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Mark Andor, Manuel Frondel, and Stephan Sommer[1]

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Abstract

The production of electricity on the basis of renewable energy technologies is a classic example of an impure public good. It is often discriminatively financed by industrial and household consumers, such as in Germany, where the energy-intensive sector benefits from a far-reaching exemption rule, while all other electricity consumers are forced to bear a higher burden. Based on randomized information treatments in a stated-choice experiment among about 11,000 German households, we explore whether this coercive payment rule affects households' willingness-to-pay (WTP) for green electricity. Our central result is that reducing inequity by abolishing the exemption for the energy-intensive industry raises households' WTP substantially.

JEL Classification: D03, D12, H41, Q20, Q50

Keywords: Stated-choice experiment; behavioral economics; fairness

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1 Mark Andor, RWI; Manuel Frondel, RWI and RUB; Stephan Sommer, RWI. *– We are grateful for invaluable comments and suggestions by Andreas Gerster, Lorenz Götte, Colin Vance, as well as for feedback from the audiences at the IAEE (International Association for Energy Economics) conference 2017 at Vienna and the EnInnov2018 symposium at Graz. We gratefully acknowledge financial support by the Collaborative Research Center "Statistical Modeling of Nonlinear Dynamic Processes" (SFB 823) of the German Research Foundation (DFG), within Project A3, "Dynamic Technology Modeling", and by the Federal Ministry of Education and Research (BMBF) within Kopernikus Project ENavi (grant 03SFK4B0).* *– All correspondence to: Manuel Frondel, RWI, Hohenzollernstr. 1-3, 45128 Essen. Germany, e-mail: manuel.frondel@rwi-essen.de*

1 Introduction

Ample empirical evidence suggests that equity motives play a key role in many areas, such as international climate negotiations (Lange and Vogt, 2003; Kesternich et al., 2014; Vogt, 2016), as well as taxation (Esarey et al., 2012; Höchtl et al., 2012; Kallbekken et al., 2010). Another important field is the price setting of private goods (Kahneman et al., 1986), for which there is evidence that people are more likely to be willing to pay for a good when its price is perceived as fair, which crucially depends on whether other customers pay the same price or whether there is price discrimination. In response to the bulk of empirical evidence, economists have developed theoretical models to account for fairness motives (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999; Rabin, 1993). Thus far, though, only few studies have analyzed the effect of fairness on the willingness-to-pay (WTP) for public goods.

This paper contributes to this line of inquiry by empirically investigating whether inequity affects households' WTP for green electricity based on randomized information treatments implemented in a stated-choice experiment among about 11,000 German households. Participants were randomly split into three experimental groups and asked for their WTP for increasing the share of green electricity in Germany, using the single-binary-choice format.

One third of the sample households were explicitly informed about the existence of an exemption rule for the energy-intensive industry in bearing the burden of disseminating renewable energy technologies and were then asked about their WTP for green electricity. Another third of the sample households received the same information, but was requested to state their WTP if the exemption was to be abolished. The remaining third of households did not receive any further information before they were asked about their WTP.

Using this study design, we test two hypotheses. First, we hypothesize that abolishing the exemption rule for the energy-intensive industry increases households' WTP for green electricity (*equity hypothesis*). Second, providing information on the industry exemption should decrease households' WTP for green electricity (*salience hypothesis*).

Eliciting the WTP for goods is ideally based on revealed, rather than hypothetical choices, because the former involve a real economic consequence, such as signing a contract (Carson, 2012; Harrison, 2006). Often, however, revealed preferences are not observable. Instead, stated-preference methods relying on hypothetical responses are frequently employed to estimate the WTP for public goods. A caveat of hypothetical elicitation formats is that they likely suffer from hypothetical bias, i.e. respondents may exaggerate their WTP or affirm a WTP question, although this decision does not necessarily reflect their true preferences (e. g. List and Gallet, 2001, Blumenschein et al., 2008, and the reviews by Harrison, 2006 and Harrison and Rutström, 2008).

Moreover, hypothetical choices might suffer from anchoring effects (Green et al., 1998) and protest bids (Jorgensen et al., 1999). These findings stimulated research on contingent valuation methods and various techniques have been proposed to elicit the true WTP, for instance, ex-ante correctives, such as the cheap-talk protocol (Cummings and Taylor, 1999) and the consequential-script (Bulte et al., 2005), and ex-post calibrations, such as the certainty approach (Johannesson et al., 1998). More recent theoretical and empirical work demonstrates the importance of "consequentiality" for incentive compatibility, according to which the incentive to truthfully reveal preferences is predicated on the respondent deeming the stated WTP as consequential (Carson and Groves, 2007; Carson et al., 2014; Vossler et al., 2012; Vossler and Holladay, 2016).

