Groh, Elke D.; Ziegler, Andreas

Working Paper

On self-interested preferences for burden sharing rules: An econometrics analysis for the costs of energy policy measures

MAGKS Joint Discussion Paper Series in Economics, No. 54-2017

Provided in Cooperation with:
Faculty of Business Administration and Economics, University of Marburg

Suggested Citation: Groh, Elke D.; Ziegler, Andreas (2017) : On self-interested preferences for burden sharing rules: An econometrics analysis for the costs of energy policy measures, MAGKS Joint Discussion Paper Series in Economics, No. 54-2017, Philipps-University Marburg, School of Business and Economics, Marburg

This Version is available at:
https://hdl.handle.net/10419/174350

Joint Discussion Paper Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 54-2017

Elke D. Groh and Andreas Ziegler

On self-interested preferences for burden sharing rules: An econometrics analysis for the costs of energy policy measures

This paper can be downloaded from
http://www.uni-marburg.de/fb02/makro/forschung/magkspapers

Coordination: Bernd Hayo • Philipps-University Marburg
School of Business and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

On self-interested preferences for burden sharing rules: An econometric analysis for the costs of energy policy measures

Elke D. Groh and Andreas Ziegler

November 2017

Elke D. Groh
University of Kassel, Institute of Economics
Nora-Platiel-Str. 5, 34109 Kassel, Germany
E-Mail: elke.groh@uni-kassel.de
Phone: +49/561/804-3044, Fax: +49/561/804-2501

Andreas Ziegler (corresponding author)
University of Kassel, Institute of Economics
Nora-Platiel-Str. 5, 34109 Kassel, Germany
E-Mail: andreas.ziegler@uni-kassel.de
Phone: +49/561/804-3038, Fax: +49/561/804-2501
and
Centre for European Economic Research (ZEW), Mannheim, Germany

On self-interested preferences for burden sharing rules: An econometric analysis for the costs of energy policy measures

November 2017

Abstract

This paper examines the acceptance of burden sharing rules that refer to the costs of the German energy transition, which is one of the most challenging and disputed national climate and energy policy measures. Based on data from a comprehensive survey of more than 2,200 citizens, the empirical analysis reveals that the polluter-pays rule has by far the highest support compared with the ability-to-pay rule and especially compared with the equal-pay rule, which is widely refused in the sample. Since the distribution of the costs of the German energy transition is largely in line with the polluter-pays rule, its strong support seems to contribute to the high acceptance of the energy transition at all. The main result of our econometric analysis with multivariate binary and ordered probit models is that not only some attitudinal factors like environmental values and political identification, but especially economic self-interest is relevant since (equivalent) energy expenditures have a significantly negative effect on the support of the polluter-pays rule and especially (equivalent) income has a significantly negative effect on the preference for the ability-to-pay rule. These results suggest that the use of distributional arguments for the criticism of energy policy measures is not necessarily value-driven on the basis of real perceptions of distributive justice, but can also be strategically motivated to prevent and combat economically unfavorable measures. Together with the strong general support of the polluter-pays rule, these results suggest that a sharp reorientation of the German energy transition due to distributional arguments is not very useful.

Keywords: Climate change; climate and energy policy measures; burden sharing rules; economic self-interest; attitudinal factors; multivariate binary and ordered probit models

JEL: Q54; Q48; Q42

1. Introduction

According to the Paris Agreement 2015 within the United Nations Framework Convention on Climate Change (UNFCCC), each country sets a target for the reduction of greenhouse gas emissions. On this basis, the main challenge for national governments is the translation of targets into regulations such as the EU Emissions Trading System (EU ETS) at the European level. However, the successful implementation of climate policy measures generally requires their public support (e.g. Kallbekken and Sælen, 2011, Gampfer, 2014), which obviously strongly depends on the policy type. For example, non-coercive climate policy measures such as subsidies mostly receive a high acceptance, whereas emission trading systems and especially carbon taxes are less supported, although they are highly favored by economists due to their cost efficiency (e.g. Hammar and Jagers, 2007, Rhodes et al., 2017). In line with several (stated preferences) studies on the individual support of domestic climate policy measures, which reveal the general relevance of their costs (e.g. Dietz and Atkinson, 2010, Sælen and Kallbekken, 2011, Brännlund and Persson, 2012, Shin et al., 2014, Gevrek and Uyduranoglu, 2015, Ščasný et al., 2017, Carratini et al., 2017), an important reason for the overall limited support of carbon taxes seems to be that they lead to direct financial burdens for the households (e.g. Drews and van den Bergh, 2016).

However, while actual costs certainly play an important role for the acceptance of climate policy measures, subjective perceptions about their costs and effectiveness as well as other attitudinal factors (e.g. personal values and norms) are also highly relevant (e.g. Ziegler, 2017a, 2017b). Based on data from a comprehensive survey of citizens, this paper empirically examines an additional important factor for the support of costly climate policy measures, i.e. distributional perceptions (e.g. Drews and van den Bergh, 2016). It can be expected that climate policy measures are only accepted if the distribution of their costs is perceived to be fair (e.g. Heindl et al., 2014). However, perceptions about a fair burden sharing across citizens can be based on very different principles like the polluter-pays rule (i.e. the rule of an equal ratio between individual contributions to climate change and individual financial contributions to the costs of the climate policy measure), the ability-to-pay rule (i.e. the rule of an equal ratio between individual financial ability and individual financial contributions to the costs of the climate policy measure), or the equal-pay rule (i.e. the rule of equal individual financial contributions to the costs of the climate policy measure).

Previous studies have already examined individual preferences for burden sharing rules in climate policy. However, many of them refer to the burden sharing of costs across countries in international climate agreements. One direction of these studies is based on data from agents involved in international climate negotiations (e.g. Lange et al., 2007, 2010, Kesternich et al., 2014). An important result of these empirical analyses is the general preference for polluter-pays rules, which refer to an equal ratio between regional abatement costs and past or current regional greenhouse gas emissions in this context. A second direction of empirical and experimental studies is based on (more or less representative) data at the citizen level. While Schleich et al. (2016) clearly confirm a strong support of the polluter-pays rule, the results in Carlsson et al. (2011, 2013), Bechtel and Scheve (2013), Gampfer (2014), Brick and Visser (2015), and Ščasný et al. (2017) are less clear-cut. A key result of some empirical analyses that include respondents from different countries is that perceptions about distributive justice can be influenced by economic self-interest (see also e.g. Brekke and Johansson-Stenman, 2008), i.e. burden sharing rules that lead to lower costs for the own countries are often preferred (e.g. Lange et al., 2007, 2010, Carlsson et al., 2013, Kesternich et al., 2014, Brick and Visser, 2015). In contrast, Carlsson et al. (2011) and Schleich et al. (2016) do not find self-interested preferences for burden sharing rules.

With respect to the domestic burden sharing of costs for national climate policy measures, Hammar and Jagers (2007) report that a specific type of the polluter-pays rule as discussed above has the strongest support in Sweden. Furthermore, they show that perceptions about burden sharing rules as well as economic self-interest (measured by the frequency of car use) play an important role for the acceptance of a specific type of policy, i.e. a CO_2 tax on gasoline and diesel. Based on citizen data from stated choice experiments, the empirical studies of Ščasný et al. (2017) for the Czech Republic, the UK, and Poland, and of Brännlund and Persson (2012) for Sweden confirm the high acceptance of the polluter-pays rule for the burden sharing of costs for unspecified domestic climate policy measures. The latter study additionally reveals a high preference for a progressive distribution of hypothetical policy costs, i.e. a specific type of the ability-to-pay rule. Strong preferences for progressive designs that refer to revenue recycling can also be found on the basis of further stated choice experiments for carbon taxes in Switzerland (e.g. Carratini et al., 2017) and fuel taxes in Norway (e.g. Sælen and Kallbekken, 2011).

