On self-interested preferences for sharing the costs of energy policy: A stated choice analysis for Germany

Elke D. Groh and Andreas Ziegler

January 2019

Preliminary version

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
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

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Abstract

This paper empirically examines the preferences for burden sharing rules that refer to the costs of energy policy. The data for this analysis stem from a computer-based survey among German citizens, which especially includes a stated choice experiment on three hypothetical energy policy packages. In order to simulate a realistic choice situation, the experimental design depends on single components of the German energy transition, which is one of the most challenging and disputed national energy policy program. In line with previous studies, our econometric analysis with mixed logit models reveals high stated preferences and thus a high willingness to pay for the polluter-pays rule, whereas the estimated stated preferences for the equal-pay rule are lowest. Furthermore, the estimation results suggest a strong acceptance of the financial support for the poorest 10% or 30% households. Also in line with previous studies, (equivalent) income has a significantly negative effect on the stated support of the ability-to-pay rule. In contrast, income has no significant effect on the stated preferences for the financial support of low-income households. These results suggest that economic self-interest is highly relevant for the general assessment of burden sharing rules in energy policy, whereas the agreement to the specific financial support of the poorest households is obviously rather value-driven and not strongly influenced by economic motives.

Keywords: Energy policy measures, energy transition, burden sharing, economic self-interest, stated choice experiment, mixed logit models

JEL: Q48, Q54, Q42

1. Introduction

The national governments have to invest in their energy infrastructure to fulfill their nationally determined contributions and in order to reach the international climate goal agreed upon in the Paris Agreement. The costs of these investments tend to be passed on to the citizens on behalf of national regulations. While the equal distribution of cost across all citizens seems to be useful to achieve the climate targets, it appears to be problematic with regard to the acceptance of the climate policy measures. The fairness of the cost distribution is often claimed to fire opposition against the climate policy measures (e.g. Frondel et al., 2017). While there are some advocates of a clear differentiation between climate and social policies, several adversaries claim that climate policies should only be implemented if they are also socially sustainable. Empirical studies show that the most efficient burden sharing rule, namely the polluter-pays rule, is the most preferred burden sharing rule among German citizens (e.g. Groh and Ziegler, 2018). However, studies also show that the cost distribution of the German energy transition (that is mainly in line with the polluter-pays rule) is perceived to be unfair (e.g. Groh and Ziegler, 2018) and constantly criticized to put an inappropriately high burden on low income households (e.g. Heindl et al., 2014, Frondel et al., 2017).

In this context, we examine preferences for national burden sharing rules that differ in the allocation of the energy policy costs between households. We especially consider the polluter-pays rule, the ability-to-pay rule, and the equal-pay rule (i.e. equal individual financial contributions to the costs of the climate policy measure). Furthermore, we also examine preferences for a principle that often accompanies the discussion on burden sharing rules in international climate negotiations, namely the poor losers rule that states that a poor party is exempted from any obligation until it reaches a certain income level (e.g. Lange et al., 2007). We implement the poor losers rule as financial support for low income households in our study, which has not been considered in previous studies on national burden sharing with the exception of Carattini et al. (2017) who show that limited acceptability of energy taxes due to distributional concerns can be reduced by the recycling of carbon taxes through lump-sum transfers or social cushioning in Switzerland. In addition to that, we consider heterogeneity in fairness preferences across respondents as, for example Groh and Ziegler (2018), Anderson et al. (2017) and Kallbekken and Sælen (2011) show that economic self-interest and attitudes like environmental values and political identification are relevant for preferences for burden sharing rules.

We conducted an online survey on preferences for energy policy measures between November 2016 and January 2017 among more than 250 respondents in Germany. Preferences for energy policy measures were measured with the help of a stated choice experiment where respondents had to make six choices between three hypothetical climate policy packages and the actual energy transition policy package in Germany. The policy measures differ in the targeted share of renewable energy in the electricity production until 2025, nuclear phase out until 2022, burden sharing of energy policy cost between households, financial support of low-income households and additional or reduced costs for the own household, respectively. In addition, the questionnaire comprised households' (equalized) income, individual values like political identification, and environmental attitudes, as well as common socio-demographic characteristics. Based on this data, our microeconometric analysis uses mixed logit models to estimate the willingness to pay for fair energy policy measures. By the inclusion of interaction terms of the individual characteristics with the attribute levels of the energy policy measures in the stated choice experiment, we examine the determinants of the preferences for the burden sharing rules.

In line with previous studies (e.g. Groh and Ziegler, 2018, Ščasný et al., 2017), our empirical analysis shows that the polluter-pays rule is the most preferred burden sharing rule. The application of the ability-to-pay (equal-pay) rule reduces the mean willingness to pay for the energy policy measure compared to the application of the polluter-pays rule. In addition, there is a mean willingness to pay for financial support for the 10% (30%) poorest households. The preferences for the different energy policy attribute levels are heterogenous across respondents. Also in line with previous studies, (equivalent) income has a significantly negative effect on the stated support of the ability-to-pay rule. In contrast, income has no significant effect on the stated preferences for the financial support of low-income households. These results suggest that economic self-interest is highly relevant for the general assessment of burden sharing rules in energy policy, whereas the agreement to the specific financial support of the poorest households is obviously rather value-driven and not strongly influenced by economic motives. The relevance of individual values is emphasized by the significant correlations of the preferences for the burden sharing rules and individual political and environmental values.