While there exists a bulk of research on the WTP for green electricity (e. g. Andor et al., 2017c; Ethier et al., 2000; Rose et al., 2002; Whitehead and Cherry, 2007), empirical evidence on the impact of fairness aspects on the WTP for public goods is scarce. Notably, we are not aware of any empirical study that analyzes the impact of fairness on the WTP for green electricity, whereas there are a few empirical articles that evolve around the notion of fairness and responsibility. Bulte et al. (2005), for instance, demonstrate that the

WTP for an environmental public good is substantially higher if an environmental problem is caused by human action, rather than having natural causes. A few other studies analyze the relationship between WTP and distributional preferences. For example, based on a student population, Ajzen et al. (2000) find that perceived fairness of a requested contribution to a local public good affects individual WTP. Using alternative polluter-pay specifications and a random telephone sample of Washington State's electorate, Johnson (2006) finds that individual support for a proposed environmental regulation increases if polluters bear higher shares in total costs. Exploring the relationship between the WTP for climate change mitigation and distributional preferences, Cai et al. (2010) argue that the WTP increases when parties that are expected to take a greater responsibility for mitigation bear larger cost shares in mitigation and when respondents think that climate change disproportionately affects the world's poor.

We complement this strand of the literature by employing a single-binary-choice question on the WTP for green electricity, a format recommended by both the National Oceanic and Atmospheric Administration (NOAA) panel on contingent valuation (Arrow et al., 1993) and the recent literature (e. g. Carson and Groves, 2007). In addition, we correct for potential hypothetical bias by applying state-of-the-art approaches, such as an ex-ante consequential script, and account for the political consequentiality of the survey as perceived by the respondents. Conducting a large-scale experiment among about 11,000 individuals, our analysis strongly contrasts with all those studies that are based on small samples, student populations, and telephone surveys with low participation rates. A further strength of our study is that it refers to a real, rather than a hypothetical policy measure: the promotion of green electricity, for which the exemption rule enjoyed by the energy-intensive industry implies a higher burden for other electricity consumers. This is all the more relevant as Germany's renewable promotion scheme causes substantial costs of around 25 billion Euros per year, equaling almost 1% of GDP.

Our central result is that abolishing the exemption for the energy-intensive industry raises households' WTP for green electricity. Most striking is the size of the effects: abolishing the exemption in contributing to this impure public good almost doubles the acceptance rate for a given burden. Our empirical finding that reducing inequity in the distribution of the cost burden increases the acceptance of bearing these costs may have far-reaching implications for policy-making in other fields where exemption rules exist as well, for instance in carbon tax schemes (Bjørner and Jensen, 2002; Martin et al., 2014; Rivers and Schaufele, 2015; Yamazaki, 2017).

In the following section, we explain Germany's promotion system, followed by a concise description of our experimental setting and the database in Sections 3 and 4. Section 5 presents the empirical results. The last section summarizes and concludes.

2 Renewable Promotion in Germany

Producing green electricity on the basis of renewable energy technologies is a classic example of an impure public good, whose consumption simultaneously generates a private and a public utility (see e. g. Kotchen, 2006): While consumers pay a price premium for being provided with green electricity, thereby enjoying a warm glow, greenhouse gas emissions that otherwise originate from fossil-based generation will be reduced by increasing green electricity production.

Yet, these advantages come at substantial costs: In many countries, green electricity is highly subsidized, with electricity consumers bearing the costs (IEA and IRENA, 2018). Energy-intensive companies, however, are frequently eligible for rebates to not endanger their international competitiveness. This holds for instance in Denmark, France, and the UK (CEER, 2017), as well as in Germany, where the share of green electricity in total consumption has been quintupled since 2000, to around one third today (BMWi, 2017). Energy-intensive facilities are, by law, eligible for rebates if the following pre-conditions are fulfilled: (1) a facility's electricity consumption level exceeds 1 million Kilowatthours (kWh), (2) its electricity cost intensity exceeds a sector-specific percentage, ranging between 14 and 20%, and (3) the facility implemented an energy management system. In 2016, about 2,800 facilities of around 2,100 companies were exempted from paying the full levy. These comprise about 4% of all companies of the industrial sector and accounted for about 40% of the industrial electricity consumption in Germany (BDEW, 2016).

Germany promotes electricity generation based on renewable energy technologies via a feed-in-tariff (FIT) system whereby green electricity has preferential access to the grid and is remunerated at technology-specific, above-market rates that are commonly guaranteed over a 20-year time period. Such FIT systems have been adopted in more than 100 countries throughout the world (REN21, 2017). Germany's FIT system, introduced in 2000 on the legal basis of the Renewable Energy Act (EEG), undoubtedly caused the tremendous increase in the capacity of renewable energy technologies from 12 to 104 Gigawatt between 2000 and 2016 (BMWi, 2017). To reach Germany's ambitious renewable goals of a share of 35% of green electricity in consumption in 2020, 50% in 2030, and 80% in 2050, these capacities must be expanded much further, to a multiple of today's renewable capacities.

The costs for the promotion of green electricity are borne by consumers via a fixed surcharge on the net price of electricity, the so-called EEG levy. Since its introduction in 2000, the EEG levy rose from zero to 6.79 cents per kWh in 2018 (Figure 1), today accounting for about a quarter of the end-use electricity price (BDEW, 2018). In 2017, annual promotion costs amounted to about 25 billion Euros, equaling almost 1% of Germany's GDP.