Ščasný et al. (2017)[1] and Carratini et al. (2017) do not only use conditional or mixed logit models for the econometric analysis of their stated choice data, but also latent class models, which provide insights on the correlations between individual characteristics and the membership to specific classes that are associated with the support of burden sharing rules. However, this approach is very indirect and inconclusive and thus not able to identify real intrinsic motives. In contrast, with respect to the distribution of costs for national climate policy measures, we directly examine explanatory factors for the preferences for three domestic burden sharing rules, i.e. a polluter-pays rule, an ability-to-pay rule, and an equal-pay rule as discussed above. This analysis allows the understanding whether some criticism of climate policy measures which refers to an unfair burden sharing is completely value-driven on the basis of real perceptions of distributive justice or whether these perceptions are based on economic self-interest, i.e. rather strategically motivated to prevent and combat economically unfavorable measures. While in the first case the acceptance of climate policy measures can be increased by distributing their costs fairer, in the latter case the increase of the support can be based on instruments that decrease the economic costs for specific groups of citizens due to the underlying burden sharing rule.

Two stated choice studies do not only apply latent class models, but also directly examine explanatory factors for the support of different burden sharing rules by including interaction terms with individual characteristics in mixed logit models. Based on citizen data from Turkey, Gevrek and Uyduranoglu (2015) consider hypothetical carbon taxes and reveal a high preference for a progressive distribution of the tax costs, i.e. a specific type of the ability-to-pay rule. Furthermore, they show a positive correlation between environmental values and the support of this progressive cost distribution. However, a main shortcoming of this econometric analysis is that it does not include a polluter-pays rule, which can obviously be extremely relevant according to the studies as discussed above. In fact, Dietz and Atkinson (2010) find a very high acceptance of the polluter-pays rule compared to the ability-to-pay rule and especially compared to the equal-pay rule for the burden sharing of costs for unspecified national

[1] Interestingly, the experiments in this study do not only include rules for the burden sharing of domestic costs, but also for the burden sharing of costs across countries in the EU. In addition to the very strong support of domestic polluter-pays rules in all three countries, the empirical analysis reveals a high preference for international polluter-pays rules in the UK and the Czech Republic, whereas the respective preferences in Poland are less clear-cut, which can be associated with economic self-interest due to the high coal and emission intensity in this country.

climate policy measures.[2] Their econometric analysis with restricted citizen data from an English urban area (i.e. London Borough of Southwark) also shows that a low socio-economic status is negatively correlated with the support of the ability-to-pay rule, which is obviously in line with economic self-interest.

Our empirical analysis builds upon these studies, but is not based on data from stated choice experiments, which are certainly useful for the analysis of preferences for non-existing policies. However, a main drawback of such stated choice studies is their hypothetical character, which can lead to hypothetical biases and thus a restricted external validity of the estimation results. Therefore, we specifically examine the German energy transition ("Energiewende") towards renewable energies (e.g. Strunz, 2014), i.e. an existing and widely well-known climate policy measure that comprises a series of regulations and that is one of the most challenging and disputed instrument in Europe and also worldwide. Two main components of this energy transition are the nuclear phase-out and the financial support of the expansion of renewable energies through the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) (e.g. Frondel et al., 2015). Due to the relevance of the former measure, the German energy transition is not exclusively a climate policy measure, although the reduction of greenhouse gas emissions is still a main objective (e.g. BMWi, 2014). The EEG provides feed-in tariffs for the generation of renewable electricity, which are recently no longer set by the government, but by an auction system.

The costs that are induced by the EEG have to be borne by many firms and especially by households since they are directly passed through to the electricity prices. The money amounts which are reallocated according to the EEG mechanism are huge. For example, the estimated EEG payments in 2017 amount to 25.7 billion Euro (e.g. BDEW, 2017). While the energy transition in total, but also their two core measures are supported by the majority of German citizens (e.g. Andor et al., 2016), their high costs are seen as a key problem by more than a quarter of the citizens (e.g. BDEW, 2016). The main basis for the public criticism of the energy transition (in the political arena e.g. by the Liberal Democratic Party, FDP) is the feed-in tariff system. Recently, this criticism is increasingly justified by the argument that the distribution of the costs of the energy transition is socially unfair (e.g. Heindl et al., 2014) and can even lead to the risk of energy poverty for low-income households (e.g. Frondel et al.,

[2] The study does not only refer to national climate policy measures, but additionally also considers a local traffic-emissions policy.

2015, Heindl, 2015). However, it is not clear whether the proponents of this criticism are really worried about the social consequences of the energy transition, which contradicts their real perception of distributive justice, or whether the arguments are strategically used due to economic self-interest, as discussed above.

Against this background, our empirical analysis thoroughly considers different variables for economic self-interest. It therefore clearly goes beyond the study of Gevrek and Uyduranoglu (2015), who do not examine economic self-interest at all, but also beyond the analysis of Dietz and Atkinson (2010). In the case of the polluter-pays rule, Dietz and Atkinson (2010) use a dummy variable for frequent car use, which can be useful for the specific analysis of fuel-oriented policy measures, but certainly not for general climate policy measures since these do not only refer to car use. Therefore, the insignificant effect of this variable on the support of the polluter-pays rule cannot be interpreted as reliable evidence that economic self-interest is irrelevant, but can also be explained by the insufficient indicator. Similarly, the use of a dummy variable for living in a social-rented accommodation as indicator for socio-economic status is rather rough. In contrast, we use more refined and reliable variables for capturing the effect of economic self-interest, i.e. with respect to the polluter-pays rule, we consider (equivalent) household energy expenditures and with respect to the ability-to-pay rule we consider (equivalent) household income for each participant in the underlying survey.

However, another main contribution of this paper is that not only variables of economic self-interest are included in the econometric analysis besides common socio-demographic and socio-economic characteristics, but also attitudinal factors that play an important role for the support of climate and energy policy measures according to previous studies (e.g. Thalmann, 2004, Attari et al., 2009, Kallbekken and Sælen, 2011, Unsworth and Fielding, 2014, Carratini et al., 2017, Ziegler, 2017a, 2017b). The joint inclusion of these two classes of variables is important for a comprehensive understanding and can avoid biased estimations results if only a restricted number of explanatory variables are included. Dietz and Atkinson (2010) use only one rather restricted indicator (i.e. a dummy variable for the concern about air pollution or climate change), whereas Gevrek and Uyduranoglu (2015) consider a more reliable variable for environmental awareness. While Dietz and Atkinson (2010) do not report a significant effect, the latter study finds that environmental values are positively correlated with a progressive distribution of the costs for carbon taxes. However, it is not clear whether these esti-

mation results are really unbiased due to the restricted number of included explanatory variables. Therefore, we consider several attitudinal variables including both a reliable indicator for environmental values on the basis of the New Ecological Paradigm (NEP) scale according to Dunlap et al. (2000) and especially also different indicators for political identification, which are strongly correlated with environmental values (e.g. Ziegler, 2017a).

In line with several previous studies as discussed above, our empirical analysis shows a clear order for the support of burden sharing rules with respect to the costs of the German energy transition, i.e. the polluter-pays rule has the highest general acceptance (nearly 80%) and the equal-pay rule has the lowest acceptance (about 16%). The strong support of the polluter-pays rule seems to contribute to the high acceptance of the energy transition since the cost distribution is mainly based on this burden sharing rule, but is in contrast to the widespread perception that the cost distribution is generally unfair. Our econometric analysis with multivariate binary and ordered probit models reveals the relevance of economic self-interest since (equivalent) energy expenditures have a significantly negative effect on the support of the polluter-pays rule and (equivalent) income has a significantly negative effect on the preference for the ability-to-pay rule. Furthermore, environmental values are significantly positively correlated with preferences for the polluter-pays rule and identifications with socially, conservatively, and liberally oriented policies have additional significant effects. These results justify the joint inclusion of indicators for economic self-interest and different attitudinal variables besides common socio-demographic and socio-economic characteristics.

The remainder of the paper is organized as follows: Section 2 presents the data and variables in our empirical analysis and discusses their expected effects on the support of burden sharing rules. Section 3 reports descriptive statistics, explains the econometric approaches, and discusses the estimation results. Section 4 draws conclusions.

2. Data, variables, and expected effects

The data for our empirical analysis were collected from computer assisted telephone interviews conducted by the German market research company SUZ (Sozialwissenschaftliches Umfragezentrum GmbH) between March and May 2015. The target population of the survey was the universe of all German households with a landline or mobile connection. The inter-

views were carried out with household members who were at least 18 years old and who were sufficiently informed about the energy consumption in the household (mostly the heads of the household). Overall, 2,243 respondents participated in the survey that was jointly organized by the Centre for European Economic Research (ZEW), Mannheim, and the University of Kassel. The questionnaire comprised one larger part (coordinated by ZEW) that refers to energy consumption, energy expenditures, and the measurement of energy poverty. A smaller part (coordinated by the University of Kassel) specifically refers to attitudes toward the German energy transition and its single energy policy measures including perceptions about burden sharing rules for their costs. Furthermore, the questionnaire comprised issues on environmental values and political identification besides common socio-demographic and socio-economic characteristics. The median of the interview duration was about 32.5 minutes.

