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Consumers' willingness to offset their CO_2 emissions from traveling: A discrete choice analysis of framing and provider contributions

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Abstract

This paper identifies potential drivers and individuals' willingness to pay (WTP) for offsetting their emissions from traveling. We focus on the effects of framing the polluting activity with different modes of transportation (i.e. bus and plane) and travel occasions (i.e. holiday and professional training) as well as the effects of contributions from the travel provider. The analyses are based on discrete choice experiments with a representative sample of about 1000 consumers from Germany. Applying mixed logit and latent class logit models, the findings suggest substantial framing effects resulting from the variation in the mode of transportation as well as a significantly higher WTP when offsets are matched by the travel provider 1:1. The findings further indicate that re-/afforestation projects in the participants' region are the preferred mode for compensation. Respondents who are more willing to offset emissions from traveling seem to be younger and female, have a higher income, exhibit stronger environmental and social preferences, and believe that offsetting is effective in protecting the climate.

Keywords: climate change; carbon offsetting; framing effects; provider contribution; willingness to pay; discrete choice experiments

JEL: H41, Q54, Q58

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1 Introduction

The consumption of private households causes approximately 60% of global greenhouse gas (GHG) emissions (Ivanova et al., 2016) and is directly responsible for nearly 30% of total energy use (IEA, 2008). By lowering energy use or relying on carbon-free energy sources households may significantly contribute to reducing emissions of GHGs and local pollutants.

Actively reducing emissions related to transport services, are particularly challenging and may involve high opportunity costs (e.g. forgone overseas vacation, time to commute to work). As far as carbon-free substitutes (e.g. for kerosene) are not yet available, voluntary carbon offsetting (VCO) is a possible mechanism to compensate emissions produced by transport services. Payments for VCO fund climate protection projects (e.g. investments in renewable energies, energy efficiency, or re-/afforestation) and thereby mitigate an amount of carbon dioxide corresponding to the emissions caused by the original activity.

In this paper, we report the results from discrete choice experiments (DCEs) and identify factors that influence the demand and willingness to pay (WTP) for VCO in order to compensate for emissions from traveling. We particularly explore the effects of framing the polluting activity with different modes of transportation (i.e. bus and plane) and different travel occasions (i.e. holiday and professional training). For both types of framings, we also study the effects of additional contributions from the travel provider.

The existing literature[1] identifies various factors which influence the WTP for VCO. Knowledge about carbon offsetting represents a considerable factor that potentially influences the demand for VCO. Ziegler et al. (2012) and Lu and Shon (2012) emphasize the importance of previous knowledge about and attitudes towards VCO which might affect the WTP of potential car buyers and air travelers. Likewise, Schwirplies and Ziegler (2016) find that consumers in Germany are still poorly informed and fairly uncertain about the use and effectiveness of VCO. Jacobsen (2011) shows that information and awareness campaigns positively influence the demand for VCO, at least in the short-run.

MacKerron et al. (2009) reveal the effect of the properties of a specific project on the WTP (especially co-benefits like "human development", "environmental protection and biodiversity", and "technology and market development"). The authors show that all of the specified co-benefits have a positive impact, but respondents

1 For an overview of this literature see also Blasch and Farsi (2014).

ranked "environmental protection and biodiversity" highest with an additional WTP estimate of 15 British Pounds (about 20 Euros) per tCO_2e. Moreover, Blasch and Farsi (2014) find that consumers have a higher preference for offsetting projects in developing countries initiated by non-governmental organizations and certified by the government.