The remainder of the paper is organized as follows: Section 2 gives a short overview on previous studies on preferences for burden sharing rules for energy policy costs, section 3 describes the data and variables used in the econometric analysis. Section 4 explains the econometric approach and discusses the estimation results. Section 5 concludes.

2. Literature review

Energy levies, carbon taxes and similar instruments have been found to have regressive effects, meaning that such instruments put a relative higher burden on low-income households compared to high-income households (see e.g. Teixidó and Verde, 2017 for the United States and e.g. Heindl et al., 2014, Frondel et al., 2017 for Germany). Cai et al. (2010) show that the national cost distribution affects citizens' support for climate policies, especially when the distribution contradicts the normative beliefs of the individuals, which is totally in line with the public choice literature (e.g. Kirchgässner and Schneider, 2003). Thus, a cost distribution that is perceived to be unfair by the citizens constitutes a barrier for the implementation of further energy policies and investments by the national governments. For this reason, it is important to investigate how the distribution of energy policy costs could be designed to be perceived as fair in order to keep the support of energy policies on a high level. Therefore, we especially consider different burden sharing rules for the distribution of energy policy costs in our stated choice experiment. While several studies focused on fairness preferences for the cost distribution across countries of individuals involved in climate negotiations (e.g. Lange et al., 2007, 2010, Hjerpe et al., 2011, Kesternich et al., 2014) or ordinary citizens (e.g. Cai et al., 2010, Kriss et al., 2011, Carlsson et al., 2011, 2013, Bechtel and Scheve, 2013, Schleich et al., 2016), fairness preferences for the cost distribution across households within a country have not been considered to the same extend. Most of these studies focus on the distribution of policy costs across socio-economic groups, neglect the responsibility for greenhouse gas emissions, and thus find clear evidence for preferences for a cost distribution following the ability-to-pay rule (e.g. Brännlund and Persson, 2012 for Swedish households, Gevrek and Uyduranoglu, 2015 for Turkish households, Frondel et al. 2017 for German households). Other studies only consider responsibility, neglect socio-economic differences, and thus find clear evidence for preferences for a cost distribution following the polluter-pays rule (e.g. Hammar and Jagers, 2007 for Swedish households).

There are a few exemptions that take into account a cost distribution across low and high income households as well as across low and high emitting households and allow to study the relative relevance of the two burden sharing rules. Ščasný et al. (2017) examine the distribution of energy policy costs within the European context in an stated choice experiment and find that the polluter-pays rule is the preferred burden sharing rule for the international cost distribution across countries but also for the national cost distribution across households for respondents from Czech Republic, Poland, and the UK. Groh and Ziegler (2018) extend this

finding to the distribution of the costs of the energy transition across households in Germany with a descriptive analysis. Dietz and Atkinson (2010) find further supporting evidence in an English urban area with a stated choice experiment on an unspecified energy policy. In addition, they found an equity-efficiency trade off, which means that the polluter-pays rule is supported due to its efficiency but at the same time, the ability-to-pay rule is supported in order to balance out distributional differences between low and high-income households caused by the application of the polluter-pays rule. In order to enhance the discussion which burden sharing rule should be applied from the citizens' viewpoint, we consider the polluter-pays rule and the ability-to-pay rule. In addition, we also consider a distribution of the cost per person (equal-pay rule) in our empirical analysis.

The discussion on burden sharing in international climate negotiations is often accompanied by a further burden sharing principle, namely the poor losers rule. Lange et al. (2007) find a strong desire of persons involved in climate negotiations to apply an exemption clause for countries with a low GDP in addition to the main burden sharing rule. Transferred to the household level, the poor losers rule states that low-income households are exempted from their obligation to bear their share of the energy policy costs defined by the main burden sharing rule until they reach a certain level of income. Therefore and due to the mixed results on the preferences for the polluter-pays and the ability-tot-pay rule in the previous literature that might result from the ignorance of such exemptions, we include an additional policy attribute in our stated choice experiment that considers the poor losers rule through special treatment of low-income households. In the political discussion and the literature, there are several suggestion such as the implementation of a consumption threshold, reduced electricity taxes, or cash transfers to low income households (e.g. Dietz and Atkinson, 2010, Kallbekken and Sælen, 2011, Neuhoff et al., 2013, Frondel et al., 2015). We consider financial support targeted at the 10% or 30% poorest households as a possible implementation of the poor losers rule.