3 Experimental Design

We conducted a stated-choice experiment in which we inquired about participants' hypothetical willingness to pay for further increases in the costs of the promotion of renewable technologies. In detail, participants were asked whether they are willing to ad-

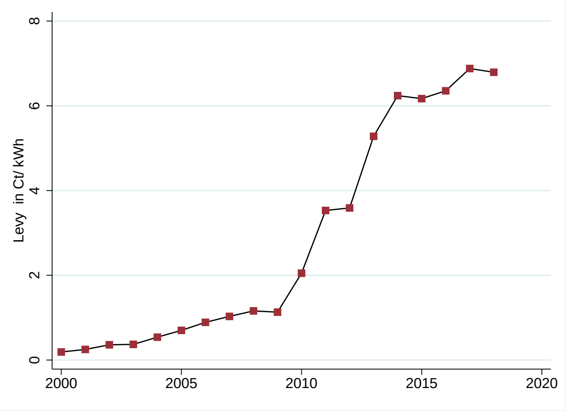


Figure 1: Levy for the Promotion of Renewable Energies in Germany. Source: BDEW (2018).

ditionally pay x ct/kWh for increasing the share of green electricity to 35% by 2020 (see Appendix A.1 for the exact questions). The amount $x \in \{1, 2, 4\}$ was randomly assigned and framed as a rise in the EEG levy. Given that this levy has increased by more than 4 ct/kWh since 2009 (see Figure 1) and a multiple of today's renewable capacity has to be deployed in oder to reach Germany's renewable goals, the amounts of 1 to 4 ct/kWh reflect a plausible range of future cost increases.

Participants were randomly split into three experimental groups: First, one third of the participants, belonging to what is called here the Retain Group, were informed about the exemption of the energy-intensive industry and were subsequently asked whether they would accept a further rise of x ct/kWh in the EEG levy. Second, subjects who were randomly assigned to the group termed Abolish Group received the same information as those of the Retain Group, but were asked about their willingness to accept a given rise in the EEG levy if the exemption for energy-intensive companies was to be abolished. Finally, subjects of the so-called Uninformed Group did not receive any further information before they were asked about whether they would accept a given levy increase.

Based on this study design, we test two hypotheses. First, we hypothesize that abolishing the exemption for energy-intensive firms increases households' WTP for green electricity (*equity hypothesis*). Second, providing information on the industry exemption decreases households' WTP for green electricity (*salience hypothesis*). In principle, the equity hypothesis can be tested by comparing the share of households of the Abolish Group that are willing to accept the randomly given increase in the EEG levy with the respective share of the Retain Group. Likewise, the salience hypothesis can be tested by contrasting the respective shares of the Retain and Uninformed Group.

While hypothetical choices are frequently employed to analyze the WTP for renewable energy technologies (e. g. Andor et al., 2017b), a potential shortcoming of this approach is that its stylized decision environment may induce participants to misreport their WTP, commonly referred to as hypothetical bias (e. g. Harrison, 2006 and List and Gallet, 2001). To mitigate this bias, we opted for using a single-binary-choice format, as it is argued to be incentive-compatible for public goods with coercive payments (Carson and Groves, 2007).[1] Furthermore, to increase the respondent's perception that their choice has real consequences, we *a priori* provided a consequential script, which emphasizes that the survey results will be made available to policy-makers and will be used for future decisions on the level of the EEG levy. Not least, we employ the so-called consequentiality approach, assuming that respondents reveal their true preferences only if they perceive their answers as consequential in terms of policy-making (Carson and Groves, 2007; Herriges et al., 2010; Vossler and Watson, 2013).

[1]To explain why single-binary-choice formats are incentive-compatible, we briefly recap the argumentation of Carson and Groves (2007). Gibbard (1973) and Satterthwaite (1975) showed that no response format that allows for more than two alternatives can be incentive compatible unless substantive additional restrictions are placed on peoples' preferences. While the Gibbard-Satterthwaite theorem does not mean that all binary discrete choice formats are incentive-compatible, it implies that all other formats are usually not incentive-compatible. For a standard public good, two assumptions have to hold so that single-binary-choice formats are incentive-compatible. First, the agency can actually compel payment for the good if it provides it. Second, the format considers only one public good. For an impure public good, such as green electricity, a third assumption must hold, i. e. only potential users are interviewed. All three assumptions are fulfilled for our empirical example.

4 Data

To elicit people's WTP for green electricity, we commissioned the survey institute *forsa* to carry out data collection. *forsa* maintains a household panel that is representative of the German-speaking population and employs a state-of-the-art tool that allows panelists to fill out the questionnaire using either a television or the internet – for more information, see http://www.forsa.com. Respondents – here the household heads – retrieve and return questionnaires from home and can interrupt and continue the survey at any time. Household heads are defined as those individuals who are responsible for the financial decisions at the household level. While some socio-economic characteristics of our sample closely match the characteristics of the population of German household heads (see Table A1 in the Appendix), sample household heads tend to be younger and better educated, suggesting that the empirical results are not representative for Germany. Notably, about one third of the respondents holds a college degree, which is higher than the national average of 21.1%. Furthermore, with 38.2%, the share of women in our sample is rather low, above all due to our decision to request household heads to participate in the survey.