Respondents who have at least a basic understanding of the German energy transition[3] were asked how strongly they accept possibilities to share the costs of the energy transition across households. The wording of the burden sharing rules in the questionnaire was as follows:

- Equal-pay rule: "Everybody should bear the same share of costs, regardless of the income and the energy consumption of the household."
- Ability-to-pay rule: "Every household should contribute to the costs according to its income. Therefore, households with a high income bear a higher share of the costs."
- Polluter-pays rule: "Every household should contribute to the costs according to its energy consumption. Therefore, households with a high energy consumption bear a higher share of the costs."

The order of presented burden sharing rules was random across the respondents to avoid a bias due to the sequence of the statements. The response options ranged between (1) "do not accept at all" and (5) "totally accept" on a five-point symmetric ordered scale, respectively. In order to prevent a central tendency bias and social desirability bias, "don't know" and "no answer" options were provided. For the econometric analysis, we consider the corresponding three raw ordinal variables "acceptance equal-pay rule", "acceptance ability-to-pay rule", and "acceptance polluter-pays rule" and additionally construct three aggregated dummy variables

[3] In this respect, the participants were asked which of the following statements they are most likely to agree with: „I have never heard about it", "I have heard about it, but do not exactly know what it is about", or "I know what it is about". Only the small group of 76 respondents who stated that they have never heard about the German transition was excluded from the questions about the burden sharing rules.

"high acceptance equal-pay rule", "high acceptance ability-to-pay rule", and "high acceptance polluter-pays rule", which take the value one if one of the two highest categories (4) or (5) was indicated, respectively.

According to economic self-interest, household income should have a negative effect on the support of the ability-to-pay rule (see also e.g. Dietz and Atkinson, 2010), which implies specific progressive distribution effects. This would be in line with empirical analyses which generally show that income negatively affects preferences for (progressive) redistribution, for example, by income taxes (e.g. Alesina and Guiliano, 2011, Guillaud, 2013, Hennighausen and Heinemann, 2015). Against this background, the respondents were asked for the amounts of the household net income in Euro.[4] Respondents who refused to state the exact amount could select a specific income class and were additionally asked for their position within the income class (i.e. in the middle of the class, above the middle, or below the middle). If these respondents answered to the position question, we assign the lower, middle, and upper quartiles, respectively, on the basis of an assumed uniform distribution of the income within the income classes. If the respondents selected an income class, but refused to answer to the position question, we assign the mean of the income classes.

However, due to different household sizes, per capita incomes are obviously more relevant than the raw data. For example, the ability-to-pay rule can be economically beneficial for a four-person household with an income that is higher than the income of a single household. Indeed, we do not focus on an indicator that divides the household income by the household size since this would weight young children and adults equally.[5] Instead, we consider an equivalent income as it is common, for example, in studies on income taxation (e.g. Hennighausen and Heinemann, 2015). Our approach refers to official statistics (e.g. Statistisches Bundesamt and Wissenschaftszentrum Berlin für Sozialforschung, 2013), which weights the first adult in the household with the factor one, children with the factor 0.3, and other older household members with the factor 0.5. While the official statistics consider children up to the age of 14 years, we use the bound of 15 years since other age data are not available. The variable "equivalent income in 1000 Euro" is then the corresponding weighted net household in-

[4] On the basis of these amounts, we have trimmed about one percent of the highest and lowest values to prevent possible incorrect data (e.g. some zero values) and outlier problems.

[5] In fact, we have also experimented with this variable since our definitions of the ability-to-pay and the equal-pay rules can, strictly speaking, be interpreted as an equal weighting of each individual. However, these additional empirical analyses provide no robust effect of the corresponding variables.

come in Euro ("equivalent income") divided by 1000. Due to our definition of the ability-to pay rule, especially compared with the equal-pay rule (which considers an equal treatment of each individual), we also consider an alternative indicator that equally weights all adults (including adolescents who are older than 14 years) in the household. Therefore, the variable "per adult income in 1000 Euro" is the household net income in Euro divided by the number of older household members ("per adult income") and additionally divided by 1000.

With respect to the acceptance of the polluter-pays rule, the household energy consumption should have a negative effect according to economic self-interest, i.e. this burden sharing rule is economically beneficial for households with a low energy consumption. Unfortunately, the reliable collection of data about energy consumption is hardly possible with telephone interviews since most citizens have no knowledge about it. Instead, the respondents were asked for the household expenditures in Euro for electricity and heating. In line with the argumentation above, we do not examine the raw data, but "equivalent energy expenditures" which are weighted with the same factors (and also trimmed) as in the case of income. For the econometric analysis, we specifically consider the variable "equivalent energy expenditures in 1000 Euro". Furthermore, as discussed above, we also examine the variable "per adult energy expenditures in 1000 Euro", which is the value of the household energy expenditures in Euro divided by the number of older household members ("per adult energy expenditures") and additionally divided by 1000.

With respect to environmental values, we consider a short version of the NEP scale (e.g. Dunlap et al., 2000), which is an established measure in the social and behavioral sciences. This approach is based on the concept that a multi-item scale is a more reliable measure of environmental values than a single-item variable (e.g. Kotchen and Reiling, 2000). Our scale is based on the following six statements: "Humans have the right to modify the natural environment to suit their needs", "humans are severely abusing the planet", "plants and animals have the same right to exist as humans", "nature is strong enough to cope with the impacts of modern industrial nations", "humans are meant to rule over the rest of nature", and "the balance of nature is very delicate and easily upset".[6] The response options for these six questions

[6] The construction of NEP scales is not consistent in previous empirical studies, i.e. only very few studies (e.g. Kotchen and Reiling, 2000) use all 15 items with exactly five ordered response categories for the agreement to the statements as suggested by Dunlap et al. (2000) (see also Ziegler, 2017a). We refer to Whitmarsh (2008, 2011) who points to pilot studies that showed that many respondents had difficulties to interpret nine of the 15 NEP items.

ranged between (1) “do not agree at all” and (5) “totally agree” on a five-point symmetric ordered scale. The variable “NEP“ is designed by constructing dummy variables that take the value one if the respondent indicated one of the two highest categories (4) or (5) in the case of the three positively keying statements or one of the two lowest categories (1) or (2) in the case of the three negatively keying statements and by adding up the values of the six dummy variables. As a consequence, “NEP” varies between zero and six.

Previous studies show that environmental values are positively correlated with the support of climate policies (e.g. Attari et al., 2009, Unsworth and Fielding, 2014, Ziegler, 2017a) and especially also with the acceptance of the German energy transition (e.g. Ziegler, 2017b). Therefore, it can be expected that environmental values are positively correlated with the support of a burden sharing rule that is most strongly associated with the concept of a policy measure. As discussed above, the costs of the EEG as main component of the German energy transition and especially of the financial support of the expansion of renewable energies[7] are directly passed through to the electricity prices so that households generally contribute to the costs according to their energy consumption. This means that the distribution of the costs is mainly based on the polluter-pays rule. As a consequence, we expect a positive correlation between “NEP” and the support of the polluter-pays rule.[8] In order to disentangle the direct correlation between environmental values and the acceptance of burden sharing rules and the indirect correlation through the general support of the energy transition, we also include the corresponding dummy variable “acceptance energy transition”. It is based on the question of how strongly the measures of the energy transition are accepted on a symmetric scale with five ordered response categories ranging from (1) “do not accept at all” to (5) “totally accept” and takes the value one if one of the two highest categories (4) or (5) was indicated, respectively. In line with the previous discussion, we also expect a positive correlation between this variable and the support of the polluter-pays rule.

[7] Consistently, Ziegler (2017b) also shows a positive correlation between environmental values and the acceptance of the financial support of the expansion of renewable energies.

[8] We generally interpret the relationships for attitudinal variables such as environmental values, but also political identification as discussed below, as correlations rather than causal effects since we cannot completely exclude the possibility that the support of specific burden sharing rules affects the attitudinal variables. In future studies, panel data analyses (which are currently not possible since such data are not available) might be useful to identify a causal relationship between these variables.