As already stated above, preferences for burden sharing rules are influenced by individual variables. Groh and Ziegler (2018), for example, show that attitudes like environmental values and political identification but especially economic self-interest are relevant for preferences for burden sharing rules. Individual self-interest could also be important for the preferences for the poor loser rule as a supplement to another main burden sharing rule because such financial discounts would directly lead to higher cost for the rest of the population. Furthermore, a recent study by Baumgärtner et al. (2017) shows that the social willingness to pay for environmental goods and policies do not only depend on the income level but also on income

inequality. Thus, the willingness to pay for energy policy measures might be by own income but also by the own income position. In addition to economic self-interest also individual values can influence preferences for burden sharing rules. For example, Anderson et al. (2017) find altruism, risk preferences and ecological concern to be important determinants. Furthermore, they find that not only individuals' own characteristics but also the characteristics of other individuals matter, which is in line with the finding of Kallbekken and Sælen (2011) who find that support of fuel taxation depends on beliefs about environmental consequences and consequences to self but also on beliefs about consequences to others. Thus, we consider economic self-interest and individual values as potential determinants for preferences for burden sharing rules and financial support of low-income households (e.g. Cai et al., 2010, Kallbekken and Sælen, 2011, Groh and Ziegler, 2018).

3. Data and variables

In order to elicit willingness to pay for energy policy attributes we apply a stated choice experiment in line with most of the previous studies on burden sharing rules (e.g. Gevrek and Uyduranoglu, 2015, Carattini et al., 2017, Ščasný et al., 2017). Stated choice experiments allow the examination of preferences for non-market goods and thus enable researchers to evaluate the preferences for energy policy measures before they are actually implemented. Although stated choice experiments are hypothetical so that the resulting willingness to pay is overestimated in most cases, the results are more reliable than results from simple survey questions. The stated choice experiment was conducted within an online questionnaire that was specifically designed to examine preferences for the German energy transition[1] and their determinants with a special focus on the distribution of energy policy cost. The questionnaire consists of three parts in total. The first part contained questions that refer to attitudes toward

[1] Germany initiated the energy transition in 2000. The goal of the program is to reduce greenhouse gas emission by 40% until 2020, to phase-out nuclear energy until 2022 and at the same time secure the supply of energy and the competitiveness of the economy (Bundesregierung, 2018). One of the two underlying core strategies is the expansion of renewable energies. The goal is to increase the share of the renewable energy in the energy production to 40-45% until 2025, to 55-60% until 2035 and to a minimum of 80% in 2050. To promote the expansion of renewable energies the Renewable Energy Sources Act (EEG) allows owners of renewable energy plants to feed-in their electricity into the grid while the network operators have the duty to buy it for a guaranteed price. The difference between the price at the electricity exchange market and the guaranteed price is compensated by a fund. This fund is fed by electricity consumers who pay an energy levy for every kilowatt hour consumed (e.g. Grösche and Schröder, 2014). The EEG was continuously updated. For example the financial support of renewable energies is retracted since 2014 and the mean amount of funding was further decreased by a tendering process for huge renewable energy plants in 2017. As the number of installed renewable energies plants increased, also the EEG levy was rising from the initial level of 0.2 Eurocents in 2000 to 6.79 Eurocents in 2018. Electricity-intensive firms can be exempted from the levy to ensure their competitiveness. The EEG led to an increase of share of the renewable energies in the electricity consumption from about 6% to 31.7% in 2016 (BMWi, 2017).

the German energy transition, on socio-economic characteristics of the households, as well as on individual preferences. The stated choice experiment on the energy policy measures was conducted in the second part and the questions in the third part referred to socio-demographic characteristics. To answer all questions the median respondent took 26.17 minutes. The online interviews were administered by the German market research institute SUZ (Sozialwissenschaftliches Umfragezentrum GmbH) within the research project "SOKO Energiewende" funded by the Ferdal Ministry of Education and Research (BMBF). In total 650 individuals that were at least 18 years old participated between November 2016 and January 2017.[2] After deleting the pre-test data, respondents that failed the control task[3], and respondents that participated in an additional information treatment, the cleaned sample includes 256 respondents.

The stated choice experiment started with a detailed description of the choice situation including cheap talk scripts to reduce the hypothetical bias (e.g. Cummings and Tylor, 1999, List, 2001) and a description of the relevant policy attributes. In the stated choice experiment, respondents faced a sequence of six choice sets where they were requested to choose one out of three unlabeled energy policy packages (choice alternatives) and the actual energy policy package of Germany (status quo alternative). The energy policy packages were described by five attributes, namely targeted share of renewable energy in the power generation until 2025, nuclear phase out until 2022, burden sharing of energy policy costs between households, financial support of low-income households and additional or reduced costs for the own household, respectively. We selected the five tariff attributes based on the objectives of the study, and with reference to previous stated choice experiments. We decided to forego more detailed attributes (e.g. share of wind, solar, and hydro power) in order to reduce cognitive effort and thus exhaustion. The attributes are described by two to six distinct attribute values that are combined without constraints so that the total number of possible combinations is far too big to use a full factorial design. The experimental design of our study considered 36 choice-tasks, blocked into 6 questionnaire versions with six choice tasks per respondent resulting in 1536 observations.