The survey took place between December 23, 2015, and February 19, 2016, a period during which 11,375 individuals were recruited to fill out the questionnaire. 814 respondents abandoned the survey prior to the experiment, which corresponds to a dropout rate of 7.2%. This rate is in line with other studies that are based on this household panel, see e. g. Andor et al. (2017a). The descriptive statistics reported in Table 1 indicate that randomization was successful and that selection bias is not an issue: with a few exceptions, socio-economic characteristics are very similar across experimental groups, as is reflected by t-test statistics for the mean differences in the covariates that are statistically not significantly different from zero.

One exception is the indicator for pro-environmental attitudes, proxied here by the statement to be in favor of voting for Germany's Green Party, for which the share of 11.3%

Table 1: Descriptive Statistics

Variable	Explanation	Retain Group	Abolish Group	Uninformed Group	Whole Sample
Age	Age of respondent	55.08	54.80 (-0.934)	54.87 (-0.689)	54.92
Female	Dummy: 1 if respondent is female	0.382	0.373 (-0.790)	0.382 (0.024)	0.379
East Germany	Dummy: 1 if household resides in East Germany	0.194	0.189 (-0.548)	0.185 (-0.975)	0.190
College degree	Dummy: 1 if respondent has a college degree	0.338	0.320 (-1.522)	0.332 (-0.476)	0.330
Children	Dummy: 1 if respondent has children	0.608	0.617 (0.786)	0.612 (0.338)	0.612
Homeowner	Dummy: 1 if household owns property	0.607	0.618 (0.984)	0.598 (-0.846)	0.608
Income	Monthly household net income in €	2,881	2,921 (1.172)	2,901 (0.604)	2,901
Green party	Dummy: 1 if respondent is inclined to green party	0.095	0.096 (0.091)	0.113 (2.327)**	0.101
Green electricity	Dummy: 1 if household is supplied by green power	0.294	0.282 (-1.100)	0.273 (-2.011)**	0.283
RES plant	Dummy: 1 if household owns RES plant	0.122	0.129 (0.935)	0.122 (0.090)	0.124
Environmental group	Dummy: 1 if respondent is a member of an environmentally active group	0.153	0.136 (-1.990)	0.137 (-1.891)	0.142
Exemption	Dummy: 1 if respondent agrees with the justification for the exemption for the energy-intensive industry	0.191	0.170 (-2.104)**	0.150 (-4.352)**	0.170
Consequential	Dummy: 1 if respondent believes that the survey has political consequences	0.761	0.768 (0.643)	0.768 (0.624)	0.766
Early quit	Dummy: 1 if respondent quit the survey before the experiment	0.076	0.072 (-0.686)	0.066 (-1.774)	0.072
	Number of observations:	3,739	3,774	3,862	11,375

Note: t-test statistics for mean differences between the control group and the treatment groups are in parentheses. * and ** denote statistical significance at the 5% and the 1% level, respectively.

is somewhat higher in the Uniformed Group than in the other experimental groups. Overall, the share of respondents who tend to vote for the Green Party amounts to about 10%, which is in line with the results of the most recent federal election of 2017. It also bears highlighting that about three quarters of the respondents perceive the survey as consequential, that is, they believe that the survey results may have political consequences. This large share hardly varies across experimental groups. For comparison purposes, Table A2 presented in Appendix A.3, displays the summary statistics for those respondents who believe in political consequences of the survey.

5 Empirical Results

The focus of our empirical analysis is a binary indicator that equals unity if a respondent is willing to accept a hypothetical increase of either 1, 2, or 4 ct/kWh in the levy raised for the promotion of green electricity and zero otherwise. The descriptive results, presented in Table 2, reveal that the acceptance rates decrease substantially with the size of the levy increase, indicating internal validity of the responses. For example, across experimental groups, the share of respondents who accept an extra 4 ct/kWh is between about 13 and 18 percentage points lower than for an increase of 1 ct/kWh.

Table 2: Share of Respondents Who Accept an Increase of 1, 2, or 4 Cents/kWh in the EEG Levy to Reach Germany's Goal of a Share of Green Electricity of 35% in 2020

	Retain Group		Abolish Group		Uninformed Group	
Levy Increase	# Obs.	Share	# Obs.	Share	# Obs.	Share
1 Cent/kWh	1,098	38.16%	1,121	73.60%	1,131	58.62%
	–	–	–	(16.82**)	–	(9.66**)
2 Cents/kWh	1,104	29.17%	1,048	67.56%	1,090	49.36%
	–	–	–	(17.82**)	–	(9.69**)
4 Cents/kWh	1,061	22.53%	1,069	60.90%	1,186	40.81%
	–	–	–	(17.95**)	–	(9.26**)

Note: z-test statistics for the equality in proportions with respect to the control group are in parentheses. ** denotes statistical significance at the 1% level.

As hypothesized, the acceptance rates differ substantially across experimental groups. For instance, the share of respondents in the Abolish Group who accept a randomly given increase in the EEG levy is about 35-40 percentage points higher than in the Retain Group, indicating that abolishing the exemption for energy-intensive firms raises the WTP for green electricity dramatically relative to the situation in which the exemption is retained. This outcome supports the *equity hypothesis*, according to which fairness considerations play an important role with respect to the WTP for green electricity. The randomized experimental design allows us to test this hypothesis on the basis of proportion tests (see Appendix A.2). Actually, the z-test statistics presented in Table 2 indicate that the differences in the average acceptance rates between the Abolish and the Retain Group are statistically significant throughout.

