the IRI (Information Resources Inc.) database for sales from 1,025 individual retailers over the 5-year period from 2017-2022 (IRI, 2023). The data are provided on a barcode level and include the store-level sales volume in weight and Euros, together with the first two digits of the postal code zone in which the stores are located. This allowed us to aggregate the data on a yearly basis from 96 different two-digit postal code areas. The aggregation permitted us to calculate the share of meat substitute (*MS*) sales (in €) in total sales (*% MS €*) in each of the 96 regions and five years. Note that our data only covers packed meat products from the self-service areas of supermarkets while products that are sold over the butcher's counter within the supermarkets are not included. Therefore, we only consider three different groups of products, sausages, meat balls and breaded meats, like escallops and nuggets, as the inclusion of products like tofu without the equivalent steak that is sold over the counter would lower the comparability of meat and meat substitute sales. Furthermore, these product categories are comparable since their processing and use is very similar (Petersen and Hirsch, 2023). The total sales volume on which our sample is based amounts to 471.8 million Euros, of which 42.0 million Euros are attributable to the sale of meat substitute products.

Secondly, previous literature on sustainability and meat substitute consumption has revealed some links between age, education, income and the consumption of meat substitutes (e.g., Onwezen et al., 2021; Panzone et al., 2016). People with higher incomes tend to be more open to meat substitutes, which could explain the differences in the share of meat substitutes across regions. In urban areas, the share of vegetarians, vegans, university students and people with higher education is higher, which may explain lower meat consumption, resp., higher meat

substitute intake in these groups. On the other hand, we expect a negative relationship between age and the share of meat substitutes in total sales in a region as older people are less willing to accept meat alternatives (Onwezen et al., 2021). Therefore, our analysis considers average per capita income (Avg. Income), age (Avg. Age), population density (Pop. Density), proportion of university students (Share Students), and proportion of women (Share Female %) in a region as sociodemographic and economic factors that are potentially related to meat substitute consumption. The data on these characteristics for each region are collected from the Federal Statistical Office in Germany (DESTATIS, 2023a). However, the data for two towns are aggregated to the city level, representing a total of 6 postal code areas and thus reducing the total number of postal code areas in our sample to 92.

Thirdly, we collect data on election results. Two federal elections (2017 and 2021) and one election to the European Parliament (2019) took place in the period. Voting in the federal (Bundestag) election in Germany consists of two votes. While the first vote refers to a local candidate, the second vote determines the total percentage of seats a party receives in the election. Since preferences for particular candidates may differ from actual political beliefs, we only consider the share that each party achieved in the second vote in each of the 92 postal code regions. In the case of the European Parliament elections, we consider the total share from the postal code region. We collect data on the second vote for the six major parties that entered the parliament: CDU-CSU (Share CDU %), SPD (Share SPD %), Greens (Share Green %), FDP (Share FDP %), AfD (Share AfD %), and The Left (Share The Left %). Note that Germany has other regional elections, such as state or mayoral elections. However, we do not use data on these elections because they are not held simultaneously throughout the country. We further include the turnout (Turnout %) as a measure of satisfaction with democracy (Grönlund and Setälä, 2007).

In our analysis, we also test whether the overall voting trend in a region is related to meat substitute consumption by calculating four different scores for each region: Left-Right, Left-Right Ordered, Climate Protection Ambitions (CPA), CPA Ordered. The left-right score is calculated using the estimated values (γ) for the position of political parties on the left-right scale in Europe derived by Lo et al. (2014a) (see Table 1) weighted with the electoral results (percentage share) in the second vote (SV) of each party in a given region and year

$$Left - Right_{i,t} = \sum_{p=1}^{P} \gamma_p * SV_{p,i,t} \ for\ i = 1,..,92 \quad (1)$$

The lower the resulting Left-Right score, the higher the election result for left/liberal parties in a given region and year. Conversely, the higher the left-right score, the better the election result for right/conservative parties. In addition to the left-right score, we derive a value for the vote for climate protection ambition (CPA) in a region i at time t. Analogous to the Left-Right score, we take the values for the ambition of each party's climate change program to achieve the 2030 climate change targets (ω) following Handrich (2021) (see Table 1) and calculate a CPA score for each region and period:

$$CPA_{i,t} = \sum_{p=1}^{P} \omega_p * SV_{p,i,t} \ for\ i = 1,..,92 \quad (2)$$

The higher the resulting CPA score, the higher the electoral support for political parties with strong climate change ambitions. The respective scores for γ and ω are presented in Table 1.

The studies by Lo et al., (2014a) and Handrich (2021) do not report any γ and ω values for the AfD. Therefore, we replace the respective value for the calculation of the left-right score with that achieved by the FPÖ, which is a comparable Austrian party (Heinisch and Werner, 2019), and with a CPA score of 0. To control for these specifications, we create two alternative ordered scores in addition to the Left-Right score and the CPA score based on a

ranking from 1 to 6 of the individual parties, whereby lower values for the alternative Left-Right (Left-Right Ordered) score indicate more liberal/left values, while higher values for the alternative CPA (CPA Ordered) score show solid electoral support for strong climate protection ambitions. The respective values for the alternative ordered scores are presented in Table 1.

We merge the data from the three sources based on the postal codes and the three election years in the period between 2017-2022. Hence, the final sample consists of 276 observations covering information from the 92 postal code areas for the three years 2017, 2019 and 2021.

3.2 Method

We estimate linear regression models to assess the relationship between the market share of meat substitutes and voting behavior, while also controlling for regional socioeconomic factors. Therefore, our model includes the % *MS €* as the dependent variable, i.e., the sales of meat substitutes divided by the total sales of meat and meat substitutes in a region (i) and period (t). In the first model, we include the election results of the *P* different political parties measured by their electoral results in the share of votes (SV) in each region and year and two time dummy variables for the years 2019 and 2021 (Y*19*, Y*21*): (3)

$$\%MS\ €_{i,t} = \alpha_i + \sum_{p=1}^{P} \beta_p * SV_{p,i,t} + \sum_{p=1}^{P} \beta_{p_{EU}} * SV_{p,i,t} * Y19_{it} + \beta_{Y19} * Y19_{it} + \beta_{Y21} * Y21_{it} + u_{i,t}$$

where $u_{i,t}$ is a random error term. The parameters β_p indicate the relationship between the share of the votes for the respective political party p and the overall % *MS €* . We also include interaction terms between the shares of votes and the dummy variable for the year 2019. The respective parameters $\beta_{p_{EU}}$ indicate whether the relationship between the voting share and the share of meat substitutes differs for the European election. We first estimate the model in (3)

separately for each party and then estimate a complete model that jointly includes the results of all parties as independent variables.

The model is extended by adding a set of *C* different socioeconomic and demographic characteristics of the regions (SOC). The resulting model is defined as follows:

$$\%MS\,€_{i,t} = \alpha_i + \sum_{p=1}^{P} \beta_p * SV_{p,i,t} + \sum_{p=1}^{P} \beta_{p_{EU}} * SV_{p,i,t} * Y19_{it} + \sum_{c=1}^{C} \beta_c * SOC_{c,i,t} + \beta_{Y19} * Y19_{it} + \beta_{Y21} * Y21_{it} + u_{i,t} \quad (4)$$

where $u_{i,t}$ is a random error term. The parameters β_c indicate the relationship between the socioeconomic variables and the share and the β_p indicates the relationship between the share of the votes for the respective political party *p* and the overall % *MS €* . Once again, we first estimate the model in (4) separately for each party and subsequently estimate a complete model that jointly includes all parties.