With respect to political identification, we do not use one-dimensional indicators for a left-green or a right-conservative orientation as it is common in previous studies (e.g. Thalmann, 2004, Attari et al., 2009, Carratini et al., 2017). Instead, we consider a much more sophisticated categorization (see also the discussion in Unsworth and Fielding, 2014) since it is possible that political orientations are interrelated, which cannot be captured by the simple left-green and right-conservative split, especially in Europe. In Germany, for example, the identification with conservative policy can be correlated with an ecological and particularly with a liberal identification, which is in contrast to the often very sharp differences between liberals and conservatives in the USA. Therefore, the respondents were asked how strongly they agree to the four following statements: "I identify myself with conservatively oriented policy", "I identify myself with liberally oriented policy", "I identify myself with socially oriented policy", and "I identify myself with ecologically oriented policy". The response options for these four questions ranged again between (1) "do not agree at all" and (5) "totally agree" on a five-point symmetric ordered scale. Based on these questions, the econometric analysis includes the four dummy variables "conservative policy identification", "liberal policy identification", "social policy identification", and "ecological policy identification" that take the value one if the respondent indicated one of the two highest categories (4) or (5), respectively.

However, due to this ambiguity in the political arena in Germany, it is rather difficult to formulate expectations about the direction of the effects of these four variables. In line with the discussion before, a positive correlation between the identification with green policy and the acceptance of the polluter-pays rule is possible due to the corresponding positive correlation of green policy identification and the acceptance of the German energy transition (e.g. Ziegler, 2017b). Furthermore, empirical studies show that a left-wing orientation is clearly positively correlated with the preference for (progressive) redistribution (e.g. Alesina and Guiliano, 2011), which is also in line with corresponding political programs. In Germany, left-wing identification is rather associated with social and ecological policy orientations, whereas right-wing identification is rather associated with conservative and also liberal policy orientations, which is in sharp contrast to several other countries and especially the USA, where a liberal orientation is clearly connected with left-wing identification. Against this background, we would expect a positive correlation between the identification with ecological and especially social policy and the support of the ability-to-pay rule, which implies progressive distribution effects as discussed above. Similarly, it can be expected that a social policy orienta-

tion is negatively correlated with the support of the equal-pay rule, which clearly implies regressive distribution effects.

Along with these main explanatory variables, we also include several socio-demographic and socio-economic variables. While "age" is the age of the respondent in years, the dummy variables "female" take the value one if the respondent is a woman. With respect to education, the respondents were asked for the highest education level of the person with the highest income in the household. The dummy variable "high education" takes the value one if the highest level is at least secondary ("Abitur"). Furthermore, the dummy variables "kids" and "foreign" take the value one if one or more children (up to 15 years) live in the household and if the respondent has a migration background (i.e. if the respondent is born abroad or is no German citizen), respectively. Finally, we control for regional heterogeneities by including the dummy variable "Eastern Germany" that takes the value one if the respondent lives in the federal states of the former East Germany (i.e. Mecklenburg-Western Pomerania, Brandenburg, Thuringia, Saxony-Anhalt, Saxony) plus Berlin.

3. Empirical analysis

3.1 Descriptive statistics

Before considering the preferences for the three burden sharing rules with respect to the costs of the German energy transition, we first consider the perceived extent of the distribution problem in this respect. For this reason, the respondents were asked how fair they perceive the distribution of the costs of the energy policy measures in Germany across the income groups. The response options on a five-point symmetric ordered scale were "very unfair", "rather unfair", "neither unfair nor fair", "rather fair", and very fair". Table 1 reports the detailed frequencies and reveals that more than half of the respondents perceive the distribution as unfair (i.e. indicated "very unfair" or "rather unfair") and only less than 18% perceive it as fair (by indicating "rather fair" or "very fair"). This result is clearly in line with the public discussion in Germany as discussed in the introduction. Furthermore, additional econometric analyses show that these perceptions are strongly correlated with the acceptance of the energy transition, i.e. citizens who perceive the cost distribution as fair clearly more often support the en-

ergy transition.[9] These results underline the necessity to analyze the understanding and preferences of different burden sharing rules for the costs of the German energy transition in the population.

Table 2 reports the corresponding detailed frequencies. The main result is the strong support of the polluter-pays rule, i.e. about 80% of the respondents indicated the two highest categories for the strength of acceptance. This result is in line with previous studies on the burden sharing of international climate policy costs across countries (e.g. Lange et al., 2007, Schleich et al., 2016) and of domestic climate policy costs across citizens (e.g. Dietz and Atkinson, 2010, Ščasný et al., 2017). In contrast, the equal-pay rule has clearly the lowest acceptance (only about 16% of the respondents indicated the two highest categories) and by far the strongest refusal (more than 70% of the respondents indicated the two lowest categories). The support of the ability-to pay rule lies between these two burden sharing rules, whereby the acceptance (about 46%) is slightly higher than the refusal (about 35%). The strong support of the polluter-pays rule seems to contribute to the high acceptance of the energy transition since the cost distribution is mainly based on this burden sharing rule. However, this strong support contradicts the widespread perception that the cost distribution of the energy policy measures is generally unfair (see Table 1). This result suggests that the main mechanism of the domestic burden sharing of costs for the German energy transition, which is mainly based on the polluter-pays rule, is often not understood in the population.

The upper part of Table 3 reports the means and standard deviations for the corresponding aggregated dummy variables as discussed above. It comprises values for all respondents and additionally the corresponding means and standard deviations for the econometric analysis of the support of burden sharing rules. The number of 1191 observations in the latter case is smaller as it is usual in econometric analyses due to missing values for some explanatory variables. However, the values for all variables in Table 3 are very similar, respectively, so that no distortions due to the smaller number of observations can be expected. The average equivalent income in our sample is about 1872 Euro, which is extremely in line with the value of about 1958 Euro in official statistics in 2015 (e.g. https://www.destatis.de/EN/FactsFigures/SocietyState/IncomeConsumptionLivingConditions/LivingConditionsRiskP

[9] These estimation results are not reported due to brevity, but are available upon request.

overty/Tables/IncomeDistribution_SILC.html).[10] Furthermore, the frequency of respondents from Eastern Germany (including Berlin) is very similar to the corresponding frequency of households in the population (about 21%, e.g. Statistisches Bundesamt, 2016), whereas the number of households with child(ren) is slightly overrepresented in our sample,[11] which is due to our slight underrepresentation of single households.

In addition, the average household energy expenditures and thus also the equivalent energy expenditures in our sample are higher than the values in the official statistics, which is, however, not very surprising since the energy expenditures are often overestimated, especially in telephone interviews, where it is not possible to look at the energy bills.[12] In contrast, values which refer to individual (and not household specific) variables cannot be directly compared with individual specific official statistics due to our sampling strategy from the population of citizens who were sufficiently informed about the energy consumption in the household and thus mostly the heads of the household. For this reason, our frequency of males and the average age is higher than in the population.[13] As a consequence, the descriptive statistics for our individual attitudinal variables as described below need not necessarily coincide with the corresponding values for the general German population, either. However, if all relevant explanatory variables are included, these deviations should not distort the estimation results in our econometric analysis since we have not excluded specific population groups.

With respect to the attitudinal variables, Table 3 reveals that the frequencies for an orientation to conservative or liberal policy are clearly lower than the frequencies for an orientation to social or ecological policy. Concerning the nearly 50% for the identification with ecological policy, it should (besides the consequences of our sampling strategy) also be noted that this identification cannot be equated with an unrestricted sympathy for the Green Party since almost all political parties in Germany claim that their policy is ecologically oriented. These claims are supported by our result that the two variables "conservative policy identification"

[10] The slightly higher average value in the population can also be influenced by very high household incomes which have a strong effect on the average income (the median equivalent income is clearly smaller), but which are truncated in our highest income class.

[11] The frequency of households with children who are younger than 18 years is about 20% according to official statistics (e.g. Statistisches Bundesamt, 2016)

[12] While the average monthly household energy expenditures in 2015 in Germany were 146 Euro (e.g. Statistisches Bundesamt, 2017), the average value in our sample is about 202 Euro (after trimming).