The existing literature generated also a wide range of WTP estimates for VCO. Brouwer et al. (2008) and Akter et al. (2009), for instance, interviewed flight passengers at Amsterdam Schiphol airport about their willingness to establish a voluntary "Carbon Travel Tax". Three quarters of their respondents are generally willing to pay such a tax, and the average WTP estimate was around 25 Euro per tCO_2e. Relying on a DCE, MacKerron et al. (2009) analyze the flight behavior and willingness of young and educated individuals from Great Britain to buy offsets from the voluntary carbon market. They find an average estimated WTP per tCO_2e of 24 British Pounds (about 32 Euros). Similarly, Blasch and Farsi (2012) analyze VCO for a broad set of consumption activities in Switzerland and estimate a marginal WTP of up to 21 Swiss Francs (about 17 Euros) per tCO_2e. They find the highest WTP estimates of about 78 Swiss Francs (about 64 Euros) per tCO_2e for flights which have a large impact on the environment. In comparison, the field-experiments conducted in Germany by Diederich and Goeschl (2012) as well as Löschel et al. (2013) reveal a mean WTP between about six and 12 Euro per tCO_2e, respectively. This range is lower than the values typically found in stated preferences studies.

We add further insights into the preferences and WTP for VCO by conducting four DCEs among an online-representative sample of 1000 German consumers. Participants were asked to choose between offsetting options in order to compensate the carbon emissions caused by traveling. Our experiments are novel in various ways. First, we test for potential effects of framing the context. Former studies already emphasize that the frame in which individuals are asked to make a contribution to public goods significantly influences their willingness to participate (e.g., Shogren et al., 2010; Cason and Raymond 2011). While most of the existing studies on VCO deal with one specific frame and consumption context, Araña and León (2013) provide evidence for framing effects by asking individuals to offset carbon emissions in an opt-in or an opt-out frame, respectively.

In our experiments, we randomly vary the framing in two respects. We assign our participants to an intrinsically and an extrinsically motivated travel occasion, i.e. holiday and professional training. Findings from the psychological literature on environmental behavior suggest that the moral obligation to engage in environmental behaviors is increasing if personal responsibility for the relevant outcomes of these behaviors is assumed (Klöckner, 2013). This idea coincides with the assumptions in Brekke et al. (2003) that an individual has a socially responsible self-image, but the perceived responsibility or duty to act in a pro-social way varies with the external situation (see also Brekke et al., 2010). We test this assumption with our framing where participants' might feel a higher degree of responsibility for a polluting activity initiated by leisure than by professional duty that also benefits their employer.

In addition, we assign the participants to different modes of transportation, i.e. bus and plane. This framing enables us to directly compare the WTP for bus and air travels, which have been analyzed in separated settings and experiments, so far, and thus cannot be directly linked or compared (e.g., Brouwer et al., 2008; Kesternich et al., 2016). We also add to the analyses in Blasch and Farsi (2014), who highlight the dependence of the willingness to offset carbon emissions on different consumption contexts such as space heating, air travels, car rental, and hotel stays, and find a significantly higher willingness in high-emission contexts.

Second, we analyze the effect of additional contributions from the provider of the polluting activity (in the literature also referred to as matching grants). So far, different matching and rebate schemes have been considered in the literature on charitable giving which might also provide relevant insights for the funding of climate protection projects. Eckel and Grossman (2003) find that contributions to a charity are significantly higher with matching than with rebate subsidies. Meier (2007) shows that a matching rate of 50 percent leads to a significantly higher willingness to donate compared to no subsidies or a matching rate of 25 percent. Karlan and List (2007) provide further evidence that a 1:1 match significantly increases contributions, but higher rates (2:1 and 3:1) have no additional impact. To our knowledge, the field experiment by Kesternich et al. (2016) is the only study analyzing the effect of matching grants (1/3:1, 1:1, and 3:1) on the willingness to compensate carbon emissions caused by bus journeys. In line with Karlan and List (2007), they conclude that the 1:1 matching scheme significantly increases the willingness to offset emissions compared to lower rates, while the higher rate leads to equivalent contributions. Our DCEs complement this literature by matching the participants' carbon offsets at the rates 33 and 100% contributed by the travel provider. In addition, our approach allows comparing the outcomes when the context varies, which offers a deeper understanding of the determinants of the revealed effects.