In particular, the targeted share of renewable energy in the power generation until 2025 could take three distinct values and reflects different energy policy goals, namely 30-35%, 40-45% and 55-60%. The level of the status quo policy is 40-45%. The shutdown of all nuclear power plants could either be implemented (yes) or withdrawn (no). The implementation is the status

[2] The study is based on two random household samples that have been recruited after telephone interviews on climate policy attitudes in 2015 and 2016.
[3] Respondents were asked to tick "rather disagree" between several questions on social norms.

quo policy. We consider three burden sharing rules, namely each person should bear the same cost burden (equal-pay rule), each household should bear costs in relation to its income (ability-to-pay rule), and each household should bear costs in relation to its energy consumption (polluter-pays rule). The polluter-pays rule is considered as the status quo level because the costs of the energy transition in Germany are mainly distributed via a renewable energy levy that is payed per kilowatt-hour consumed. With regard to the financial support of low-income households, we also consider three levels, namely no financial support, financial support for the 10% and for the 30% poorest households where no support is the status quo level. The last attribute is our payment vehicle, namely the deviations from monthly costs to the respondents' households compared to the status quo policy, which allows us to estimate the willingness to pay for each level of the policy attributes. The cost deviations are 50 Euro less, 20 Euro less, the same cost, 20 Euro more, 50 Euro more and 100 Euro more. Table 1 summarizes the attributes and the corresponding attribute levels in the stated choice experiment. Table 2 visualizes an exemplary choice set for the stated choice experiment. Table 2 also shows that the alternatives were unlabeled.

While it is possible to estimate the mean preferences for the policy measure attributes without considering individual characteristics, it is highly relevant which characteristics are driving the preferences in order to target future energy policy measures more accurately. Therefore, we take into account households income, individual values and further socio-demographic characteristics in our econometric analysis. Income is considered through different variables. For the first measure, namely equivalent household net income, we asked respondents to indicate their households' total monthly net income by intervals of 500 Euro up to a level of 7,000 Euro and more. Net income is explained to the respondents in line with the household questionnaire of German Socio-Economic Panel (GSOEP)[4] as the sum of the incomes of all persons living in the household after taxes and social contributions but including pensions and transfers such as unemployment benefits and alimonies. In order to make households with different household size and composition comparable, we are using the new OECD scale[5] which is a common approach in studies on related topics, for example on income taxation (e.g. Hennighausen and Heinemann, 2015). In order to reduce the effect of outliers, we also consider the logarithm of the equalized household net income. Furthermore, we use an aggregate of equalized income in our econometric analysis, namely a dummy variable that takes the

[4] The German Socio-Economic Panel is a large scale representative survey of about 11,000 private households and approximately 30,000 persons that takes place every year on behalf of the German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung e.V.).

[5] I.e. the first person of the household receives a weight of 1.0, every further person older than 14 years old receives a weight of 0.5, and children younger than 14 receive a weight of 0.3.

value one if the households belongs to the 30% poorest households of the population. The mean household net income of our estimation sample is 2166.50 Euro, which is only slightly higher than the respective value in the German population.

As it is often argued that not only absolute but also relative income is determining policy preferences, we also take into account the estimated income position of the respondents. Previous literature on income inequality revealed that individuals are not able to estimate their position on the income ladder and that these wrong estimates affect policy preferences for example for redistributive policies (e.g. Cruces et al., 2013, Kuziemko et al., 2015, Karadja et al., 2017). Therefore, we asked our respondents to estimate the percentage of households in Germany that have a lower equalized household net income than their own household. In line with previous findings (e.g. Cruces et al., 2013, Kuziemko et al., 2015, Engelhardt and Wagener, 2017, Karadja et al., 2017, Bublitz, 2017) most of the respondents underestimate their own income position (compared to the income percentiles from the GSOEP v32 for the year 2014).

In addition to the income variables, also individual values could play an important role for the distributional preferences (e.g. Groh and Ziegler, 2018). Thus, we take into account environmental awareness, support of the energy transition and political orientations as additional individual characteristics. Environmental awareness is measured by a short version of the frequently used New Ecological Paradigm (NEP) scale (Dunlap et al., 2000, Whitmarsh, 2008, 2011). Political orientations are based on four statements from Ziegler (2017) that are related to conservative, liberal, social and ecological political orientation in order to account for the German political landscape. With respect to socio-demographic characterisitcs, we consider age, gender, education, kids, and Eastern Germany as control variables. Table 3 gives a detailed overview on the definitions of the variables and reports the means and the standard deviations of the individual characteristics.

4. Economic approach and first empirical results

We use a mixed logit model for the analysis of the stated choice experiment (e.g. Louviere et al., 2000). It is the state-of-practice and has several advantages for the present study compared to other models. One advantage is that mixed logit models allow for heterogeneity in preferences across respondents by random parameters, i.e. parameters have a mean and a standard deviation (e.g. Greene and Hensher, 2003). Furthermore, mixed logit models do not rely on

the assumption of independence from irrelevant alternatives, i.e. the choice probability is independent from the introduction of new alternatives (e.g. Train, 2003; Greene and Hensher, 2003). Related to this, mixed logit models do not assume independence of choices, which is important as respondents performed six sequential choices. The analysis results in the estimation of mean parameters for all explanatory variables and their standard deviations with the exception of the parameter for the cost deviation, the alternative specific constant for the status quo and the interactions with individual specific variables, which are fixed. Based on the parameter estimates of the mixed logit model, the marginal willingness to pay for the single attribute levels can be estimated by dividing the estimated random parameter of the specific attribute by the fixed coefficient of the cost attribute. Positive values imply that respondents would be willing to pay additional money for a change from the status quo level towards the given attribute level. Negative values imply that respondents would be willing to accept a change towards the attribute level if they receive a payment of the estimated amount. By this standard procedure, we receive seven willingness to pay estimates indicating stated preferences for climate policy attributes in the baseline model. The dependent variable in our econometric analysis is the choice among the three hypothetical energy policy packages and the status quo policy package of the energy transition. To capture the effect of the status quo alternative we included a status quo dummy variable that takes the value one for the energy transition policy package. The five attributes of the stated choice experiment that have been introduced before act as basis for the explanatory variables. The cost deviations from the status quo policy package is treated as continuous variable. The remaining attributes contain discrete values, and thus dummy variables for each value of the attributes are generated.