[13] Due to different definitions, the values for our variables "high education" and "foreign" cannot be compared at all with official statistics for these characteristics.

and "ecological policy identification" are not negatively correlated so that orientations to conservative and ecological policies are not mutually exclusive. In addition, differences in the average values in our sample compared to previous samples in Germany (e.g. Ziegler, 2017a) can also be based on slight differences in the questions of the underlying surveys and the survey period. Furthermore, the study of Ziegler (2017a) was based on data from a computer-based survey and not a telephone survey as in the current study. Therefore, it is possible that a social desirability bias toward "green" questions (e.g. with respect to "NEP" and "ecological policy identification") is a bit higher in our study, which nevertheless should not distort the results in the following econometric analysis as discussed above.

3.2 Econometric analysis

While the three dependent variables "acceptance equal-pay rule", "acceptance ability-to-pay rule", and "acceptance polluter-pays rule" are ordinal, the other three dependent variables "high acceptance equal-pay rule", "high acceptance ability-to-pay rule", and "high acceptance polluter-pays rule" are binary. Therefore, we consider ordered probit models in the first case and binary probit models in the second case. Specifically, we consider multivariate instead of univariate ordered and binary probit models for the joint analysis of the support of the three burden sharing rules that allow for potential correlations between the three dependent variables in the error terms of the underlying latent variables. The estimation of these models requires the application of the simulated maximum likelihood method (SML) using the Geweke-Hajivassiliou-Keane (GHK) simulator. In this respect, we used 200 random draws in the GHK simulator. Furthermore, we always consider robust estimations of the standard deviations of the parameter estimates according to White (1982). All estimations (just like the calculations reported in Table 1, Table 2, and Table 3) were conducted with the statistical software package STATA. For the SML estimation of the multivariate ordered and binary probit models we specifically used the Stata module "CMP" according to Roodman (2011).

While Table 4 reports the estimation results for the multivariate ordered probit models, Table 5 comprises the estimation results for the multivariate binary probit models.[14] Furthermore,

[14] In both model approaches, two of the three correlations in the error terms are significantly negative which underlines the importance of applying multivariate instead of univariate probit models. The additional estimation results for these correlations are not reported due to brevity, but are available upon request.

Table 6 reports estimated average marginal probability effects (in the case of the continuous variables especially including the income and energy expenditures variables) and estimated average discrete probability effects (in the case of the dummy variables) for those explanatory variables that are significantly correlated with the acceptance of a burden sharing rule in the multivariate probit models. Model 1 and model 2 differ in the inclusion of equivalent and per adult income and energy expenditures variables, respectively. One main result is the robust significantly negative effect of the two income variables on the support of the ability-to-pay rule in all model approaches. Table 6 additionally reveals that the estimated effect is not trivial, i.e. an increase of the equivalent or per adult income by 1000 Euro leads to an approximately estimated decrease of the average probability for the support of the ability-to-pay rule by more than five percentage points, respectively. In the case of equivalent income this means an estimated decrease of this probability by almost eleven percent compared with the estimated average probability of about 48% (which is identical with the mean of this dependent variable in the econometric analysis, see Table 3). In sum, this result clearly reveals strong self-interested preferences for this burden sharing rule.

In comparison, the evidence for a negative effect of the two energy expenditures variables is slightly weaker since they have no significant effects on the acceptance of the polluter-pays rule in the multivariate ordered probit models. However, the corresponding p-values of 0.103 are only minimally higher than 10%. Furthermore, in the multivariate binary probit models, where the different categories of the ordinal dependent variables are compressed in two alternatives of a generally higher and lower preference for a burden sharing rule instead of only considering the highest and lowest levels,[15] the equivalent energy expenditures have a weakly significantly negative effect and the per adult energy expenditures even have a negative effect at the 5% significance level. Table 6 additionally reveals that the estimated effects, especially in the latter case, are not completely trivial, either, since an increase of the per adult energy expenditures by 100 Euro leads to an approximately estimated decrease of the average probability for the support of the polluter-pays rule by more than four percentage points. In sum, these results also reveal some evidence for a self-interested preference for this burden sharing

[15] In fact, an estimated slope parameter in an ordinal probit model only indicates the significant or insignificant correlation of the corresponding explanatory variable with the highest and lowest values (i.e. "totally accept" and "do not accept at all" in our case) of the ordered dependent variable. It thus gives no direct indication to the correlation with the other categories of the dependent variable.

rule. In contrast, the significantly positive effect of the income variables on the acceptance of the polluter-pays rule in the multivariate binary probit models cannot be explained by economic self-interest.

While Table 4 reveals a significantly negative correlation of environmental values and the acceptance of the equal-pay rule in the multivariate ordered probit models, Table 5 shows a weakly significantly positive correlation of "NEP" and the preference for the ability-to-pay rule in the multivariate binary probit models. However, the main result for environmental values is their strong significantly positive correlation with the support of the polluter-pays rule in all model specifications. On the basis of previous studies which show that environmental values are positively correlated with the support of climate policies (e.g. Attari et al., 2009, Unsworth and Fielding, 2014, Ziegler, 2017a) including the acceptance of the German energy transition (e.g. Ziegler, 2017b), this result is in line with our expectations since the distribution of the costs of the German energy transition is mainly based on the polluter-pays rule. In contrast to the strong positive correlation of the identification with ecological policy and the acceptance of the German energy transition (e.g. Ziegler, 2017b), this policy identification is neither significantly correlated with the support of the polluter-pays rule nor with the acceptance of the other two burden sharing rules in any model specification. This result suggests that citizens with high or low ecological policy identification are not very different with respect to the perception of a fair burden sharing of the costs of the energy transition.

Another explanation of the result is that many citizens do not refer this burden sharing rule to the energy transition. This speculation is supported by the surprisingly weakly significantly positive correlation of liberal policy identification and the even strongly significantly positive correlation of conservative policy identification with the acceptance of the polluter-pays rule in all model specifications, respectively. A further indication to this speculation is the significantly negative correlation of the identification with social policy with the support of this burden sharing rule in the ordered probit models. However, the main result for social policy identification is its significantly negative correlation with the preference for the equal-pay rule and its significantly positive correlation with the acceptance of the ability-to-pay rule. Especially the latter correlation is substantial. According to Table 6, the estimated average probability for the support of the ability-to-pay rule for citizens with strong social policy identification is more than 13 percentage points higher than for citizens with weak social policy identification.

This corresponds to a difference of more than 27% between these two groups compared with the estimated average probability of about 48%. In sum, since the equal-pay rule implies regressive and the ability-to-pay rule implies progressive distribution effects, these results are strongly in line with previous studies which show that a left-wing orientation is generally positively correlated with the preference for (progressive) redistribution (e.g. Alesina and Guiliano, 2011).

Table 4, Table 5, and Table 6 finally reveal significant effects of some socio-demographic and socio-economic variables. For example, females have a significantly higher preference for the polluter-pays rule than males and a high education has a significantly negative effect on the support of the equal-pay rule. In the multivariate binary probit models, citizens with a migration background and citizens from Eastern Germany have a significantly stronger acceptance of the equal-pay rule, whereas "kids" has no significant effect on the support of any burden sharing rule in any model specification.

4. Conclusions

Based on data from a comprehensive survey of more than 2,200 citizens, this paper empirically examines the preferences for burden sharing rules that refer to the costs of the German energy transition. The descriptive statistics reveal that the polluter-pays rule has by far the highest acceptance, i.e. more than 80% of the respondents generally support this burden sharing rule. It is therefore more often supported than the ability-to-pay rule and especially than the equal-pay rule, which is only accepted by about 16%, but refused by more than 70%. Since the main costs of the German energy transition according to the EEG are borne by many firms and especially by households as electricity consumers and thus are widely distributed according to the polluter-pays rule, the strong support of this burden sharing rule seems to contribute to the high acceptance of the energy transition at all (e.g. Andor et al., 2016, Ziegler, 2017b). However, the strong support of the polluter-pays rule contradicts the widespread perception that the cost distribution for the energy policy measures in Germany is unfair. A possible explanation for this implausibility is that the complicated mechanism of the cost distribution within the energy transition and especially within the EEG is widely not understood and thus not related with the polluter-pays rule. In order to further increase the acceptance of the ener-

gy transition and especially the acceptance of its cost distribution, these results suggest public information campaigns about the underlying burden sharing rule.