The offsetting alternatives in our experiments are further described by a variety of attributes that might influence the demand for VCO, i.e. the price per tCO_2e, the place of compensation, and the compensation scheme. Our results from mixed logit and latent class logit analyses indicate remarkable framing effects which result from the variation in the mode of transportation, i.e. participants are more willing to offset emissions from bus travels and at the same time to pay higher prices per tCO_2e for these offsetting projects. Also, in line with previous studies, participants exhibit a significantly higher estimated WTP for offsets which are matched by the travel provider according to a 1:1 matching scheme. Our findings further indicate that re-/afforestation projects are preferred to energy efficiency or renewable energy projects. Likewise the estimated WTP is higher for regional projects than for projects implemented in another European or in a developing country. Finally, we characterize participants with a higher willingness to offset emissions from traveling. These are generally more likely to be younger and female, to have higher income, exhibit stronger environmental and social preferences, and believe in a high effectiveness of VCO in protecting the climate.

Our findings are expected to be interesting for policy makers, offsetting providers as they shed light on consumers' motivation to compensate their emissions. The characterization of participants with a higher propensity to choose one of our offsetting options might support policy and practitioners in developing effective strategies that promote and enhance consumers' use of VCO.

The remainder of the paper is organized as follows: Section 2 discusses the survey administration and experimental design. Section 3 explains our econometric approach. Section 4 presents the main empirical findings. The final Section 5 summarizes these results and draws some important conclusions.

2 Survey and experimental design

2.1 Survey administration

The data for our analyses stem from an online-representative web-based survey among a total of 1005 consumers in Germany. The survey was carried out in April 2014 by the market research company GfK SE (Gesellschaft für Konsumforschung) drawing the sample from the GfK Online Panel based on official population statistics (e.g., age, gender, and region). The survey was structured in several sections and collected information on personal beliefs about climate change and its consequences, individual travel behavior and experiences with VCO including a short explanation about VCO, specific attitudes towards VCO and the environment, as well as socio-economic and socio-demographic characteristics. On average, the completion of the survey took about 19 minutes.

Table 1 and Table 2 provide a description and summary of the characteristics of the sample, respectively. The age of the participants ranges between 18 and 90 with an average value of 46.5 years. 50.8 percent of the participants are qualified to pursue a degree in higher education (i.e. "Abitur" in Germany), 27.26 percent earn an individual income above 2000 Euro per month,[2] and participants have on average 1.1 own children.[3][4]

2.2 Experimental design

The main component of the survey was the experimental part for which we designed four DCEs. The experiments started with a brief introduction of the (hypothetical) choice situation. Participants were asked to imagine that they book a short journey with duration of two to five days. The costs for this journey are borne by themselves. They received information about the amount of carbon emissions, which are produced by this journey, and were asked to decide whether they want to offset these emissions.

The framing of the four experiments varied with mode of transportation (either long distance bus or plane) and travel occasion (either a holiday trip or a trip to a

2 The sample median is in the interval of 1500 but less than 2000 Euros and 22% of respondents responded "don't know/no answer" to the income question.

3 In our sample, single-person households are underrepresented and individuals with a higher educational level are overrepresented compared to the population (see https://www.destatis.de/DE/Startseite.html).

4 All values refer to the inclusion of the category "don't know / no answer", respectively.

professional training). Table 3 provides an overview of the resulting four frames. The amount of carbon emissions produced by a journey is calculated from the emission intensity of the particular mode of transportation and the assumed distance of the journey. Each participant was randomly assigned to two of the four DCEs, which were introduced as follows:

(i) Holiday trip by bus: You travel by bus to reach a large city which is about 250 kilometers away from your hometown. The bus ticket costs 20 Euros. The journey is a vacation trip. Outward and return journey cause about 20 kilograms of carbon emissions. (N = 503 respondents)

(ii) Trip to professional training by bus: You travel by bus to reach a large city which is about 250 kilometers away from your hometown. The bus ticket costs 20 Euros. The travel occasion is a professional training. Outward and return journey cause about 20 kilograms of carbon emissions. (N = 501 respondents)

(iii) Holiday trip by plane: You travel by plane to reach a large city which is about 1000 kilometers away from your hometown. The plane ticket costs 250 Euros. The journey is a vacation trip. Outward and return journey cause about 700 kilograms of carbon emissions. (N = 503 respondents)