Furthermore, as the *salience hypothesis* suggests, when respondents are explicitly informed about the existence of the industry exemption, as is done for those of the Retain Group, the acceptance rates are some 20 percentage points lower compared to that of the Uninformed Group. Most striking is the size of the effects: abolishing the exemption in contributing to this impure public good more than doubles the acceptance rates for given increases of 2 and 4 ct/kWh, a larger effect than when quartering this burden.

To check the robustness of our results, we follow Carson and Groves (2007), Carson et al. (2014), Vossler et al. (2012), and Vossler and Holladay (2016), who recently highlighted the importance of "consequentiality" to ensure the incentive compatibility of hypothetical responses. To this end, we asked the survey participants whether they believe that the results obtained from the survey may have political consequences. Exploiting this binary information and only taking account of the answers of respondents who perceive the survey as consequential, we find similar results, reported in Table A3 in Appendix A.3, as for the entire sample (Table 2). Most notably, the propensity of accepting higher EEG levies is higher among respondents who perceive the survey as consequential than for the entire sample. Yet, the differences in mean acceptance rates across experimental groups are similar in magnitude.

In addition to the robustness check based on consequentiality, we now estimate three linear probability models to confirm the results reported in Table 2. In Specification (1), presented in Appendix A.2, only the indicators for the Abolish and the Uninformed Group and the dummy variables for the levy increases of 2 and 4 ct/kWh, as well as the corresponding interaction terms, are included as regressors. In Specification (2), socio-economic characteristics are added as controls. In a third model specification, Specification (2) is completed by adding the full set of interaction terms where the experimental group indicators are interacted with all socio-economic characteristics.

Focusing first on the coefficient estimates resulting from Specification (1) (left-hand panel of Table 3), we again find strong treatment effects that exactly mimic the differences in mean acceptances across experimental groups (Table 2). For instance, with 0.354, the estimate of the coefficient on the Abolish Group indicator yields a treatment effect of abolishing the industry exemption relative to the Retain Group that is identical to the difference of 35.4 percentage points between the average acceptance rates of both groups for an EEG levy increase of 1 ct/kWh.

Table 3: Linear Probability Model Regression Results for the Share of Respondents Who Accept an Increase of 1, 2, or 4 Cents/kWh in the EEG Levy to Reach Germany's Goal of a Share of Green Electricity of 35% in 2020

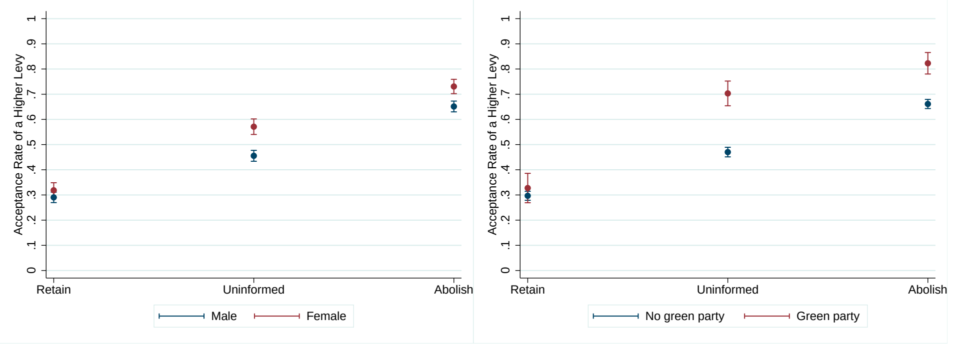
	Socio-economic Characteristics			
	Excluded		Included	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Abolish	0.354**	(0.020)	0.364**	(0.021)
Uninformed	0.205**	(0.021)	0.208**	(0.022)
2 Cents	-0.090**	(0.020)	-0.085**	(0.022)
4 Cents	-0.156**	(0.019)	-0.158**	(0.021)
Abolish × 2 Cents	0.030	(0.028)	0.024	(0.030)
Abolish × 4 Cents	0.029	(0.028)	0.020	(0.030)
Uninformed × 2 Cents	-0.003	(0.029)	-0.012	(0.031)
Uninformed × 4 Cents	-0.022	(0.028)	-0.025	(0.030)
Female	–	–	0.075**	(0.011)
East Germany	–	–	-0.060**	(0.013)
College degree	–	–	0.037**	(0.011)
Children	–	–	-0.020	(0.012)
Green party	–	–	0.149**	(0.016)
Homeowner	–	–	-0.040**	(0.012)
Green electricity	–	–	0.077**	(0.011)
Renewable system	–	–	0.043**	(0.016)
Environmental group	–	–	0.058**	(0.014)
Age	–	–	0.002**	(0.000)
ln(Income)	–	–	0.052**	(0.011)
Constant	0.382**	(0.015)	-0.191*	(0.089)
No. of observations	9,908		8,372	

Note: Robust standard errors are reported in parentheses. **,* denote statistical significance at the 1 % and 5 %level, respectively.