However, it is also possible that the widespread perception that the cost distribution for the energy policy measures is unfair is not conceptually based on the underlying burden sharing rule, but rather on the overall high perceived costs, which are considered as a strong problem by a relevant group of citizens (e.g. BDEW, 2016). This would suggest that not only for economic reasons, the energy policy measures should be implemented as cost efficient as possible (e.g. Hammar and Jagers, 2007, Rhodes et al., 2017) in order to restrict the energy price increases. Furthermore, the discussion about the risk of energy poverty for low-income households (e.g. Frondel et al., 2015, Heindl, 2015) can also contribute to the perception that the cost distribution for the energy policy measures in Germany is unfair. In this respect, however, it can be argued that high energy costs are not the main reason for "energy poverty", but low incomes, i.e. households with problems to pay their energy bills also have the problem to pay other costs, for example, for food or housing. As a consequence, another burden sharing mechanism within the energy transition and especially within the EEG would obviously not be very useful in this respect and would especially be in sharp contrast to the preferences of the strong majority of German citizens. Instead, direct financial transfers for poor households (besides general cost efficiency as aforementioned) would be a much more effective and accepted policy instrument to avoid general poverty including energy poverty.

Our econometric analysis with multivariate binary and ordered probit models clarifies some important drivers for distributional perceptions about a "fair" burden sharing with respect to the costs of the German energy transition. In particular, it reveals the strong relevance of economic self-interest for the support of burden sharing rules since (equivalent) energy expenditures have a significantly negative effect on the support of the polluter-pays rule and especially (equivalent) income has a significantly negative effect on the preference for the ability-to-pay rule. These results suggest that the use of distributional arguments for the criticism of climate policy measures by specific population groups is not necessarily value-driven on the basis of real perceptions of distributive justice, but can also be strategically motivated to prevent and combat measures, which are economically unfavorable for them. These results strengthen the view that a sharp reorientation of the German energy transition due to distributional arguments is certainly not very useful. Instead, a possible policy direction for the group

of households with high energy expenditures are information campaigns about the high potential of energy saving. Furthermore, instead of generally basing the cost distribution for the energy policy measures on the ability-to-pay rule, the higher support of this burden sharing rule by low-income households strengthens the idea of direct financial transfers as discussed above since they lead to similar distributional results as the implementation of the ability-to-pay rule.

Our econometric analysis finally reveals that not only economic self-interest, but also attitudinal factors are relevant for the acceptance of different burden sharing rule. For example, environmental values are significantly positively correlated with preferences for the polluter-pays rule and identifications with socially, conservatively, and liberally oriented policies have additional significant effects. This strongly justifies the joint inclusion of these two groups of indicators besides common socio-demographic and socio-economic characteristics in order to avoid distorted estimation results due to omitted variable biases. A possible direction for future studies is the analysis of the relevance of further values and also social norms for the support of different burden sharing rules. In addition, it would also be interesting to examine whether common behavioral factors such as time preferences, trust, or social preferences play a role in this respect. Another direction for future research is the systematic analysis of the relevance of economic self-interest for the support of burden sharing rules on the basis of stated choice data, where (in contrast to previous studies) the burden sharing rules are related to an existing energy policy measure like the German energy transition including the EEG.

Acknowledgements

This paper was carried out within the research project "Sociopolitical consequences of the energy transition in Germany" (SOKO Energiewende), supported by the German Federal Ministry of Education and Research (BMBF). Participants at the 39th International Conference of the International Association of Energy Economics (IAEE) 2016, the 9th International Workshop on Empirical Methods in Energy Economics (EMEE) 2016, and the 23rd Annual Conference of the European Association of Environmental and Resource Economists (EAERE) 2017 provided excellent insights that markedly improved the paper.

References

Alesina, Alberto and Paola Giuliano (2011), Preferences for redistribution, in: Benhabib Jess, Alberto Bisin, and Matthew O. Jackson (eds.), *Handbook of Social Economics: Volume 1A*, Elsevier, 93-132.

Andor, Mark, Manuel Frondel, and Sonja Rinne (2016), Wie unbeliebt ist Kohle und wie beliebt sind die Erneuerbaren? Eine empirische Regionalanalyse der energiepolitischen Präferenzen deutscher Haushalte, *Zeitschrift für Umweltpolitik und Umweltrecht* 39 (2-3), 127-148.

Attari, Shahzeen Z., Mary Schoen, Cliff I. Davidson, Michael L. DeKay, Wändi Bruine de Bruin, Robyn Dawes, and Mitchell J. Small (2009), Preferences for change: Do individuals prefer voluntary actions, soft regulations, or hard regulations to decrease fossil fuel consumption, *Ecological Economics* 68 (6), 1701-1710.

BDEW (Bundesverband der Energie- und Wasserwirtschaft e.V.) (2016), *BDEW-Energiemonitor 2016: Das Meinungsbild der Bevölkerung*, Berlin.

BDEW (Bundesverband der Energie- und Wasserwirtschaft e.V.) (2017), *Erneuerbare Energien und das EEG: Zahlen, Fakten, Grafiken (2017)*, Berlin.

Bechtel, Michael M. and Kenneth F. Scheve (2013), Mass support for global climate agreements depends on institutional design, *Proceedings of the National Academy of Science* 110 (34), 13763-13768.

BMWi (Bundesministerium für Wirtschaft und Energie) (2014), *Ein gutes Stück Arbeit. Die Energie der Zukunft. Erster Fortschrittsbericht zur Energiewende*, Berlin.

Brännlund, Runar and Lars Persson (2012), To tax, or not to tax: Preferences for climate policy attributes, *Climate Policy* 12 (6), 704-721.

Brick, Kerri and Martine Visser (2015), What is fair? An experimental guide to climate negotiations, *European Economic Review* 74, 79-95.

Brekke, Kjell Arne and Olof Johansson-Stenman (2008), The behavioural economics of climate change, *Oxford Review of Economic Policy* 24 (2), 280-297.

Carlsson, Fredrik, Mitesh Kataria, Elina Lampi, Åsa Löfgren, and Thomas Sterner (2011), Is fairness blind? The effect of framing on preferences for effort-sharing rules, *Ecological Economics* 70 (8), 1529-1535.

Carlsson, Fredrik, Mitesh Kataria, Alan Krupnick, Elina Lampi, Åsa Löfgren, Ping Qin, and Thomas Sterner (2013), A fair share: Burden-sharing preferences in the United States and China, *Resource and Energy Economics* 35 (1), 1-17.

Carratini, Stefano, Andrea Baranzini, Phillippe Thalmann, Frédéric Varone, and Frank Vöhringer (2017), Green taxes in a post-Paris world: Are millions of nays inevitable?, *Environmental and Resource Economics* 68 (1), 97-128.

Dietz, Simon and Giles Atkinson (2010), The equity-efficiency trade-off in environmental policy: Evidence from stated preferences, *Land Economics* 86 (3), 423-443.

Dunlap, Riley E., Kent D. Van Liere, Angela G. Mertig, and Robert Emmet Jones (2000), New Trends in measuring environmental attitudes: Measuring endorsement of the new ecological paradigm: A revised NEP scale, *Journal of Social Issues* 56 (3), 425-442.

Drews, Stefan and Jeroen C.J.M. van den Bergh (2016), What explains public support for climate policies? A review of empirical and experimental studies, *Climate Policy* 16 (7), 855-876.

Frondel, Manuel, Stephan Sommer, and Colin Vance (2015), The burden of Germany's energy transition: An empirical analysis of distributional effects, *Economic Analysis and Policy* 45, 89-99.

Gampfer, Robert (2014), Do individuals care about fairness in burden sharing for climate change mitigation? Evidence from a lab experiment, *Climatic Change* 124 (1-2), 65-77.

Gevrek, Z. Eylem and Ayse Uyduranoglu (2015), Public preferences for carbon tax attributes, *Ecological Economics* 118, 186-197.

Guillaud, Elvire (2013), Preferences for redistribution: An empirical analysis over 33 countries, *The Journal of Economic Inequality* 11 (1), 57-78.

Hammar, Henrik and Sverker C. Jagers (2007), What is a fair CO2 tax increase? On fair emission reductions in the transport sector, *Ecological Economics* 61, 377-387.

Heindl, Peter (2015), Measuring fuel poverty: General considerations and application to German household data, *FinanzArchiv: Public Finance Analysis* 71 (2), 178-215.