In the second part of the analysis, we use the overall tendencies regarding left and right voting (Left-Right score and the alternative Left-Right score) instead of the results for the share of votes (SV). We again include the C different socioeconomic and -demographic characteristics of the regions (SOC) and the time dummy variables. The resulting model is defined as follows:

$$\%MS\,€_{i,t} = \alpha_i + \beta_{LR} * Left - Right_{i,t} + \beta_{LR_{EU}} * Left - Right_{i,t} * Y19_{i,t} + \sum_{c=1,\dots,C} \beta_c * SOC_{c,i,t} + +\beta_{Y19} * Y19_{it} + \beta_{Y21} * Y21_{it} + u_{i,t} \quad (5)$$

Similarly, the model is defined as follows for the overall electoral support for Climate Protection Ambitions (CPA score and the alternative CPA score):

$$\%MS\ €_{i,t} = \alpha_i + \beta_{CPA} * CPA_{i,t} + \beta_{CPA_{EU}} * CPA_{i,t} * Y19_{i,t} + \sum_{c=1,\dots,C}^{C} \beta_c * SOC_{c,i,t} \quad (6)$$

$$+ +\beta_{Y19} * Y19_{it} + \beta_{Y21} * Y21_{it} + u_{i,t}$$

Since our data covers three years and 92 different regions, we assume that we have a panel data set. Equations (3-6) can therefore be estimated using either a random effects model or a fixed effects model. The random effects model is preferred over the fixed effects model if the individual intercept is unrelated to the explanatory variables in the model (Wooldridge, 2013). The Hausman test was used to test this assumption and revealed that the fixed effects model is the preferred choice to estimate equations (3)-(6). The results are presented in the Appendix, Table 1.

3.3 Robustness checks

Johnston et al. (2018) emphasize that research on voting behavior potentially suffers from confounding and collinearity. An approach which is frequently used to solve this problem involves the collection of more data or the exclusion of variables from the analysis (Wooldridge, 2013). However, O'Brien (2017) highlights that, based on a high variance inflation factor, dropping one variable of interest undermines the purpose of multiple regression analyses, namely to control for other variables. In addition, the model could then suffer from omitted variable bias (Wooldridge, 2013). Hence, Johnston et al. (2018) suggest that either a principal component analysis or a factor analysis should be carried out on the independent variables and in a second step a regression model should be estimated with the resulting factors as independent variables and the dependent variable of interest. Standardized coefficients can be obtained based on the sum product of each variable's factor loading with the estimated regression coefficients (Johnston et al., 2018; Massy, 1965). These coefficients can subsequently be interpreted in terms of their relative importance to the model.

The data in our sample also suffer from a high correlation between some of the variables, particularly between the voting behavior and the sociodemographic variables as well as the % *MS €*, i.e., the dependent variable. Table 2 in the Appendix contains the pairwise correlations between the variables. For example, there is a high positive correlation between the average age in a region and voting for the AfD there ($\rho_{AfD,Age} = 0.75$), and a high negative correlation between both variables and the share of meat substitutes ($\rho_{AfD,\%MS€} = -0.51$; $\rho_{Age,\%MS€} = -0.425$). Therefore, as they include the sociodemographic factor, we perform a factor analysis for the variable sets considered in the models (4)-(6) to account for this structure in the data. The respective factor loadings are then determined for the F different factors based on the Eigenvalue criterion of 1 and varimax rotation (Backhaus et al., 2021). Factor scores are calculated for each factor and observation and are then used as variables to estimate the model below:

$$\%MS\ €_{i,t} = \alpha_i + \sum_{f=1,\dots,f}^{F} \beta_f * Faktor_{f,i,t} + 19_{it} * \beta_{19} + 21_{it} * \beta_{21} + u_{i,t}\ for\ i = 1,..,92 \quad (7)$$

The estimated $\widehat{\beta_f}$s subsequently serve to calculate the standardized coefficients as a sum product with the varimax rotated factor loadings.

4 Results

4.1 Descriptive results

Table 2 Sample Statistics

Variable	Mean	Std. Dev.	Min	Max
% MS €	8.6%	0.051	1.2%	25.6%

Variable	Mean	Std. Dev.	Min	Max
Share Green %	13.9%	0.07	1.6%	31.4%
Share The Left %	6.4%	0.04	1.6%	18.8%
Share SPD %	20.4%	0.07	6.1%	36.3%
Share CDU %	29.2%	0.07	14.2%	55.2%
Share FDP %	9.1%	0.03	2.0%	17.2%
Share AFD %	11.9%	0.06	4.5%	32.7%
Left-Right	0.136	0.132	-0.207	0.571
Left-Right Ordered	3.496	0.254	2.645	4.070
CPA	1.678	0.186	1.105	2.053
CPA Ordered	3.151	0.276	2.291	3.759
Turnout (in %)	71.4%	0.08	52.4%	83.4%
Share Students (in %)	3.3%	0.026	0.0%	11.8%
Avg. Income (in 10.000 €)	2.328	0.228	1.855	3.192
Avg. Age (years)	44.868	1.641	40.7	49.382
Pop. Density (in people/km^2)	509.325	787.358	47.429	4789.835
Share Female (in %)	50.6%	0.004	49.5%	51.8%

N=276. Note: The voting results do not represent the general election results as the values are not weighted according to the population in the respective regions.

Table 1 presents the descriptive statistics. It can be observed that meat substitutes have an average market share of 8.6%, with a minimum of 1.2% and a maximum of 25.6% in a postal code area. Note that this share is larger than that reported by the Federal Statistical Office for

the population in Germany, which indicates a market share of 1.3% for 2021 (DESTATIS, 2022). This might be due to the product categories selected. Additionally, the market share increases significantly from 5.3% in 2017 to 7.4% in 2019 (p=0.00) and reaching 13.2% in 2021 (p=0.00).

The Greens obtained an average percentage of 13.9% across all postal code areas over the three years, while the lowest value over the observed period is 1.6% and the highest is 31.4%. Note that the values for the individual parties do not add up to 1, as there are other smaller parties in Germany, which are not represented in the parliament (Bundestag) and are therefore excluded from the analysis. The mean left-right value of 0.136 with a minimum of -0.207 and a maximum value of 0.571indicates a center-right position across the German regions. Furthermore, the mean CPA of 1.678, with a minimum of 1.105 and a maximum of 2.053, indicates moderate vote for strong climate ambitions. The average turnout across regions is 71.4%, while 3.3% of the population in the regions are students at universities or colleges. Finally, on average there are slightly more women than men in the regions. See Appendix, Figure 1 for a graphical representation of the distribution of the socioeconomic variables across regions for the year 2021.

Figure 1a presents the share of meat substitutes in the total meat market in Germany by postal code regions for the year 2021. The figure reveals considerable differences in the meat substitute purchase behavior across regions. In particular, the market shares of meat substitutes are higher in the southwest of Germany than in the northeast of Germany. The highest market share can be observed in the region around Heidelberg in the federal state Baden Württemberg with 25.59%, while the lowest share of 2.64% is found in a region in the east of Mecklenburg-Vorpommern and north of Brandenburg.