Estimating Specification (2), where socio-economic characteristics are included as regressors, hardly varies the magnitude of the treatment effects (right-hand panel of Table 3). This outcome is to be expected if randomization into the experimental groups is successful. The coefficient estimates for the socio-economic characteristics are all unsurprising and indicate that women, college graduates, and participants with green attitudes are more likely to accept an increase in the EEG levy than the reference person, who *inter alia* is male and in the Retain Group. Moreover, the propensity to be willing to pay more for green electricity increases with age and income, while it is lower for households residing in East Germany and for homeowners. It also bears noting that these results turn out to be robust when we focus only on those respondents who believe that the survey results may have political consequences. The estimates reported in Table A4 in Appendix A.3 reconfirm the very large treatment effects, particularly with respect to the difference between the Abolish and the Retain Group, which amounts to some 37 percentage points.

Investigating the heterogeneity of the treatment effects with respect to socio-economic characteristics in our third model specification, in which the experimental group dummies are interacted with all socio-economic characteristics, we find that both female respondents and respondents who are inclined to vote the green party have particularly strong preferences for fairness. In fact, Figure 2 illustrates that the difference between the acceptance rates in the Abolish and the Retain Group is particularly pronounced for voters of the green party.

Finally, while we tacitly assume in our analysis that respondents perceive the exemption rule for the energy-intensive industry as unfair, we admit that we have no empirical information on this issue. Yet, as an indication for the perceived unfairness of the industry exemption, we exploit information that we obtained in the aftermath of the experiment by asking participants whether they agree or disagree with the justification of the industry exemption. On average, only 17% of the respondents think that the industry exemption is justified (Table 1), which points to the notion that the exemption is widely perceived as unfair. It bears noting, however, that the randomized assignment to an experimental group across which the provision of information on the exemption is varied, has a bearing on the responses: Figure 3 illustrates that the percentage of respondents agreeing with



(a) Variation in Treatment Effects across Gender **(b)** Treatment Effects across Green Attitudes

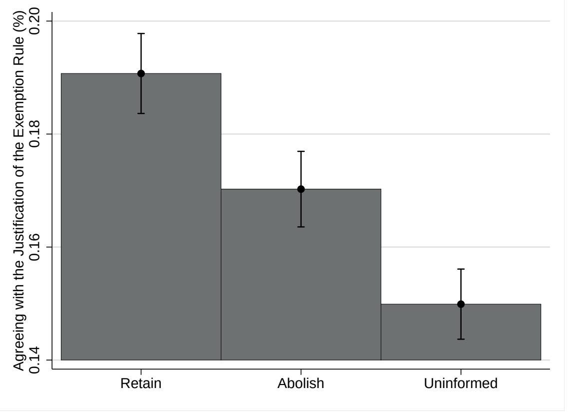
Note: Robust standard errors on the means are used for the error bars (n=8,372).

Figure 2: Heterogeneous Treatment Effects

the justification of the exemption rule is higher among those individuals who received information on the exemption in the experiment than for those who did not obtain this information. These differences across experimental groups are statistically significantly different from zero, as can be seen from the test statistics reported in Table 1. From Figure 3, we also learn that with about 15% the share of respondents who think that the industry exemption is justified is lower for the Uninformed Group than for the other groups.

6 Summary and Conclusion

The perceived fairness of a price is widely recognized to be a critical determinant for people's WTP for a good (Ajzen et al., 2000; Kahneman et al., 1986). In this paper, we have explored how equity motives, particularly the inequality in the coercive payments for green electricity, affect the willingness-to-pay (WTP) for this impure public good. Based on randomized information treatments implemented in a stated-choice experiment among nearly 11,000 German households, we find that, on the one hand, abolishing the exemption for the energy-intensive industry substantially raises households' WTP for green electricity. On the other hand, when households learn about the prevalence of un-



Note: Robust standard errors on the means are used for the error bars (n=9,552).

Figure 3: Treatment Effect on the Agreement of the Exemption Rule

even contributions, our results indicate that this knowledge considerably decreases their WTP.

A caveat of our stated-preference approach is the potential emergence of hypothetical bias. To mitigate this bias, we have employed a consequential script as ex-ante corrective and the consequentiality approach, assuming that respondents reveal their true preferences if they perceive their answers as consequential in terms of policy-making (Carson and Groves, 2007; Herriges et al., 2010; Vossler and Watson, 2013). On the basis of the latter approach, we conclude that our key results of large treatment effects is robust. While we are optimistic to have reduced hypothetical bias by pursuing these approaches, we argue that even if there was any hypothetical bias, it seems unlikely that hypothetical bias renders our conclusions invalid given the large treatment effects.

The empirical outcome that the distribution of the cost burden highly matters for the acceptance of bearing these costs may be a general principle that may have strong implications for policy-making in other fields, such as carbon taxation. For instance, Rivers and Schaufele (2015) suggest that the introduction of a carbon tax in British Columbia was only publicly accepted because the government reduced the tax rate for low-income households and companies. Apparently, as the acceptance of policies crucially hinges on the distribution of the associated costs, conceiving appropriate payment rules is key for the public acceptance of any policy instrument, not least greenhouse gas abatement measures.

A Appendix

A.1 Translation of the Description of the Experiment

Introduction to the Experiment

”We will now ask about how much you are willing to pay for electricity that is generated with different energy sources and technologies. In what follows, we will call it your ’willingness-to-pay’.”