In our basic specification, we estimate a mixed logit model to account for unobserved heterogeneity in the data. We use 500 Halton draws to estimate the random parameters. Table 4 reveals that all of the mean parameter estimates are statistically significant at the 1% level with the exemption of the dummy variable for the status quo alternative. We find that our respondents have a preference for the increase of the climate protection goals, for the nuclear phase-out, for the polluter-pays rule and for the financial support of low income households. Consistent with economic theory, private costs have a negative effect on the choice for the policy package. The insignificantly estimated parameter of the alternative specific constant for the status quo alternative is also not surprising as the change of a policy doesn't result in transaction costs to the respondents as it is the case, for example, in electricity contract choice. Table 4 shows that there is a negative willingness to pay for a change from the polluter-pays rule to the ability-to-pay rule and also to the equal-pay rule. In order to compensate a change from

the polluter-pays rule towards the ability-to-pay rule it requires 87.24 Euros and even 169.80 Euros for a change towards the equal-pay rule. Regarding the financial support of the 10% and 30% poorest households, there is a willingness to pay of 137.18 Euro and 149.86 Euro compared to no financial support, respectively. Thus, in the mean, respondents have a clear preference for the application of the polluter-pays rule and they are willing to contribute a larger amount of money in order to secure a specific welfare level of poor households. The significant parameter estimates for the standard deviations of the random parameters in the second column of Table 4 indicate that there is heterogeneity in the parameter estimates across the sample. For this reason, we estimate an additional mixed logit model including interactions of the attribute levels of interest and individual characteristics to explore the sources of heterogeneity and to identify the drivers of the preferences for the distribution of energy policy costs.

Table 5 reports the estimated means as well as the estimated standard deviations for the mixed logit model including the interactions of attribute levels and individual characteristics. The four models differ in the definition of the income variable. Model 1 contains the equivalent household income in 1000 Euros, model 2 contains the logarithm of the equivalent household income and model 3 contains a dummy variable for households that belong to the lower 30% of the income distribution. Model 4 contains the perceived income position of the household in order to examine if preferences are driven by positional considerations. Model 1 and 2 point out the relevance of economic self-interest as the (logarithmized) equivalent household income is negatively correlated with preferences for the ability-to-pay rule. However, there is no evidence for an effect of income on the preferences for financial support of the poorest households. Model 3 and 4 show no significant correlation of income pointing out that the dummy variable for low-income households might be too aggregated and that the relative income position seems not to play a major role for preferences for the distribution of energy policy costs.

In addition to the relevance of economic self-interest, Table 5 shows that in all four model specifications and in line with the previously cited literature (e.g. Groh and Ziegler, 2018) individual values are relevant for the preferences for the distribution of the energy policy costs. Preferences for the equal-pay rule are negatively correlated with social political orientation, while preferences for the ability-to pay rule are negatively correlated with conservative political orientation and positively correlated with environmental awareness. Furthermore,

financial support of the 10% poorest households is positively correlated with social political orientation and with support of the energy transition.

These results suggest that economic self-interest is highly relevant for the general assessment of burden sharing rules in energy policy, whereas the agreement to the specific financial support of the poorest households is obviously rather value-driven and not strongly influenced by economic motives. The importance of values is also stressed by the relevance of the political orientation for the preferences for the burden sharing rules and for the financial support of poor households. However, it is especially emphasized by further preliminary results (not jet reported here) from a model including social preferences (measured in an incentivized framed field experiment) and trust (measured with validated survey questions) that shows highly significantly positive correlation of the social values with the preferences for the financial support of the poorest households.

5. First conclusions and political implications

Our econometric analysis with mixed logit models reveals high preferences and thus a high willingness to pay for the polluter-pays rule, whereas the estimated preferences for the equal-pay rule are lowest. Furthermore, the estimation results suggest a strong acceptance of the financial support for the poorest 10% or 30% households, which transfers the finding on the desired application of the poor loser rule in international climate negotiations (e.g. Lange et al., 2007) to the national context. In line with previous studies, (equivalent) income has a significantly negative effect on the stated support for the ability-to-pay rule. In contrast, income has no significant effect on the stated preferences for the financial support of low-income households. These results suggest that economic self-interest is highly relevant for the general assessment of burden sharing rules in energy policy, whereas the agreement to the specific financial support of the poorest households is obviously rather value-driven and not strongly influenced by economic motives. Additional, very preliminary results stress the relevance of individual values as, for example, social preferences as well as trust are highly significantly and positively correlated with the preferences for the support of low-income households in a mixed logit model including interactions with socio-psychological variables in addition to the variables considered so far. These results need to be tested for robustness before they will be added to this paper.