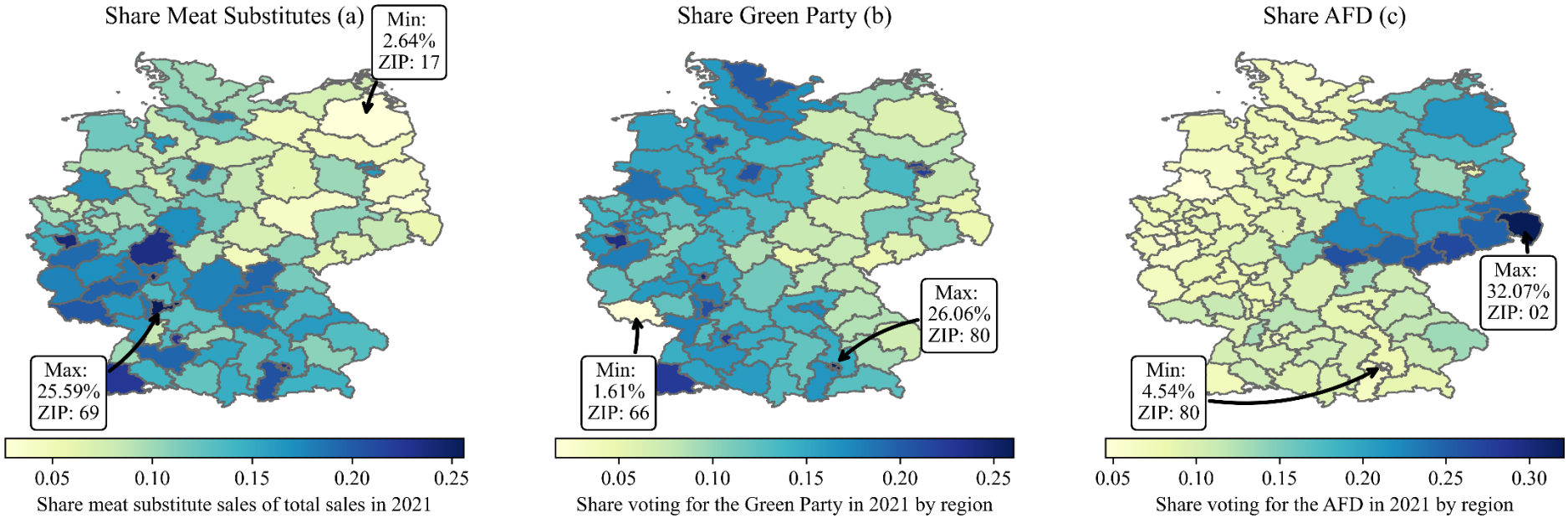


Figure 1 Meat substitute consumption and election results of the AFD and the Green Party in the federal election in Germany in 2021 by regions

Note: ZIP: postal code region.

In the eastern regions of Germany, the Green Party, which stands for strong climate ambitions and left policies, achieves lower results than in the western regions (cf. Figure 1b). Additionally, the Green Party obtains higher shares in large cities like Berlin, with the highest share in the Munich region at 26.1%. However, the lowest score obtained by the Greens, namely1.61%, in the 2021 federal election in the region that includes partly the Saarland in the southwest of Germany is due to errors made by the Green Party itself in its registration. As the party could not agree on a state list in the Saarland it was ineligible for the second vote (Bloomberg, 2021). In contrast, the AfD, as an example of a party without climate protection ambitions and right-wing policies, receives more votes in percentage terms in the eastern regions of Germany and lower shares in the western regions (cf. Figure 1c). The AfD achieved its lowest percentage in the Munich region of Bavaria with 4.54%, and its highest share in eastern Saxony with 32.07%.

To summarize, there are not only regional differences in voting behavior for the individual parties, but the market share of meat substitutes also varies considerably from region to region in Germany. The factors related to these differences are explored in the next chapter.

4.2 Results on voting, socioeconomic factors, and consumption of meat substitutes

Table 3 presents the estimated results for equation (3). In columns (1) through (6) we present the estimates for each party separately, while the joint estimates are shown in column (7). A percentage point increase in the share of votes for the Green Party in a region is associated with a 0.405 percentage points higher share of meat substitutes in the respective market ($p<0.01$). This effect is slightly lower, but still significant ($0.405-0.243= 0.162$; $F=25,58$, $p<0.001$), for the EU election in 2019. Furthermore, it can be observed that voting for The Left has a positive impact and voting for the SPD has a negative impact on the share of meat substitutes. For both models, the relationship is statistically significant. On the other hand, there is no statistically significant relationship with the electoral shares of the market-liberal party FDP in the federal elections ($p>0.1$) or in EU elections ($F=2.59$, $p=0.081$). The results for the two conservative

parties are mixed. While the relationship between voting for the CDU and the market share of meat substitutes is positive, the relationship with the AfD is, as expected, negative although slightly lower/higher for the EU election in 2019, respectively. Finally, the estimated coefficients for the time dummy variables for the years 2019 and 2021 show that the market share of meat substitutes increased in the observed period.

Table 3 Results of fixed effects regression models explaining meat substitute consumption in Germany by voting behavior

	(1) (Green) % MS €	(2) (The Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €
Share Green %	.405***						.318*
	(.099)						(.164)
Share Green %*Y19	-.243***						-.316***
	(.044)						(.109)
Share The Left %		.820***					.383
		(.145)					(.279)
Share The Left %*Y19		.010					-.277**
		(.022)					(.129)
Share SPD %			-.517***				-.185
			(.071)				(.185)
Share SPD %*Y19			-.024				-.124
			(.023)				(.108)
Share FDP %				-.117			.225

	(1) (Green) % MS €	(2) (The Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €
				(.126)			(.254)
Share FDP %*Y19				-.172**			.064
				(.077)			(.117)
Share CDU %					.355***		.014
					(.093)		(.168)
Share CDU %*Y19					-.157***		-.249**
					(.036)		(.105)
Share AFD %						-.706***	-.712***
						(.149)	(.214)
Share AFD %*Y19						.103***	-.112
						(.019)	(.102)
2019 (EU dummy)	.024***	.05***	.001	.024***	.081***	-.003	.171*
	(.003)	(.006)	(.004)	(.005)	(.014)	(.004)	(.095)
2021 (dummy)	.058***	.114***	.108***	.08***	.112***	.064***	.073***
	(.006)	(.007)	(.006)	(.004)	(.01)	(.004)	(.017)

	(1) (Green) % MS €	(2) (The Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €
Constant	.018**	-.021	.157***	.065***	-.066**	.146***	.094
	(.009)	(.013)	(.014)	(.013)	(.031)	(.019)	(.151)
Observations	276	276	276	276	276	276	276
Within R2	0.856	0.860	0.871	0.833	0.847	0.854	0.895
Overall R2	0.621	0.084	0.264	0.406	0.444	0.579	0.629
Between R2	0.4	0.236	0.001	0.134	0.050	0.369	0.435
ll	788.164	792.12	802.444	767.291	779.325	786.288	831.161
F-stat	206.153	184.837	178.33	115.049	161.797	146.896	89.288
p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
F-Test party coefs.	25.580	31.700	27.630	2.590	18.590	21.810	11.840
P	<0.001	<0.001	0.009	0.081	<0.001	<0.001	<0.001

Note: The standard errors are cluster robust by postal code region. The reference year is 2017. Alternative for Germany (AfD), the Christian Democratic Union-Christian Social Union (CDU), the Free Democratic Party (FDP), Alliance 90/Die Grünen (Green), Die Linke (The Left) and the Social Democratic Party of Germany (SPD). a The Joint F-stat party c. is the value of the F-test for the null hypothesis that the estimated coefficients of the party are jointly equal to 0. * p<.10; ** p<.05; *** p<.01. *

Column (7) in Table 3 presents the combined results, including the results of all parties in a single estimation. Again, voting for the Green Party is associated with a higher market share for meat substitutes. However, this effect drops to almost zero for the 2019 European election. In addition, while we observe a negative association between the election share of The Left and the CDU in the EU election, the coefficients for the federal election do not differ from zero. Finally, once again, voting for the AfD is associated with lower meat substitute consumption and the effect does not differ for the 2019 EU election. There is no discernable link between meat substitute consumption and the election results of the remaining parties. Thus, while we find that voting for the Greens, which is the most sustainable among the parties analyzed and the only one explicitly in favor of supporting the market success of meat substitutes, is positively related to meat substitute consumption, the opposite is applies to the AfD.