Heindl, Peter, Rudolf Schüßler, and Andreas Löschel (2014), Ist die Energiewende sozial gerecht?, *Wirtschaftsdienst* 94 (7), 508-514.

Hennighausen, Tanja and Friedrich Heinemann (2015), Don't tax me? Determinants of individual attitudes toward progressive taxation, *German Economic Review* 16 (3), 255-289.

Kallbekken, Steffen and Håkon Sælen (2011), Public acceptance for environmental taxes: Self-interest, environmental and distributional concerns, *Energy Policy* 39 (5), 2966-2973.

Kesternich, Martin, Andreas Löschel, and Andreas Ziegler (2014), *Negotiating weights for burden sharing rules among heterogenous parties: Empirical evidence form a survey among delegates in international climate negotiations,* ZEW Discussion Paper, 14-031.

Kotchen, Matthew J. and Stephen D. Reiling (2000), Environmental attitudes, motivations, and contingent valuation of nonuse values: A case study involving endangered species, *Ecological Economics* 32 (1), 93-107.

Lange, Andreas, Carsten Vogt, and Andreas Ziegler (2007), On the importance of equity in international climate policy: An empirical analysis, *Energy Economics* 29 (3), 545-562.

Lange, Andreas, Andreas Löschel, Carsten Vogt, and Andreas Ziegler (2010), On the self-interested use of equity in international climate negotiations, *European Economic Review* 54 (3), 359-375.

Rhodes, Ekaterina, Jonn Axsen, and Mark Jaccard (2017), Exploring citizen support for different types of climate policy, *Ecological Economics* 137, 56-69.

Roodman, David (2011), Estimating fully observed recursive mixed-process models with cmp, *Stata Journal* 11 (2), 159-206.

Sælen, Håkon and Steffen Kallbekken (2011), A choice experiment on fuel taxation and earmarking in Norway, *Ecological Economics* 70, 2181-2190.

Schleich, Joachim, Elisabeth Dütschke, Claudia Schwirplies, and Andreas Ziegler (2016), Citizens' perceptions of justice in international climate policy: An empirical analysis, *Climate Policy* 16 (1), 50-67.

Ščasný, Milan, Iva Zvěřinová, Mikolaj Czajkowski, Eva Kyselá, and Katarzyna Zagórska (2017), Public acceptability of climate change mitigation policies: A discrete choice experiment, *Climate Policy* 17 (sup1), 111-130.

Shin, Jungwoo, JongRoul Woo, Sung-Yoon Huh, Jongsu Lee, and Gicheol Jeong (2014), Analyzing public preferences and increasing acceptability for the Renewable Portfolio Standard in Korea, *Energy Economics* 42, 17-26.

Statistisches Bundesamt (2016), Bevölkerung und Erwerbstätigkeit: Haushalte und Familien - Ergebnisse des Mikrozensus 2015, *Fachserie 1, Reihe 3*.

Statistisches Bundesamt (2017), Wirtschaftsrechnungen: Laufende Wirtschaftsrechnungen – Einkommen, Einnahmen und Ausgaben privater Haushalte 2015, *Fachserie 15, Reihe 1*.

Statistisches Bundesamt and Wissenschaftszentrum Berlin für Sozialforschung (2013), *Datenreport 2013: Ein Sozialbericht für die Bundesrepublik Deutschland.*

Strunz, Sebastian (2014), The German energy transition as a regime shift, *Ecological Economics* 100, 150-158.

Thalmann, Philippe (2004), The public acceptance of green taxes: 2 million voters express their opinion, *Public Choice* 119 (1-2), 179-217.

Unsworth, Kerrie L. and Kelly S. Fielding (2014), It's political: How the salience of one's political identity changes climate change beliefs and policy support, *Global Environmental Change* 27, 131-137.

White, Halbert (1982), Maximum likelihood estimation of misspecified models, *Econometrica* 50, 1-25.

Whitmarsh, Lorraine (2008), Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response, *Journal of Risk Research* 11 (3), 351-374.

Whitmarsh, Lorraine (2011), Skepticism and uncertainty about global climate change: Dimensions, determinants and change over time, *Global Environmental Change* 21 (2), 690-700.

Ziegler, Andreas (2017a), Political orientation, environmental values, and climate change beliefs and attitudes: An empirical cross country analysis, *Energy Economics* 63, 144-153.

Ziegler, Andreas (2017b), *Economic calculus or personal and social values? A microeconometric analysis of the acceptance of climate and energy policy measures*, MAGKS Discussion Paper No. 16-2017.

Tables

Table 1: Frequencies of the perception about the fairness of the cost distribution with respect to the energy policy measures in Germany across the income groups

Very unfair	Rather unfair	Neither unfair nor fair	Rather fair	Very fair	Total frequency
336 (15.97%)	803 (38.17%)	595 (28.28%)	324 (15.40%)	46 (2.19%)	2104 (100%)

Table 2: Frequencies of the acceptance of different burden sharing rules for the costs of the German energy transition

	Strength of acceptance					
Burden sharing rules	(1) (do not accept at all)	(2)	(3)	(4)	(5) (totally accept)	Total frequencies
Equal-pay rule	1195 (55.89%)	320 (14.97%)	271 (12.68%)	138 (6.45%)	214 (10.01%)	2138 (100%)
Ability-to-pay rule	524 (24.57%)	216 (10.13%)	406 (19.03%)	444 (20.82%)	543 (25.46%)	2133 (100%)
Polluter-pays rule	127 (5.93%)	65 (3.03%)	241 (11.25%)	535 (24.97%)	1175 (54.83%)	2143 (100%)

Table 3: Descriptive statistics

Variables	Number of observations	Mean (standard deviation)	Mean (standard deviation) in the econometric analysis (with 1191 observations)
High acceptance equal-pay rule	2138	0.165 (0.37)	0.160 (0.37)
High acceptance ability-to-pay rule	2133	0.463 (0.50)	0.482 (0.50)
High acceptance polluter-pays rule	2143	0.798 (0.40)	0.799 (0.40)
Equivalent income	1954	1871.673 (878.58)	-
Equivalent income in 1000 Euro	1954	1.872 (0.88)	1.938 (0.84)
Per adult income	1954	1581.807 (790.58)	-
Per adult income in 1000 Euro	1954	1.582 (0.79)	1.625 (0.75)
Equivalent energy expenditures	1682	127.550 (64.56)	-
Equivalent energy expenditures in 1000 Euro	1682	0.128 (0.06)	0.128 (0.06)
Per adult energy expenditures	1682	107.873 (59.49)	-
Per adult energy expenditures in 1000 Euro	1682	0.108 (0.06)	0.108 (0.06)
NEP	2183	4.771 (1.28)	4.820 (1.27)
Acceptance energy transition	2131	0.501 (0.50)	0.521 (0.50)
Conservative policy identification	2124	0.196 (0.40)	0.204 (0.40)
Liberal policy identification	2112	0.181 (0.39)	0.176 (0.38)
Social policy identification	2150	0.530 (0.50)	0.561 (0.50)
Ecological policy identification	2145	0.495 (0.50)	0.511 (0.50)
Age	2222	53.873 (14.88)	54.005 (14.32)
Female	2243	0.436 (0.50)	0.401 (0.49)
High education	2178	0.551 (0.50)	0.564 (0.50)
Kids	2237	0.231 (0.42)	0.250 (0.43)
Foreign	2237	0.090 (0.29)	0.076 (0.27)
Eastern Germany	1952	0.193 (0.39)	0.198 (0.40)

Table 4: Simulated maximum likelihood estimates (robust z-statistics) in multivariate ordered probit models, overall number of observations: 1191