From a political viewpoint, our results show that although the support of the currently applied burden sharing rule in the German energy transition is high, there is a clear indication that social aspects should be considered directly in the design of energy policy measures. The application of the poor losers rule as a supplement to another main burden sharing rule seems to be accepted by all socio-economic groups. Measures to secure the welfare of low-income households as suggested by Granqvist and Grover's (2016) as well as other researchers can therefore be expected to receive high rates of acceptance among German citizens.

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).

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Tables

Table 1: Attributes and attribute levels in the stated choice experiment

Attributes	**Attribute levels** (status quo level is underlined)
Targeted share of renewable energies in the power generation by 2025	30-35%, 40-45%, 55-60%
Shutdown of all nuclear power plants by 2022	Yes, no
Participation of households in the costs of the energy transition	Each person should bear the same cost burden, each household should bear costs in relation to its income, each household should bear costs in relation to its energy consumption
Financial support to low-income households	No financial support, financial support for the 10% poorest households, financial support for the 30% poorest households
Additional or reduced monthly costs for your household compared to the currently planned measures of the energy transition	50 Euro less, 20 Euro less, the same cost, 20 Euro more, 50 Euro more, 100 Euro more

Table 2 Example of choice card used in the survey

Criteria	**Policy package 1**	**Policy package 2**	**Policy package 3**	**None of the three policy packages (i.e. current policy package of the energy transition**
Targeted share of renewable energies in the power generation by 2025	40-45%	55-60%	30-35%	40-45%
Shutdown of all nuclear power plants by 2022	Yes	No	No	Yes
Participation of households in the costs of the energy transition	Each person should bear the same cost burden	Each household should bear costs in relation to its energy consumption	Each household should bear costs in relation to its income	Each household should bear costs in relation to its energy consumption
Financial support to low-income households	Financial support for the 10% poorest households	Financial support for the 30% poorest households	No financial support	No financial support
Additional or reduced monthly costs for your household compared to the currently planned measures of the energy transition	20 Euro less	50 Euro more	20 Euro more	The same cost
Your Choice (please select your preferred policy package)	□	□	□	□

Table 3: Descriptive statistics of individual characteristics

Variable	Description	Observations	Mean	Standard deviation
Equivalent household income (1000 Euro/ Month)	Equivalent household net income (OECD scale) in 1000 Euros per month.	256	2.27	1.03
Logarithmized equivalent household income	Logarithm of equivalent household net income in Euros per month.	256	7.62	0.49
30% poorest households	Dummy variable that takes the value one for households with an equivalent income that is lower than the income of 70% of the population (poorest 30% of households).	256	0.12	0.33
Subjective income position	Estimated share of households with a lower equalized household net income	256	48.54	20.72
Environmental awareness (NEP)	In accordance with Whitmarsh (2011), the indicator is based on the stated agreement (five-point scale) to the 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 were meant to rule over the rest of nature", "the balance of nature is very delicate and easily upset". The variable is designed by adding up dummies that take the value 1 if the respondent rather or totally agrees/ disagrees to the respective positively/ negatively keying statement.	256	5.05	1.26
Support of the energy transition	Dummy variable that takes the value one if the respondent rather or totally supports the energy transition.	255	0.93	0.26
Conservative political orientation	Dummy variables that take the value one if the respondent rather or totally agrees to the statement "I identify myself with conservatively/ liberally/ socially/ ecologically oriented politics".	256	0.20	0.40
Liberal political orientation		256	0.40	0.49
Social political orientation		256	0.79	0.41
Ecological political orientation		256	0.75	0.43
Age	Age of the respondent in years.	256	53.22	13.41
Female	Dummy variable that takes the value one if the respondent is a woman.	256	0.39	0.49
University degree	Dummy variable that takes the value one if the respondent has a university degree.	256	0.53	0.50
Kids	Dummy variables that takes the value one if at least one child younger than 14 years lives in the respondent's household.	256	0.38	0.81
Eastern Germany	Dummy variable that takes the value one if the respondent lives in Eastern Germany (including Berlin).	256	0.15	0.36

Table 4: Mixed logit model for energy policy package attributes

Variables	Mean	Standard deviation	Marginal mean WTP
Private cost	-0.01*** (-5.07)	--	--
Constant for the status quo alternative	0.28 (1.38)	--	--
Targeted share of renewable energies: 30-35%	-1.59*** (-5.83)	1.89*** (7.01)	-190.02
Targeted share of renewable energies: 55-60%	0.54** (3.05)	1.69*** (7.11)	65.37
Withdraw nuclear phase-out	-3.99*** (-8.29)	3.76*** (3.91)	-479.88
Equal-pay rule	-1.41*** (-6.22)	1.24*** (5.44)	-169.80
Ability-to-pay rule	-0.73*** (-3.67)	1.82*** (6.54)	-87.24
Financial support for the 10% poorest households	1.14*** (5.37)	-1.32** (-5.83)	137.18
Financial support for the 30% poorest households	1.25*** (5.84)	1.71*** (6.68)	149.86
Number of observations (number of respondents)	1536 (256)		

Note: For all SML estimations in MXLM 500 Halton draws were used. The basis of the estimation results are data from the SC experiment among three hypothetical policy packages and the current policy package of the energy transition with $M = 6$ choice sets. The table reports for each explanatory variable the parameter estimates and the corresponding z-statistics in parentheses. * (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively.