Table 4 shows the estimation results of equation (4) which examines the relationship between the market share of meat substitutes and voting behavior as well as controlling for socioeconomic factors. Columns (1) through (6) of Table 4 present the estimates for each party separately while (7) shows the joint estimates. Column (8) shows the standardized coefficients as described in 3.3.

The model in column (1) includes the election results of the Green Party as the main independent variable and the sociodemographic control variables. The result of the estimated coefficient for the Share Green % variable indicates a positive relationship between the share that the Green Party obtains in a region and the market share of meat substitutes there. More precisely, a one percentage point higher share of the second vote for the Greens is associated with a 0.333 percentage points rise in the market share of meat substitutes. This supports the hypothesis that green voting behavior is related to higher meat substitute sales. However, this relationship is lower at the election for the European parliament in 2019 (.333-.245=.088; $F=20.710$, $p<0.01$). According to Handrich (2021), The Left, (column 2) has the second most

ambitious green election program, and the result it obtained differs in that the overall relationship is statistically insignificant. Nevertheless, the interaction term of the European Parliament election in 2019 and the federal result of The Left is positively associated with the market share of meat substitutes. The estimated coefficient for the share of the SPD and the market share of meat substitutes is statistically significant and negative. Therefore, the results partially contradict the hypothesis that more liberal/left voters eat more sustainable foods. However, meat substitute consumption is higher in regions where voting favors strong sustainability ambitions, i.e., via the Green Party.

Table 4 Results of fixed effects regression models explaining meat substitute consumption in Germany by socioeconomic and voting factors

	Fixed effects estimation							Standardized coefficients
	(1) (Green) % MS €	(2) (Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €	(8) (All Parties)
Share Green %	.333***						.425**	0.029
	(.101)						(.211)	
Share Green %*Y19	-.245***						-.240	
	(.046)						(.200)	
Share The Left %		-.057					-.390	-0.002
		(.178)					(.272)	
Share The Left		.192***					-.078	
		(.047)					(.205)	
Share SPD %			-.228***				-.126	-0.019
			(.077)				(.145)	
Share SPD %*Y19			-.002				-.035	
			(.027)				(.163)	
Share FDP %				.171			.386	0.013
				(.147)			(.269)	
Share FDP %*Y19				-.228**			.073	
				(.094)			(.158)	
Share CDU %					.232***		.174	0.004
					(.073)		(.155)	
Share CDU %*Y19					-.124***		-.116	
					(.036)		(.176)	
Share AFD %						-.084	-.077	-0.023
						(.114)	(.215)	
Share AFD %*Y19						.139***	.047	
						(.024)	(.186)	
Share Students	.056	.056	.108	.127	.074	.086	.251	0.046
	(.322)	(.43)	(.419)	(.422)	(.455)	(.43)	(.353)	
Avg. Income	-.674***	-.502***	-.383**	-.469**	-.397**	-.413**	-.856***	0.031

	Fixed effects estimation							Standardized coefficients
	(1) (Green) % MS €	(2) (Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €	(8) (All Parties)
	(.169)	(.185)	(.191)	(.2)	(.186)	(.172)	(.175)	
Avg. Income^2	.118***	.09**	.058	.083**	.062*	.072**	.16***	
	(.033)	(.037)	(.037)	(.041)	(.036)	(.033)	(.035)	
Avg. Age	.892***	1.313***	.922***	1.294***	1.179***	1.288***	.918***	-0.051
	(.254)	(.314)	(.289)	(.278)	(.261)	(.282)	(.307)	
Avg. Age^2	-.009***	-.014***	-.01***	-.014***	-.012***	-.014***	-.009***	
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	
Turnout in %	.127**	-.004	.095	.122*	.03	.037	.115	0.007
	(.05)	(.058)	(.06)	(.062)	(.06)	(.057)	(.101)	
Pop. Density	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000**	0.057
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
Share Female in %	-5.073	-4.7	-1.059	-2.985	-3.247	-3.775	-7.155	0.003
	(4.149)	(4.733)	(5.145)	(4.916)	(4.923)	(4.694)	(4.538)	
2019 (EU-dummy)	.055***	.008	.028**	.062***	.071***	.008	.076	
	(.008)	(.016)	(.013)	(.012)	(.013)	(.013)	(.16)	
2021 (dummy)	.061***	.074***	.091***	.077***	.096***	.074***	.048**	
	(.013)	(.015)	(.013)	(.012)	(.013)	(.012)	(.02)	
Constant	-18.101***	-27.611***	-20.906***	-28.048***	-25.909***	-27.654***	-17.964**	
	(6.522)	(7.711)	(7.23)	(7.257)	(6.798)	(7.243)	(7.352)	
Observations	276	276	276	276	276	276	276	
Within R2	0.922	0.909	0.907	0.906	0.909	0.912	0.930	
Between R2	0.058	0.078	0.077	0.108	0.061	0.098	0.011	
Overall R2	0.062	0.079	0.068	0.091	0.062	0.083	0.045	
ll	872.439	850.823	848.448	846.641	851.193	855.381	888.289	
F-stat all coefs.	146.044	111.535	119.547	107.324	117.748	111.062	96.414	
P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

	Fixed effects estimation							Standardized coefficients
	(1) (Green) % MS €	(2) (Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €	(8) (All Parties)
Joint F-stat party c.[a]	20.710	11.960	5.010	5.600	11.710	17.55	9.300	
P	<0.001	<0.001	0.009	0.005	0.001	<0.001	<0.001	

Note: The standard errors are cluster robust by postal code region. The reference year is 2017. Alternative for Germany (AfD), the Christian Democratic Union-Christian Social Union (CDU), the Free Democratic Party (FDP), Alliance 90/Die Grünen (Green), Die Linke (The Left) and the Social Democratic Party of Germany (SPD). [a] The Joint F-stat party c. is the value of the F-test for the null hypothesis that the estimated coefficients of the party are jointly equal to 0. The results of the factor analysis and the subsequent fixed effects estimation are shown in the Appendix, Tables 4 and 5. * p<.10; ** p<.05; *** p<.01. *

We now turn to the more conservative parties with less ambitious environmental programs as defined by Handrich's (2021) assessment. The link between the FDP result in the federal election and market share is not significant, while it is negative for the 2019 European elections. Based on the federal election results, the estimated relationship for the largest conservative party (CDU) and the total share of meat substitutes is positive. However, the interaction term of the European Parliament elections and the CDU share reduces the overall positive relationship (0.232-0.124=0.108; F=11.710, $p<0.01$). Finally, the estimated coefficient for the AFD is negative, as expected, but not significantly different from zero, which contradicts the hypothesis that more conservative voters tend to eat less sustainable products. Furthermore, the relationship is even positive for the interaction between the share of the AfD and the dummy variable for the European Parliament elections. Thus, this result tends to contradict the hypothesis that more conservative, less liberally orientated voters consume less sustainable food. When the results of all parties are combined in one model (column (7)), only the relationship between the share of the Green Party and the market share of meat substitutes remains statistically significant and positive.