	Dependent variables					
	Model 1			Model 2		
Explanatory variables	Acceptance equal-pay rule	Acceptance ability-to-pay rule	Acceptance polluter-pays rule	Acceptance equal-pay rule	Acceptance ability-to-pay rule	Acceptance polluter-pays rule
Equivalent income in 1000 Euro	-0.050 (-1.05)	-0.139*** (-3.16)	0.062 (1.30)	-- (--)	-- (--)	-- (--)
Per adult income in 1000 Euro	-- (--)	-- (--)	-- (--)	-0.057 (-1.08)	-0.141*** (-2.85)	0.070 (1.29)
Equivalent energy expenditures in 1000 Euro	-0.197 (-0.33)	0.225 (0.41)	-0.910 (-1.63)	-- (--)	-- (--)	-- (--)
Per adult energy expenditures in 1000 Euro	-- (--)	-- (--)	-- (--)	-0.365 (-0.55)	0.391 (0.66)	-1.048 (-1.63)
NEP	-0.062** (-2.27)	0.036 (1.44)	0.106*** (3.77)	-0.061** (-2.25)	0.036 (1.46)	0.106*** (3.79)
Acceptance energy transition	0.041 (0.59)	0.095 (1.46)	0.166** (2.41)	0.039 (0.56)	0.093 (1.43)	0.166** (2.41)
Conservative policy identification	0.111 (1.33)	-0.065 (-0.77)	0.222*** (2.60)	0.109 (1.31)	-0.068 (-0.81)	0.222*** (2.61)
Liberal policy identification	0.132 (1.50)	-0.098 (-1.13)	0.149* (1.68)	0.130 (1.48)	-0.104 (-1.20)	0.149* (1.69)
Social policy identification	-0.142* (-1.87)	0.288*** (3.99)	-0.158** (-2.18)	-0.141* (-1.87)	0.291*** (4.03)	-0.160** (-2.20)
Ecological policy identification	0.009 (0.12)	-0.032 (-0.43)	0.027 (0.38)	0.010 (0.13)	-0.031 (-0.42)	0.028 (0.39)
Age	0.001 (0.35)	0.005** (2.00)	0.003 (1.33)	0.001 (0.40)	0.005* (1.94)	0.003 (1.32)
Female	-0.123* (-1.74)	-0.042 (-0.63)	0.135* (1.94)	-0.118* (-1.67)	-0.033 (-0.49)	0.135** (1.96)
High education	-0.248*** (-3.33)	0.025 (0.35)	0.059 (0.81)	-0.250*** (-3.42)	0.012 (0.17)	0.060 (0.84)
Kids	-0.037 (-0.42)	0.007 (0.09)	0.016 (0.19)	-0.013 (-0.15)	0.051 (0.64)	0.013 (0.15)
Foreign	0.219 (1.64)	0.136 (1.10)	-0.005 (-0.04)	0.223* (1.67)	0.144 (1.17)	-0.005 (-0.03)
Eastern Germany	0.126 (1.45)	-0.129 (-1.57)	-0.018 (-0.22)	0.127 (1.47)	-0.122 (-1.49)	-0.018 (-0.21)

Note: * (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively

Table 5: Simulated maximum likelihood estimates (robust z-statistics) in multivariate binary probit models, overall number of observations: 1191

	Dependent variables					
	Model 1			Model 2		
Explanatory variables	High acceptance equal-pay rule	High acceptance ability-to-pay rule	High acceptance polluter-pays rule	High acceptance equal-pay rule	High acceptance ability-to-pay rule	High acceptance polluter-pays rule
Equivalent income in 1000 Euro	-0.005 (-0.08)	-0.134*** (-2.67)	0.146** (2.33)	-- (--)	-- (--)	-- (--)
Per adult income in 1000 Euro	-- (--)	-- (--)	-- (--)	-0.009 (-0.13)	-0.140** (-2.47)	0.146** (2.12)
Equivalent energy expenditures in 1000 Euro	0.122 (0.17)	0.195 (0.31)	-1.133* (-1.69)	-- (--)	-- (--)	-- (--)
Per adult energy expenditures in 1000 Euro	-- (--)	-- (--)	-- (--)	-0.165 (-0.21)	0.205 (0.30)	-1.563** (-2.12)
NEP	-0.057 (-1.63)	0.053* (1.76)	0.111*** (3.25)	-0.057 (-1.62)	0.054* (1.79)	0.111*** (3.26)
Acceptance energy transition	-0.008 (-0.09)	0.104 (1.37)	0.233*** (2.69)	-0.010 (-0.11)	0.101 (1.33)	0.234*** (2.70)
Conservative policy identification	0.061 (0.56)	-0.044 (-0.47)	0.327*** (2.81)	0.060 (0.56)	-0.047 (-0.51)	0.327*** (2.81)
Liberal policy identification	0.129 (1.13)	-0.090 (-0.90)	0.201* (1.65)	0.130 (1.14)	-0.096 (-0.97)	0.207* (1.71)
Social policy identification	-0.255*** (-2.58)	0.338*** (4.00)	-0.053 (-0.56)	-0.254*** (-2.58)	0.340*** (4.03)	-0.058 (-0.62)
Ecological policy identification	0.120 (1.19)	-0.048 (-0.55)	0.057 (0.59)	0.119 (1.17)	-0.046 (-0.54)	0.057 (0.59)
Age	-0.000 (-0.01)	0.006* (1.93)	0.002 (0.50)	0.000 (0.08)	0.006* (1.93)	0.002 (0.61)
Female	-0.072 (-0.76)	0.045 (0.58)	0.242*** (2.71)	-0.071 (-0.76)	0.054 (0.71)	0.238*** (2.67)
High education	-0.313*** (-3.19)	0.017 (0.21)	0.067 (0.73)	-0.310*** (-3.22)	0.007 (0.09)	0.079 (0.88)
Kids	-0.036 (-0.31)	0.030 (0.32)	0.034 (0.32)	-0.035 (-0.30)	0.075 (0.78)	0.010 (0.10)
Foreign	0.310** (1.99)	0.047 (0.33)	-0.123 (-0.79)	0.311** (2.01)	0.054 (0.38)	-0.125 (-0.80)
Eastern Germany	0.234** (2.17)	-0.079 (-0.84)	-0.061 (-0.58)	0.232** (2.17)	-0.074 (-0.79)	-0.066 (-0.63)
Constant	-0.556* (-1.84)	-0.600** (-2.35)	-0.230 (-0.79)	-0.536* (-1.81)	-0.642** (-2.56)	-0.177 (-0.63)

Note: * (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively

Table 6: Estimated average marginal and discrete probability effects (robust z-statistics) in multivariate binary probit models, overall number of observations: 1191

	Dependent variables					
	Model 1			Model 2		
Explanatory variables	High acceptance equal-pay rule	High acceptance ability-to-pay rule	High acceptance polluter-pays rule	High acceptance equal-pay rule	High acceptance ability-to-pay rule	High acceptance polluter-pays rule
Equivalent income in 1000 Euro	n.s.	-0.052*** (-2.70)	0.039** (2.35)	-- (--)	-- (--)	-- (--)
Per adult income in 1000 Euro	-- (--)	-- (--)	-- (--)	n.s.	-0.054** (-2.49)	0.039** (2.13)
Equivalent energy expenditures in 1000 Euro	n.s.	n.s.	-0.303* (-1.69)	-- (--)	-- (--)	-- (--)
Per adult energy expenditures in 1000 Euro	-- (--)	-- (--)	-- (--)	n.s.	n.s.	-0.419** (-2.13)
NEP	n.s.	0.020* (1.77)	0.030*** (3.29)	n.s.	0.021* (1.80)	0.030*** (3.30)
Acceptance energy transition	n.s.	n.s.	0.063*** (2.69)	n.s.	n.s.	0.063*** (2.70)
Conservative policy identification	n.s.	n.s.	0.081*** (3.11)	n.s.	n.s.	0.081*** (3.11)
Liberal policy identification	n.s.	n.s.	0.051* (1.76)	n.s.	n.s.	0.053* (1.82)
Social policy identification	-0.061** (-2.56)	0.132*** (4.04)	n.s.	-0.061** (-2.56)	0.133*** (4.06)	n.s.
Ecological policy identification	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Age	n.s.	0.002* (1.93)	n.s.	n.s.	0.002* (1.94)	n.s.
Female	n.s.	n.s.	0.064*** (2.78)	n.s.	n.s.	0.063*** (2.74)
High education	-0.076*** (-3.17)	n.s.	n.s.	-0.075*** (-3.19)	n.s.	n.s.
Kids	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Foreign	0.083* (1.80)	n.s.	n.s.	0.083* (1.82)	n.s.	n.s.
Eastern Germany	0.059** (2.05)	n.s.	n.s.	0.059** (2.05)	n.s.	n.s.

Note: * (**, ***) means that the appropriate effect is different from zero at the 10% (5%, 1%) significance level, respectively; n.s. means that the appropriate effect is not significant