Information on the Promotion of Green Electricity

”Germany’s promotion of green electricity has contributed to the deployment of 93 Gigawatt (GW) of renewable energy technologies by 2014 and a share of 28% of green electricity in production. The German government aims at increasing the share of green electricity to 35% by 2020. In Germany, the promotion of green electricity is financed via the so-called EEG levy. This levy has to be paid by every household for each unit of electricity consumed (kWh) and amounts to 6.17 ct/kWh in 2015. Since the average electricity price in 2015 is 28.8 ct/kWh, this corresponds to a share of some 21%.

Choice Situation

Uninformed Group: ”Are you willing to pay an increase in the EEG levy by x ct/kWh (to then y ct/kWh) in order to achieve the goal of increasing the share of green electricity to 35% by 2020?”
Retain Group: ”About 4% of industrial companies, which cover about 40% of the industrial electricity consumption, do not have to pay the full amount of the EEG levy. This exemption is intended to shield companies, so as not to undermine their international competitiveness. If the exemption for the energy-intensive is retained, are you willing to pay an increase in the EEG levy by x ct/kWh (to then y ct/kWh) in order to achieve the goal of increasing the share of green electricity to 35% by 2020?”
Abolish Group: ”About 4% of industrial companies, which cover about 40% of the industrial electricity consumption, do not have to pay the full amount of the EEG levy. This exemption is

intended to shield companies, so as not to undermine their international competitiveness. If the exemption was to be abolished, are you willing to pay an increase in the EEG levy by x ct/kWh (to then y ct/kWh) in order to achieve the goal of increasing the share of green electricity to 35% by 2020?”

Consequentiality

“How likely do you believe that results of surveys, such as the present one, influence policy decisions on the amount of the surcharge for the promotion of renewable energy technologies (EEG Levy)?” The answers to this question are measured on a 5-point Likert scale, where 1 stands for “Very unlikely” and 5 indicates “Very likely”.

Opinion about the Exemption

“Currently energy-intensive companies do not have to pay the full amount of the EEG levy. What is your opinion about this rule?” The possible answers to this question are “I think they are appropriate” and “I think they are inappropriate”.

A.2 Methods

To test whether our binary dependent variable Y_i, which equals unity if respondent i is willing to accept a hypothetical increase of either 1, 2, or 4 ct/kWh in the EEG levy, differs across experimental groups (see Table 2), we perform tests on the equality of proportions π_1 and π_2. The test is based on the null hypothesis $H_0: \pi_1 = \pi_2$ and the normally distributed test statistic $z = \frac{\hat{\pi}_1 - \hat{\pi}_2}{\sqrt{\hat{\pi}_1/n_1 + \hat{\pi}_2/n_2}}$, where $\hat{\pi}_1$ and $\hat{\pi}_2$ are the sample proportions of Group 1 and 2, respectively, and n_1 and n_2 denote the respective group sizes (Ott and Longnecker, 2010).

In principle, to estimate treatment effects, it suffices to simply take the differences in Y across experimental groups: Given perfect randomization, the difference between two group averages in Y is then a consistent estimator for the corresponding average treatment effect. Alternatively, treatment effects can be estimated by a linear probability model (Angrist and Pischke, 2009), such as Specification (1):[2]

$$\begin{aligned} Y_i = \alpha + \omega_{Abolish} Abolish_i + \omega_{Uninformed} Uninformed_i + \omega_2 2Cents_i + \omega_4 4Cents_i \\ + \omega_{2A} 2Cents_i \cdot Abolish_i + \omega_{4U} 4Cents_i \cdot Uninformed_i + \epsilon_i, \end{aligned} \tag{1}$$

where $Abolish_i$ and $Uninformed_i$ denote a dummy variable that equals unity if individual i is in the Abolish and Uninformed Group, respectively. $2Cents_i$ and $4Cents_i$ indicate whether individual i was faced with an increase in the EEG levy of 2 and 4 ct per kWh, respectively. $2Cents_i \cdot Abolish_i$ and $4Cents_i \cdot Uninformed_i$ denote the corresponding interaction terms. $\omega_{Abolish}$, $\omega_{Uninformed}$, ω_2, ω_4, ω_{2A}, and ω_{4U} are coefficients to be estimated and ϵ_i designates an error term.

As a robustness check, we add socio-economic characteristics, captured by vector $\boldsymbol{x}$, to Specification (1):

$$\begin{aligned} Y_i = \alpha + \boldsymbol{\beta}^T \boldsymbol{x}_i + \omega_{Abolish} Abolish_i + \omega_{Uninformed} Uninformed_i + \omega_2 2Cents_i + \omega_4 4Cents_i \\ + \omega_{2A} 2Cents_i \cdot Abolish_i + \omega_{4U} 4Cents_i \cdot Uninformed_i + \nu_i. \end{aligned} \tag{2}$$

[2] To estimate treatment effects on the basis of regression models, we follow Angrist and Pischke (2009), who advocate for using linear, instead of nonlinear probability models, such as probit or logit, because the latter require distributional assumptions.

Finally, to investigate heterogeneity across experimental groups with respect to socio-economic characteristics, we add interaction terms of the treatment groups with these characteristics to Specification (2) and estimate this third specification.