The influence of socioeconomic factors is largely consistent across models. While we cannot detect any relationship between gender or the proportion of students in the total population and the market share of meat substitutes, we do find that income and age have a U-shaped and an inverted U-shaped relationship with the market share, respectively. Based on the model in column (1), income is negatively related to meat substitute consumption up to 2.86[3] i.e., 28.600€, while it is associated with higher meat substitute consumption once this threshold has been passed. Higher average age is associated with larger shares of meat substitute consumption, whereby this relationship becomes negative at an age of 49.5. In addition,

[3] According to Wooldridge (2013) the turning point can be calculated as $x^* = -\frac{\widehat{\beta_1}}{2*\widehat{\beta_2}}$, whereby $\widehat{\beta_1}$ belongs to the linear term, while $\widehat{\beta_2}$ belongs to the quadratic term.

population density is positively related to the market share of meat substitutes, suggesting higher meat substitute consumption in urban areas. The relationship between turnout and market share of meat substitutes tends to be positive but is only statistically significant in two of the seven models. The R^2 of the models ranges from 90.6% for the FDP model (column (4)) to 93% for the model including all parties' results (column (7)), indicating that a large share of the variance in the market share of meat substitutes can be explained by the political and sociodemographic factors included.

Column (8) presents the standardized coefficients for the model in column (7). The standardized coefficients are calculated as the sum product of the estimated coefficients from the model using factors as independent variables (Appendix, Table 5) and the factor loadings (Appendix, Table 4). These standardized coefficients can be interpreted as the relative strength of the respective independent variable in explaining variation in the dependent variable (Johnston et al., 2018). The results reveal that population density has the greatest relevance when explaining the variance in our model, as its standardized coefficient is the largest in absolute values. Thus, the share of meat substitutes in the market is larger in areas with higher population densities which confirms the above results. This is followed by the negative relationship between age and the market share of meat substitutes and positive relationships with both the proportion of students and income. The Green Party exhibits the highest standardized coefficient related to voting for political parties and is positive. This confirms our finding that the market share of meat substitutes increases significantly when the Greens achieve strong election results. In contrast, the share falls most strongly when electors vote for the AfD, followed by the SPD.

To summarize, the results suggest that socioeconomic characteristics and the election results obtained by the Greens and the AfD have the strongest predictive power in explaining the share of meat substitutes in different regions.

4.3 The left-right score and CPA score and meat substitute consumption

We now focus on the scores for left-right and climate change (CPA) voting in Germany and meat substitute consumption. Figure 2a shows the distribution of left-right voting behavior in Germany in 2021. Note that a higher score indicates a tendency toward conservative/right parties in a region, while a lower score indicates a trend toward more left/liberal voting behavior. The lowest score is observed in the Hamburg region, while the highest score is found in the eastern part of Saxony. In the context of CPA, a higher score indicates a greater share of votes for political parties with stronger climate protection ambitions. Figure 2b shows that there is stronger voter support for the CPA in the western parts of Germany than in the eastern region.

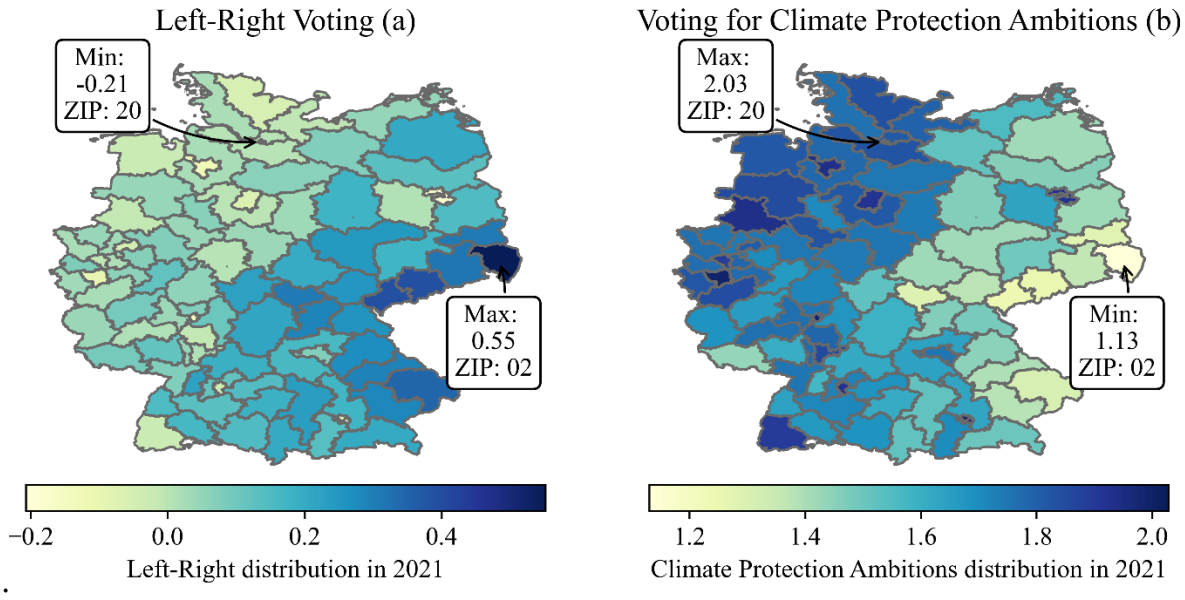


Figure 2 Regional distribution of the Left-Right Score and CPA in 2021

Note: the Left-Right score is calculated based on the results of Lo et al. (2014b), while the CPA score is based on the results of Handrich (2021). The calculation is explained in equations 1 and 2, respectively. ZIP: postal code region.

Table 4 presents the regression results for the relationship of meat substitute consumption with the left-right score and voting for climate change ambitions in the regions (CPA score). The model in column (1) shows that there is a significant relationship between the interaction of the

left-right score with the 2019 (EU parliament) dummy and the market share of meat substitutes. Although the respective coefficient is positive, the negative main effect for the Left-Right score means that the overall relationship with the EU is negative (-0.054+0.042=-0.012; F=7.590, p<0.01). Column 2 shows that this result does not remain robust if the ordered score for left-right voting is used. As expected, the estimated coefficient for the association between voting for climate change ambitions (CPA) and the share of meat substitutes in column (3) is positive and statistically significant. However, the relationship is somewhat reduced by the 2019 European Parliament election. The results are robust to the alternative specification in column (4) where the ordered CPA is used. Therefore, in line with the results in section 4.2, we find evidence for the hypothesis that the more conservative a region is, the lower the market share of meat substitutes. Moreover, we find evidence for a relationship between voting for climate change ambitions and the market share of meat substitutes. In general, the CPA score appears to be a better predictor of meat substitute consumption than the Left-Right score in Germany. The results for the socioeconomic variables are similar to those in Table 3, except for the quadratic relationship between income and meat substitute consumption.