Table 5: Mixed logit model for energy policy package attributes including interactions with individual characteristics (observations: 1530, respondents: 255, halton draws: 500)

Model and definition of the income variable	**Model 1: Equalized household income (1000 Euros/ month)**		**Model 2: Logarithmized equalized household income**		**Model 3: Dummy for belonging to the 30% poorest households**		**Model 4: Estimated income position of the respondents**	
Explanatory variables	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Private cost	-0.01*** (-4.58)	--	-0.01*** (-4.63)	--	-0.01*** (-4.64)	--	-0.01*** (-4.54)	
Constant for the status quo alternative	0.24 (1.24)	--	0.23 (1.22)	--	0.22 (1.14)	--	0.23 (1.20)	
Equal-pay rule	0.05 (0.04)	-1.13*** (-3.87)	-1.76 (-0.51)	-1.13*** (-3.92)	0.86 (0.97)	-1.17*** (-4.04)	-0.31 (-0.23)	-1.16*** (-4.09)
x equivalent household income	0.01 (0.05)	--	0.24 (0.62)	--	-0.41 (-0.67)	--	0.01 (0.62)	--
x environmental awareness (NEP)	0.01 (0.07)	--	0.02 (0.13)	--	0.02 (0.11)	--	0.02 (0.15)	--
x support of the energy transition	-0.33 (-0.58)	--	-0.28 (-0.50)	--	-0.31 (-0.54)	--	-0.27 (-0.47)	--
x conservative political orientation	-0.68 (-1.48)	--	-0.71 (-1.58)	--	-072 (-1.57)	--	-0.71 (-1.56)	--
x liberal political orientation	0.15 (0.43)	--	0.13 (0.39)	--	0.15 (0.44)	--	0.15 (0.43)	--
x social political orientation	-0.83* (-1.87)	--	-0.85* (-1.88)	--	-0.86* (-1.87)	--	-0.84* (-1.84)	--
x ecological political orientation	0.09 (0.19)	--	0.10 (0.22)	--	0.09 (0.21)	--	0.09 (0.20)	--
x age	-0.00 (-0.24)	--	-0.00 (-0.29)	--	-0.00 (-0.24)	--	-0.00 (0.20)	--
x female	0.02 (0.06)	--	0.03 (0.09)	--	0.01 (0.03)	--	0.03 (0.07)	--
x university degree	0.02 (0.06)	--	-0.20 (-0.62)	--	-0.20 (-0.61)	--	-0.19 (-0.59)	--
x kids	-0.74 (-1.26)	--	-0.72 (-1.24)	--	-0.70 (-1.21)	--	-0.76 (-1.33)	--
x Eastern Germany	-1.01* (-1.91)	--	-1.01* (1.93)	--	-0.98* (-1.84)	--	-0.97* (-1.81)	--
Ability-to-pay rule	0.84 (0.67)	1.69*** (6.39)	4.24 (1.54)	1.71*** (6.45)	0.02 (0.01)	1.75*** (6.46)	0.60 (0.48)	1.71*** (6.39)
x equivalent household income	-0.32** (-2.06)	--	-0.56* (-1.67)	--	0.16 (0.33)	--	-0.01 (-1.45)	--
x environmental awareness (NEP)	0.35** (2.29)	--	0.35** (2.26)	--	0.37** (2.24)	--	0.35** (2.22	--
x support of the energy transition	-0.94* (-1.74)	--	-0.86 (-1.55)	--	-0.85 (-1.51)	--	-0.84 (-1.54)	--
x conservative political orientation	-0.76* (-1.70)	--	-0.76* (-1.67)	--	-0.83* (-1.75)	--	-0.91* (-1.69)	--
x liberal political orientation	0.14 (0.34)	--	0.07 (0.17)	--	0.02 (0.05)	--	0.10 (0.25)	--
x social political orientation	0.16 (0.35)	--	0.20 (0.43)	--	0.23 (0.48)	--	0.19 (0.41)	--
x ecological political orientation	-0.60 (-1.29)	--	-0.60 (-1.27)	--	-0.64 (-1.37)	--	-0.61 (-1.34)	--
x age	-0.02 (-1.33)	--	-0.02 (-1.20)	--	-0.02 (-1.29)	--	-0.02 (-1.28)	--
x female	-0.29 (-0.76)	--	-0.33 (-0.84)	--	-0.32 (-0.82)	--	-0.36 (-0.91)	--
x university degree	0.34 (0.89)	--	0.31 (0.80)	--	0.17 (0.43)	--	0.25 (0.67)	--
x kids	-1.09* (-2.16)	--	-1.06** (-2.10)	--	-1.01* (-2.02)	--	-0.93* (-1.86)	--
x Eastern Germany	-0.58 (-1.28)	--	-0.53 (-1.17)	--	-0.51 (-1.09)	--	-0.59 (-1.27)	--