A.3 Tables

Table A1: Comparison of the Sample Household Heads with the Population of German Household Heads

Variable	Sample	Germany (2016)
1 Person household	0.245	0.411
2 Person household	0.483	0.340
3 Person household	0.139	0.123
Household with 4 or more members	0.133	0.127
East Germany	0.190	0.208
Household income $>$ €4,700	0.119	0.128
Age between 18 and 34	0.091	0.200
Age between 35 and 64	0.640	0.524
Age 65 and above	0.269	0.276
Female	0.379	0.352
College degree	0.330	0.211

Data for the population of German household heads is drawn from Destatis (2017). This data source asks the main earner to complete the questionnaire, whereas we ask the household member who usually makes financial decisions at the household level. Furthermore, the variable high income is top-coded at 4,500 EUR, while in our sample the upper threshold is at 4,700 EUR.

Table A2: Descriptive Statistics for Respondents who Believe that the Survey has Political Consequences

Variable	Explanation	Retain Group	Abolish Group	Uninformed Group	Whole Sample
Age	Age of respondent	55.13	55.04	55.12	55.09
			(-0.236)	(-0.017)	
Female	Dummy: 1 if respondent is female	0.364	0.368	0.384	0.372
			(0.285)	(1.480)	
East Germany	Dummy: 1 if household resides in East Germany	0.176	0.186	0.176	0.179
			(0.979)	(0.054)	
College degree	Dummy: 1 if respondent has a college degree	0.354	0.340	0.353	0.349
			(-1.046)	(-0.098)	
Children	Dummy: 1 if respondent has children	0.655	0.665	0.656	0.659
			(0.756)	(0.089)	
Homeowner	Dummy: 1 if household owns property	0.617	0.624	0.606	0.616
			(0.517)	(-0.814)	
Income	Monthly household net income in €	2,942	2,979	2,965	2,962
			(0.902)	(0.565)	
Green party	Dummy: 1 if respondent is inclined to green party	0.106	0.109	0.127	0.114
			(0.331)	(2.275)**	
Green electricity	Dummy: 1 if household is supplied by green power	0.317	0.293	0.282	0.297
			(-1.881)	(-2.735)**	
RES plant	Dummy: 1 if household owns RES plant	0.131	0.137	0.126	0.131
			(0.647)	(-0.522)	
Environmental group	Dummy: 1 if respondent is member of an environmentally active group	0.166	0.143	0.145	0.151
			(-2.259)**	(-2.078)**	
Exemption	Dummy: 1 if respondent agrees with the justification of the exemption for the energy-intensive industry	0.211	0.179	0.160	0.183
			(-2.780)**	(-4.536)**	
	Number of observations:	2,546	2,612	2,691	7,849

Note: t-test statistics for mean differences between the control group and the treatment groups are in parentheses. * and ** denote statistical significance at the 5% and the 1% level, respectively.

Table A3: Share of Respondents Who Accept an Increase of 1, 2, or 4 Cents/kWh in the EEG Levy to Reach Germany's Goal of a Share of Green Electricity of 35% in 2020

	Retain Group		Abolish Group		Uninformed Group	
Levy Increase	# Obs.	Share	# Obs.	Share	# Obs.	Share
1 Cent/kWh	814	44.96%	866	78.06%	834	67.03%
	–	–	–	(13.97**)	–	(9.02**)
2 Cents/kWh	810	34.44%	784	71.17%	803	56.79%
	–	–	–	(14.68**)	–	(9.01**)
4 Cents/kWh	793	27.11%	805	65.59%	918	47.39%
	–	–	–	(15.41**)	–	(8.62**)

Note: z-test statistics for the equality in proportions with respect to the control group are in parentheses. ** denotes statistical significance at the 1% level.

Table A4: Linear Probability Model Regression Results for those Respondents who Believe in Political Consequences

	Socio-Economic Characteristics			
	Excluded		Included	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Abolish	0.331**	(0.022)	0.346**	(0.024)
Uninformed	0.221**	(0.024)	0.230**	(0.026)
2 Cents	-0.105**	(0.024)	-0.095**	(0.026)
4 Cents	-0.179**	(0.024)	-0.181**	(0.025)
Abolish × 2 Cents	0.036	(0.032)	0.019	(0.035)
Abolish × 4 Cents	0.054	(0.032)	0.044	(0.034)
Uninformed × 2 Cents	0.003	(0.034)	-0.011	(0.037)
Uninformed × 4 Cents	-0.018	(0.033)	-0.026	(0.035)
Female	–	–	0.070**	(0.012)
East Germany	–	–	-0.053**	(0.016)
College degree	–	–	0.033**	(0.013)
Children	–	–	-0.014	(0.014)
Green party	–	–	0.128**	(0.017)
Homeowner	–	–	-0.043**	(0.014)
Green electricity	–	–	0.057**	(0.013)
Renewable system	–	–	0.037*	(0.017)
Environmental group	–	–	0.063**	(0.016)
Age	–	–	0.002**	(0.000)
ln(Income)	–	–	0.049**	(0.013)
Constant	0.450**	(0.017)	-0.098	(0.103)
No. of observations	7,427		6,314	

Note: Robust standard errors are reported in parentheses. **,* denote statistical significance at the 1 % and 5 %level, respectively.

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