Table 5 Results of fixed effects regression models of meat substitute consumption and Left-Right voting and CPA in Germany

	Fixed effects estimation				Standardized coefficients after factor analysis	
	(1)	(2)	(3)	(4)	(5)	(6)
	% MS €	% MS €	% MS €	% MS €		
Left-Right	-0.054				-0.026	
	(0.069)					
Left-Right*Y19	0.042***					

	Fixed effects estimation				Standardized coefficients after factor analysis	
	(1)	(2)	(3)	(4)	(5)	(6)
	% MS €	% MS €	% MS €	% MS €		
	(0.012)					
Left-Right ordered		-0.002				
		(0.023)				
Left-Right ordered*Y19		0.026**				
		(0.011)				
CPA			0.109***			0.007
			(0.037)			
CPA*Y19			-0.055***			
			(0.011)			
CPA ordered				0.049**		
				(0.021)		
CPA*Y19				-0.029***		
				(0.007)		
Share Students	0.092	0.072	0.067	0.051	0.021	0.016
	(0.424)	(0.437)	(0.362)	(0.394)		
Avg. Income	-0.333*	-0.390**	-0.518***	-0.459**	-0.009	-0.004
	(0.190)	(0.194)	(0.173)	(0.180)		
Avg. Income^2	0.047	0.057	0.080**	0.066*		
	(0.037)	(0.038)	(0.033)	(0.035)		
Avg. Age	1.174***	1.217***	0.911***	1.066***	-0.0003	-0.001
	(0.325)	(0.292)	(0.264)	(0.267)		
Avg. Age^2	-0.013***	-0.013***	-.009***	-0.011***		

	Fixed effects estimation				Standardized coefficients after factor analysis	
	(1)	(2)	(3)	(4)	(5)	(6)
	% MS €	% MS €	% MS €	% MS €		
	(0.004)	(0.003)	(0.003)	(0.003)		
Turnout in %	0.123**	0.119**	0.184***	0.181***	-0.008	0.0001
	(0.052)	(0.057)	(0.058)	(0.056)		
Pop. Density	0.001***	0.001***	0.000***	0.000***	0.030	0.015
	(0.000)	(0.000)	(0.000)	(0.000)		
Share Female in %	-3.211	-2.855	-4.929	-4.553	0.029	0.020
	(4.812)	(4.809)	(4.228)	(4.345)		
2019 (EU dummy)	.036***	-0.040	0.139***	0.144***		
	(0.012)	(0.048)	(0.020)	(0.025)		
2021 (dummy)	0.077***	0.083***	0.077***	0.080***		
	(0.013)	(0.015)	(0.012)	(0.013)		
Constant	-25.453***	-26.517***	-19.067***	-22.616***		
	(8.413)	(7.602)	(6.581)	(6.791)		
Observations	276	276	276	276		
Within R2	0.907	0.906	0.918	0.912		
Between R2	0.101	0.101	0.060	0.070		
Overall R2	0.080	0.079	0.060	0.065		
ll	848.034	847.118	865.126	855.452		
F-stat	110.487	111.725	130.38	119.747		
P	<0.001	<0.001	<0.001	<0.001		
Joint F-stat Score[a]	7.590	4.590	16.430	10.990		
p-value	0.001	0.013	<0.001	<0.001		

Note: The standard errors are cluster robust errors by postal code region. The reference year is 2017. # is the interaction of the variable with the EU Parliament dummy variable. Climate Protection Ambitions (CPA). * p<.10; ** p<.05; *** p<.01. The standardized coefficients are calculated based on the sum over the product of each variable's factor with the regression coefficients estimated in Tables 6 and 7 in the Appendix. [a] The Joint F-stat Score is the value of the F-test for the null hypothesis that the estimated coefficients of the scores are jointly equal to 0.

We also perform the same robustness checks as above and report results for the standardized coefficients in columns (5) and (6). Once again, the results indicate that population density plays a decisive role in explaining the variance in the *% MS €*. In addition, we find that more conservative regions correspond to regions with lower meat substitute consumption. Finally, it appears that the CPA score is moderately related to the variance of the market share of meat substitutes, while we identify stronger effects from gender, the share of university students and the population density.

5 Discussion, Policy Implications & Conclusion

5.1 Discussion of empirical results

Both public health and environmental issues demand a reduction in meat consumption. However, this remains a challenge (Willett et al., 2019). Meat substitutes are a potential alternative that could contribute to reducing the intake and external effects of meat consumption (Siegrist and Hartmann, 2023). However, in recent years the market growth of meat substitutes has fallen below the level anticipated, for example, by the investment bank Barclays in 2019 (Barclays, 2019). While we find that the overall market share for meat substitutes increased from 2017-2021, there are significant regional differences within Germany.

Our results show that the differences in meat substitute consumption between regions in Germany is mainly attributable to differences in socioeconomic and demographic factors, together with political attitudes towards the Green Party and climate protection ambitions. Our

results are in line with those of Carlsson et al., (2022), who found that differences in the willingness to switch to meat substitutes can be explained by differences in the age and the population density within a region. Furthermore, in line with the findings of Heijnk et al. (2023), we cannot detect any evidence to support the idea that differences in the share of meat substitutes are attributable to gender. However, our findings regarding gender and meat substitute consumption in Germany do contradict the results reported in the literature review of Onwezen et al. (2021). Earlier literature has presented rather mixed findings regarding the relationship between income and the adoption of meat substitutes. For example, Li et al., (2023) report that there is no relationship between income and the purchase intent for pea burgers and detect a negative relationship towards meat substitute burgers with animal proteins. Additionally, Heijnk et al., (2023) report a negative relationship between income and the attitude towards plant-based meat substitutes, while Carlsson et al., (2022) suggest it has no influence on the willingness to switch. However, our results indicate a U-shaped relationship between average income in a region and the share of meat substitutes on the market. This indicates that the relationship between income and meat substitute consumption seems to vary depending on the context analyzed and the income level. Therefore, further research is needed in this direction. In contrast, the positive influence of population density seems to be consistent with previous literature (Carlsson et al., 2022; Onwezen et al., 2021).

The aim of this article is not only to examine sociodemographic factors, but to determine whether there is a relationship between political voting and consumption. Jost (2017) argues that there are significant differences regarding meat consumption between consumers who consider themselves to be liberal and those who identify as conservatives. Along these lines, previous literature has analyzed the relationship between liberal and conservative attitudes and meat consumption. Nezlek and Forestell (2019) report that consumers who tend to be more conservative consume more meat, and Milfont et al., (2021) report that those with more liberal

leanings are more likely to be vegan or vegetarian. On the other hand, Li et al., (2023) who analyzed the preferences for beef, blended (mixed beef and mushroom), pea protein or animal-like protein burgers, found no relationship between a liberal attitude compared to other political attitudes and meat substitute preferences. Our results reveal that the differences in meat substitute consumption can be explained by the Left-Right voting attitude within a region. More specifically, we find strong evidence that meat substitute consumption is higher in regions where the Greens, who can be considered the party with the strongest election program for climate actions (Handrich, 2021) and who are the only party to actively promote meat substitutes in their election program, achieve better election results with the market share of meat substitutes. Moreover, our results indicate, although not quite as clearly, that voting behavior for the right-wing party (AfD) in Germany is negatively related to meat substitute consumption. However, based on the joint score for left-right voting behavior, for the European election we find evidence for higher meat substitute consumption in regions with a more conservative/right voting behavior.

We not only analyzed the left-right heuristic, but also the relationship between voting behavior for climate protection measures and meat substitute consumption. While Marcus et al., (2022) find no support for the link between German consumers' environmental concerns and their intention to consume meat substitutes, Heijnk et al., (2023) report a positive relationship between a favorable attitude towards meat substitutes and climate concerns in Germany. We also find strong support for a positive relationship between voting for climate protection positions (CPA scale) in a region and consumption of meat substitutes. This also indicates that the CPA score might be the more appropriate heuristic than the right-left score when explaining meat substitute consumption.

5.2 Managerial implications

Several managerial implications for agribusiness actors can be derived from our results. First, we find differences in the share of meat substitutes that can be explained by the regional income levels, i.e., lower incomes lead to lower consumption levels of meat substitutes. There is evidence that consumers discern a vegan tax on meat substitutes which, in turn, might act as a deterrent (Kerslake et al., 2022). Given that meat substitutes cost considerably more than meat products in Germany (Petersen et al., 2023; Petersen et al., 2021), it might be expedient to adjust prices of meat substitutes to help these products reach more consumers, particularly in regions with lower average incomes.