Financial support for the 10% poorest households	0.57 (0.55)	-1.06*** (-4.42)	1.57 (0.58)	-1.97*** (-4.36)	0.48 (0.47)	-1.11*** (-4.27)	0.92 (0.83)	-1.06*** (-4.43)
x equivalent household income	-0.02 (-0.11)	--	-0.14 (-0.41)	--	0.21 (0.43)	--	-0.01 (-0.76)	--
x environmental awareness (NEP)	-0.16 (-1.23)	--	-0.16 (-1.23)	--	-0.16 (-1.21)	--	-0.17 (-1.27)	--
x support of the energy transition	0.95* (1.68)	--	0.94* (1.66)	--	0.99* (1.72)	--	0.95* (1.68)	--
x conservative political orientation	-0.04 (-0.09)	--	-0.02 (-0.04)	--	-0.04 (-0.10)	--	-0.03 (-0.07)	--
x liberal political orientation	-0.28 (-0.86)	--	-0.28 (-0.86)	--	-0.28 (-0.88)	--	-0.28 (-0.88)	--
x social political orientation	1.27*** (2.98)	--	1.27*** (2.96)	--	1.25*** (2.92)	--	1.24*** (2.86)	--
x ecological political orientation	-0.43 (-1.02)	--	-0.43 (-1.02)	--	-0.42 (-0.98)	--	-0.40 (-0.96)	--
x age	-0.01 (-0.46)	--	-0.01 (-0.43)	--	-0.01 (-0.47)	--	-0.01 (-0.56)	--
x female	0.98** (1.98)	--	0.67* (1.94)	--	0.70** (2.04)	--	0.65* (1.86)	--
x university degree	-0.06 (-0.19)	--	-0.04 (-0.12)	--	-0.06 (-0.19)	--	-0.02 (-0.06)	--
x kids	0.28 (0.72)	--	0.28 (0.70)	--	0.26 (0.66)	--	0.30 (0.77)	--
x Eastern Germany	0.06 (0.16)	--	0.07 (0.17)	--	0.04 (0.10)	--	0.03 (0.07)	--
Financial support for the 30% poorest households	1.25 (0.92)	1.57*** (5.39)	-0.79 (-0.23)	1.56*** (5.52)	1.47 (1.20)	1.56*** (5.63)	1.04 (0.76)	1.57*** (5.40)
x equivalent household income	0.09 (0.48)	--	0.30 (0.73)	--	-0.48 (-0.90)	--	0.01 (0.75)	--
x environmental awareness (NEP)	0.14 (0.84)	--	0.15 (0.86)	--	0.13 (0.76)	--	0.14 (0.79)	--
x support of the energy transition	0.48 (0.68)	--	0.48 (0.69)	--	0.47 (0.67)	--	0.55 (0.77)	--
x conservative political orientation	-0.58 (-1.11)	--	-0.59 (-1.15)	--	-0.56 (-1.06)	--	-0.59 (-1.14)	--
x liberal political orientation	0.01 (0.02)	--	0.00 (0.02)	--	0.02 (0.06)	--	0.01 (0.01)	--
x social political orientation	0.40 (0.86)	--	0.39 (0.83)	--	0.45 (0.94)	--	0.42 (0.89)	--
x ecological political orientation	-0.03 (-0.06)	--	-0.02 (-0.04)	--	-0.01 (-0.02)	--	-0.03 (-0.06)	--
x age	-0.03** (-1.96)	--	-0.03** (-2.00)	--	-0.03** (-1.98)	--	-0.03* (-1.87)	--
x female	0.51 (1.33)	--	0.52 (1.36)	--	0.54 (1.40)	--	0.55 (1.39)	--
x university degree	-0.52 (-1.41)	--	-0.56 (-1.54)	--	-0.54 (-1.55)	--	-0.53 (-1.52)	--
x kids	0.24 (0.49)	--	0.26 (0.53)	--	0.27 (0.57)	--	0.18 (0.38)	--
x Eastern Germany	0.30 (0.76)	--	0.31 (0.78)	--	0.30 (0.75)	--	0.33 (0.82)	--
Targeted share of renewable energies: 30-35%	-1.55*** (-6.18)	1.75*** (6.97)	-1.55*** (-6.13)	1.76*** (7.00)	-1.55*** (-6.07)	1.86*** (5.32)	-1.58*** (-6.25)	1.91*** (6.62)
Targeted share of renewable energies: 55-60%	0.51*** (2.72)	1.65*** (6.75)	0.50*** (2.70)	1.64*** (6.73)	0.49*** (2.61)	1.66*** (6.94)	0.49*** (2.66)	1.63*** (6.66)
Withdraw nuclear phase-out	-3.88*** (-7.33)	3.99*** (8.73)	-3.89*** (-7.22)	3.99*** (8.53)	-3.85*** (-7.33)	3.82*** (6.48)	-3.83*** (-7.51)	4.01*** (8.32)

Note: The basis of the estimation results are data from the SC experiment among three hypothetical policy packages and the current policy package of the energy transition with $M = 6$ choice sets. The table reports for each explanatory variable the parameter estimates and the corresponding z-statistics in parentheses. * (**, ***) means that the appropriate parameter is different from zero at the 10% (5%, 1%) significance level, respectively.