(iv) Trip to professional training by plane: You travel by plane to reach a large city which is about 1000 kilometers away from your hometown. The plane ticket costs 250 Euros. The travel occasion is a professional training. Outward and return journey cause about 700 kilograms of carbon emissions. (N = 503 respondents)

Each experiment consisted of six choice sets with three offsetting alternatives and one opt-out option (see Figure 1), resulting in more than 3000 observations from approximately 500 participants per experiment. The three offsetting alternatives were described by four attributes: (1) price in Euro per tCO_2e, (2) place of compensation, (3) compensation scheme, and (4) contribution from the provider. Table 4 summarizes these attributes and the corresponding attribute levels. Instead of the underlying price per tCO_2e, participants were confronted with the actual price of the compensation. “Contribution from the provider” resulted (except for attribute level “none”) in an additional amount of carbon offsets financed by the travel provider. In line with former studies (e.g., Karlan and List, 2007; Kesternich et al., 2016), we considered matching rates which increased the amount of carbon offsets by one third (1/3:1) or by 100% (1:1).

Typically, the validity of DCEs may suffer from the hypothetical nature of the decisions made by participants. We tried to address this potential hypothetical bias in two ways. First, we used cheap talk scripts which have proved to reduce or even eliminate this hypothetical bias (e.g., Cummings and Taylor, 1999; List, 2001; Aadland and Caplan, 2006). In this respect, we explicitly highlighted the importance that participants make their decision just as they would in a real booking situation and take account of their personal financial situation. Second, we included the opt-out option to make the choice situation more realistic. Whenever participants decided to choose this opt-out option, we receive no information about the relative attractiveness of the three offsetting alternatives offered. However, it is plausible to assume that several participants are generally not willing to pay for carbon offsetting in reality (in line with the approach in Adamowicz et al., 2011) and not including an opt-out option would most likely lead to strongly biased results.

The experimental design was developed using the Sawtooth software and employed the complete enumeration method. This design strategy assured minimal overlap of choice sets and achieved an efficiency of approximately 98 percent.

3 Econometric approach

The basis for our econometric analysis is the participant's choice (for each of the four DCEs, respectively) among the four mutually exclusive alternatives (i.e. the three offsetting alternatives and the opt-out option) in each choice set as discussed above. The hypothetical utility of participant i (i = 1,…,N) from VCO alternative j (j = 1,…,4) in choice set m (m = 1,…,6) is

$$U_{ijm} = \beta_i' x_{ijm} + \varepsilon_{ijm} .$$

The latent variables U_{ijm} thus depend on the vectors $x_{ijm} = (x_{ijm1},\ldots,x_{ijm5})'$ of the four attributes and an alternative-specific constant (ASC) for the opt-out option. The ASC reflects the change in utility if emissions are not compensated and captures all effects that cannot be explained by the attributes. $\beta_i = (\beta_{i1},\ldots,\beta_{i5})'$ is the unknown parameter vector and the error terms ε_{ijm} summarize all unobserved factors. According to the random utility maximization theory (e.g., McFadden, 1974), participant i chooses category j in choice set m if the utility of alternative j is the largest of all utilities. The choice probability is (e.g., Rolfe et al., 2000):

$$P_{ijm} = P(U_{ijm} > U_{ij'm};\ \forall j \neq j') = P\left(\beta_i' x_{ijm} + \varepsilon_{ijm} > \beta_i' x_{ij'm} + \varepsilon_{ij'm};\ \forall j \neq j'\right)$$

with $\beta_i = \beta$ ($\forall$ i). The assumption of independently and standard (type 1) extreme value distributed error terms ε_{ijm} (e.g., Louviere et al., 2000) leads to the common multinomial or (with only alternative-specific attributes) to the conditional logit model, which both rely on the so-called independence from irrelevant alternatives (IIA) property.