In the case of Germany, almost 30% of the population is over 60 years of age (DESTATIS, 2023c). However, in the literature and according to our results, age is negatively related to meat substitute consumption (e.g. Carlsson et al., 2022; Heijnk et al., 2023; Onwezen et al., 2021). Therefore, manufacturers should take steps to convince older consumers of the quality of meat substitutes as a healthy alternative to meat products by developing marketing strategies that target this age group more effectively.

Finally, in the context of plant-based meats, Yule and Cummings (2023) suggest that advertising which reflects consumers' own political ideas is becoming increasingly appealing. In particular in the case of the Green Party, our results indicate that there is indeed a relationship between political parties and meat substitute consumption. Therefore, marketing strategies that divide the market into consumer groups according to voting behavior might help meat substitute producers to increase their market share. Hoogstraaten et al., (2023) report that producers of meat substitutes only declare the environmental benefits of their products as secondary claims and focus more strongly on the taste factor. Therefore, even if consumers' political attitudes do not indicate a general interest in environmental sustainability or animal welfare, efforts could

still focus specifically on issues related to environmental benefits which might appeal even more strongly to Green voters.

5.3 Policy implications

As discussed above, managerial implications suggest that meat substitutes should be offered at lower prices if they are to reach a broader customer group and this implies that the framework conditions must be changed so that the prices for meat substitutes go down (Funke et al., 2022). In Germany, a value-added tax (VAT) of 7% is levied on meat products while meat substitutes are taxed at 19%, so this price reduction could be achieved by lowering the tax rate for meat substitutes. Alternatively, taxes on meat products could be increased, to make meat substitutes cheaper in comparison (Siegrist and Hartmann, 2023). Roosen et al. (2022) show that an increase in meat taxes in Germany would lead to significant changes in meat consumption as the demand for pork and beef products is rather elastic. Zhao et al. (2022) find that own-price elasticities of meat in the US are lower than those of plant-based meat substitutes. Hence, higher taxes on meat products, combined with lower taxes on meat substitutes could lead to significant changes in consumer behavior, away from meat and towards increased meat substitute consumption. However, Zhao et al. (2022) report no relevant cross-price elasticity between (red) meat and meat substitutes, which implies that a decrease in the tax on meat substitutes could be particularly effective in promoting higher market shares of these alternatives.

5.4 Limitations

Despite the strengths of this study, such as the revealed preference data from supermarkets rather than stated preference data and the comprehensive sample underlying the analysis, it is not without limitations. Since we do not have household characteristics that match the sales data at the consumer-level, we can only assume that the differences in the sociodemographic variables and voting behavior across the regions explain the variance in the market share of meat substitutes. Therefore, it would be interesting to see whether the results can be replicated

with other data sets in the future. Secondly, political opinions and voting behavior vary considerably over time depending on recent events. However, we only observe political opinions at three different points in time. Therefore, attitudes towards the parties at other points in time during the same year might differ from those at the election. Nevertheless, we believe that the political opinions really do reflect the political views of the German population in the different years. Thirdly, our study is based on a sample from supermarkets, discounters and hypermarkets. Therefore, the data does not cover a considerable share of products sold/consumed in Germany, such as at butchers' shops or in restaurants. As a result, the market for meat and meat substitutes is not fully covered in the market share calculation. However, the aim of the study is to estimate and test how consumer characteristics and voting behavior relates to meat substitute consumption. Since the same sample characteristics apply to the regions, we consider the data suffices to explain the relationship. Finally, the results could be affected by endogeneity caused by the omission of variables related to consumers' lifestyle segments, as these factors could be related to both meat substitute consumption and voting behavior (Grunert, 2006; Hoek et al., 2011).

5.5 Conclusion

In this paper, we used revealed preference data on the sales of meat and meat substitutes in Germany to test the left-right and the environmental concerns framework to explain meat substitute consumption. We find significant differences in the level of meat substitute consumption across regions, and a growing market share over the years 2019 to 2021. We conclude that the left-right framework is less suitable for explaining meat substitute consumption than the environmental concerns framework. To summarize, although sociodemographic differences, i.e., age, population density and income are important for explaining differences in meat substitute consumption, we also find evidence that political attitudes are related to sustainable food choices.

Appendix, Table 1 Hausman test for random effects

Equation 3	(1) (Green) % MS €	(2) (Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €
Hausmann test for random effects χ^2	5.110	107.71	31.85	26.79	4.63	6.82	57.8
p	0.078	<0.001	<0.001	<0.001	0.099	0.033	<0.001

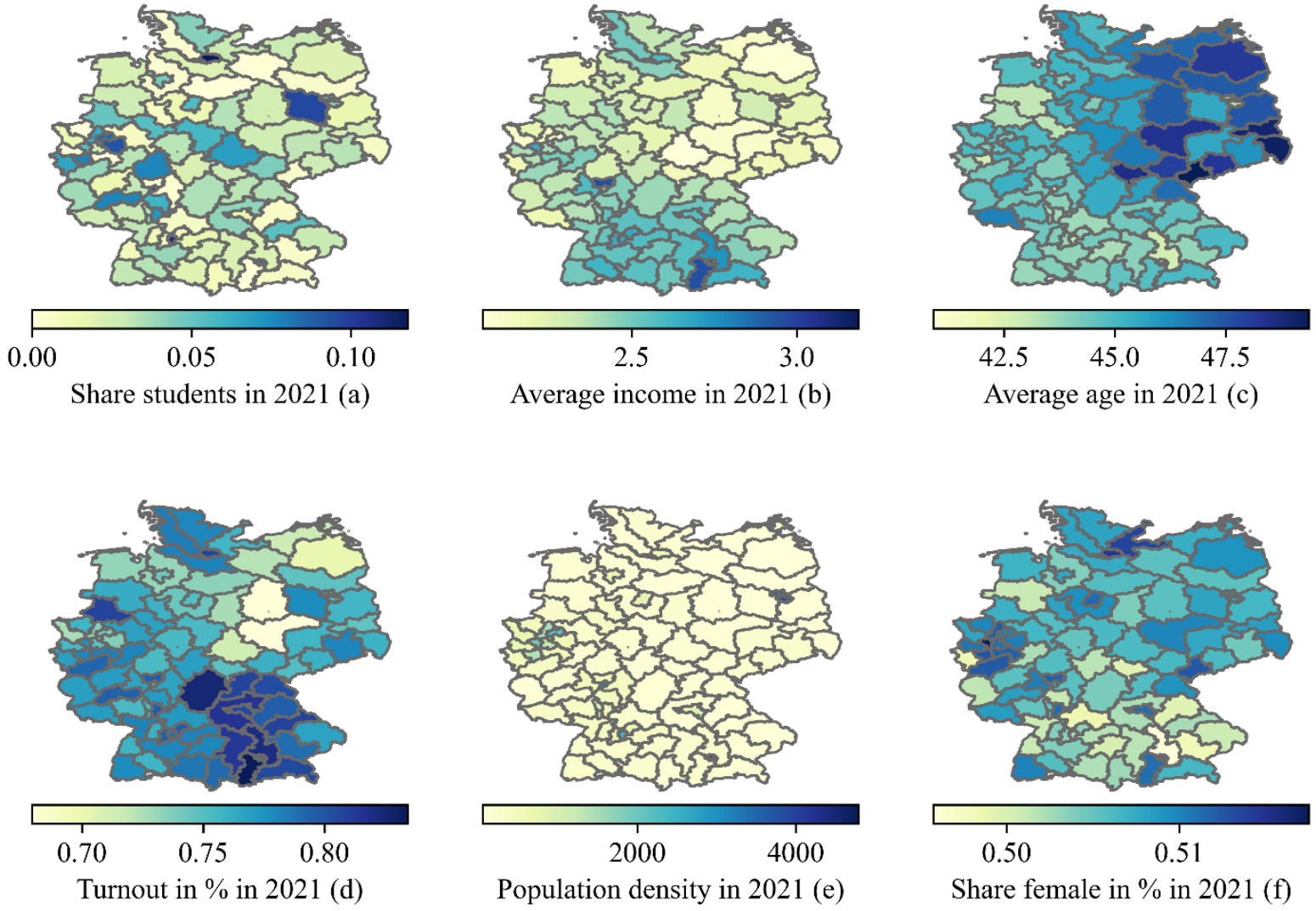
Equation 4	(1) (Green) % MS €	(2) (Left) % MS €	(3) (SPD) % MS €	(4) (FDP) % MS €	(5) (CDU) % MS €	(6) (AFD) % MS €	(7) (All Parties) % MS €
Hausmann test for random effects χ^2	65.70	65.850	45.780	68.710	63.320	77.000	67.130
p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Appendix, Table 1 Matrix of correlations $\rho_{x,y}$

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) % MS all €	1.000														
(2) Share Students	0.307	1.000													
(3) Avg. Income	0.484	0.044	1.000												
(4) Avg. Age	-0.425	-0.342	-0.548	1.000											
(5) Turnout in %	0.313	0.045	0.113	-0.167	1.000										
(6) Pop. Density	0.271	0.473	0.262	-0.506	0.030	1.000									
(7) Share Female in %	0.084	0.192	-0.035	0.165	-0.007	0.315	1.000								
(8) Share Green in %	0.416	0.270	0.542	-0.541	-0.424	0.395	0.145	1.000							
(9) Share The Left in %	-0.508	0.033	-0.657	0.491	-0.002	0.034	0.148	-0.521	1.000						
(10) Share SPD in %	0.292	0.143	-0.207	-0.028	0.410	0.047	0.236	-0.083	-0.141	1.000					
(11) Share CDU in %	-0.205	-0.237	0.217	-0.258	0.023	-0.258	-0.324	-0.178	-0.307	-0.420	1.000				

(12) Share FDP in %	0.357	0.098	0.243	-0.317	0.804	0.178	0.102	-0.183	-0.134	0.487	-0.134	1.000			
(13) Share AFD in %	-0.511	-0.206	-0.525	0.749	-0.072	-0.291	-0.064	-0.608	0.696	-0.339	-0.254	-0.232	1.000		
(14) Left-Right	-0.415	-0.403	-0.131	0.469	0.033	-0.501	-0.351	-0.622	0.131	-0.541	0.434	-0.172	0.675	1.000	
(15) CPA	0.383	0.324	0.412	-0.707	-0.093	0.431	0.225	0.799	-0.453	0.274	-0.006	0.132	-0.857	-0.831	1.000

Note: $\rho_{x,y}$ Pearson correlation between variable x and y.



Appendix, Figure 1 Distribution of socioeconomic variables across regions for 2021

Appendix Factor Analysis

Prior to the factor analysis, we perform the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test for sphericity to determine whether the data are suitable for factor analysis (Backhaus et al., 2021). The Bartlett test, which compares the correlation matrix with the identity correlation matrix, is significantly different from 0, which implies that the correlation matrix is unequal to the identity matrix (Backhaus et al., 2021). The overall KMO test result of 0.49 is slightly below the lower bound of 0.5, indicating that the data are not really suitable for factor analysis (Kaiser and Rice, 1974). The full results are presented in the Appendix, Table 2. However, this outcome is probably due to the low correlation between each party's election results. Thus, the closeness to the overall cut-off of 0.5, prompted us to proceed with the factor analysis. The results of varimax-adjusted factor loadings are presented in the Appendix, Tables 3 and 5.

Appendix, Table 2 Kaiser-Meyer-Olkin Measure of Sampling Adequacy

	KMO[1]
Share students	0.814
Avg. Income	0.637
Avg. Age	0.637
Turnout in %	0.689
Pop. Density	0.603
Share Female in %	0.308
Share Green in %	0.441
Share The Left in %	0.564

Share SPD in %	0.264
Share CDU in %	0.222
Share FDP in %	0.594
Share AFD in %	0.523
Overall	0.492

Note: [1]The test was performed using Stata's 'estate kmo' command.

Appendix, Table 3 Results of varimax-adjusted factor loadings

	All			
	F.1	F.2	F.3	F.4
Share Green in %	-0.72	-0.47	0.37	0.17
Share T. Left in %	0.91	-0.03	0.22	0.04
Share SPD in %	-0.16	0.50	-0.12	0.75
Share FDP in %	-0.25	0.05	-0.28	-0.76
Share CDU in %	-0.16	0.89	0.13	0.16
Share AFD in %	0.89	-0.14	-0.14	-0.09
Share Students	-0.05	0.06	0.75	0.15
Avg. Income	-0.73	0.08	0.19	-0.27
Avg. Age	0.70	-0.24	-0.49	0.28
Turnout in %	0.04	0.95	0.02	-0.01
Pop. Density	-0.16	0.05	0.87	0.10
Share Female in %	0.05	-0.07	0.29	0.62

Note: F.: Factor.

Appendix, Table 4 Results of fixed-effects estimation of the factors and the share of meat substitutes

	(1) (All) % MS €
Factor 1	-0.016
	(0.019)
Factor 2	0.006
	(0.009)
Factor 3	0.065***
	(0.021)
Factor 4	-0.023***
	(0.006)
2019 (EU dummy)	0.032***
	(.011)
2021 (dummy)	.112***
	(.009)
_cons	0.038***
	(0.005)
Observations	276
Within R^2	0.868
Overall R^2	0.444

	(1) (All) % MS €
Between R^2	0.354
Ll	799.905
F-stat	140.76
P	<0.001
Hausmann test for random effects χ^2	34.020
P	<0.001

Appendix, Table 5 Results of varimax-adjusted factor loadings for

	Left-Right		CPA		
	F.1	F.2	F.1	F.2	F.3
Left-Right	-0.76	0.25			
CPA			0.77	0.32	-0.22
Share Students	0.66	0.22	0.30	0.66	0.11
Avg. Income	-0.01	0.77	0.75	-0.16	0.10
Avg. Age	-0.28	-0.88	-0.93	-0.06	-0.14
Turnout in %	-0.12	0.36	0.04	0.01	0.98
Pop. Density	0.73	0.40	0.51	0.65	0.05
Share Female in %	0.70	-0.35	-0.17	0.80	-0.07

Note: F.: Factor.

Appendix, Table 6 Results of fixed-effects estimation of the factors and the share of meat substitutes

	(1)	(2)
	% MS €	% MS €
factor1_lr	0.070***	
	(0.025)	
factor2_lr	-0.001	
	(0.022)	
factor1_cpa		0.013
		(0.014)
factor2_cpa		0.039
		(0.036)
factor3_cpa		-0.001
		(0.006)
2019 (EU dummy)	0.000	0.020**
	(0.007)	(0.008)
2021 (dummy)	0.070***	0.080***
	(0.007)	(0.006)
_cons	0.063***	0.053***
	(0.003)	(0.004)
Observations	276	276
Within R2	0.848	0.836
Overall R2	0.259	0.425
Between R2	0.122	0.189
Ll	780.335	770.016
F-stat	133.681	103.417

p	0	0
Hausmann test for random effects χ^2	17.060	10.170
P	0.002	0.017

Standard errors are in parentheses *** p<.01, ** p<.05, * p<.1

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