The inclusion of an opt-out choice option, however, renders the IIA property implausible. We therefore apply the more flexible mixed logit models (MLM; also referred to as random parameter logit models). MLM allow for taste heterogeneity across participants and thus are able to incorporate correlations between the choice alternatives by attaching a random component to the parameters β_{ik} (i = 1,…,N) for the k = 1,…,5 attributes (including the ASC for the opt-out option) assuming that the β_{ik} are normally distributed (e.g., Revelt and Train, 1998; Hensher and Greene, 2003). Following Hole (2007), the probability of the observed sequence of choices across all six choice sets for participant i is then:

$$P_i(\theta) = \int \prod_{m=1}^{6} \frac{e^{\beta_i' x_{ijm}}}{\sum_{k=1}^{4} e^{\beta_i' x_{ikm}}} \varphi(\beta_i) d\beta_i$$

where $\beta_i = (\beta_{i1},...,\beta_{i5})$ and $\varphi(\beta_i)$ is the joint density function of the normally distributed β_i. These probabilities, which are characterized by multiple integrals, are approximated by simulation methods using 1000 Halton draws. The parameters are therefore estimated by the simulated maximum likelihood method. Random parameters are estimated for ASC for the opt-out option and the three attributes compensation scheme, place of compensation, and grants from the provider, whereas the price attribute is kept fixed. This is common practice as we use the estimated parameters of the price attribute for WTP calculations (e.g., Valck et al., 2014). The vector x_{ijm} includes the price attribute as quantitative variable with five values and all other attribute levels in Table 4 as well as the ASC as dummy variables.[5] The estimated average WTP is

$$W\hat{T}P = -\frac{\hat{E}(\hat{\beta}^{attributelevel})}{\hat{\beta}^{price}}.$$

For the ASC, the WTP can be interpreted as the marginal value of not compensating emissions, while for the three discrete attributes the WTP can be interpreted as the marginal value of moving away from the base alternative (i.e. in a developing country for the place of compensation, re-/afforestation for the compensation scheme, no contribution from the provider) for each attribute level.

We additionally consider latent class logit models (LCLM) which, in contrast to MLM, rely on discrete parameter variation (Greene and Hensher, 2003). LCLM assume that participants are sorted into a set of Q classes and are particularly attractive in our case. Some participants are generally not willing to compensate emissions and thus exhibit a higher probability of choosing the opt-out option regardless of the attribute levels. These participants might, for example, not believe in anthropogenic climate change, believe that they are not responsible for climate change, or that climate change cannot be effectively limited by climate protection activities. In this case, heterogeneity across respondents is better reflected as discrete and should lead to preference classes with heterogeneity in the parameter for the opt-out option. Accordingly, we estimate the LCLM with two classes:

Class 1: participants with a higher or equal probability of choosing the opt-out option, i.e. $\beta^{ASC} \geq 0$ (non-offsetters), and

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5 As a robustness check, we have also estimated nested logit models with the three offsetting options in one nest and the opt-out option in another. The application of this model approach does not lead to qualitatively different estimation results compared to the estimation results from the MLM. To save space, we do not discuss the results of the nested logit model, but they are available upon request.

Class 2: participants with a lower probability of choosing the opt-out option, i.e. $\beta^{ASC} < 0$ (offsetters).

Participants in class 1 might also exhibit a higher sensitivity to the price attribute because the price in the opt-out option is always zero. One might be concerned about the price attendance (i.e. that the price attribute is disregarded) by participants especially in the bus experiments due to the quite modest absolute compensation costs ranging between 0.20 and 1 Euro for bus trips. Although this might true, there is, however, no reason to believe that these participants will pay a higher attention to the low price when facing real offsetting decisions in the field.

In the LCLM, $\beta_q = (\beta_{q1},...,\beta_{q5})'$ is the class-specific vector of parameters in class q. The probability of the observed sequence of choices across all six choice sets for participant i is:

$$P_i = \sum_{q=1}^{Q} H_{iq} P_{iq}(\beta_q)$$

where the joint conditional probability of the observed sequence of choices across all six choice sets is given by

$$P_{iq}(\beta_q) = \prod_{m=1}^{6} \frac{e^{\beta_q' x_{ijm}}}{\sum_{k=1}^{4} e^{\beta_q' x_{ikm}}}.$$

Assuming that the membership to a class q depends on a vector $z_i = (z_{i1},\ldots, z_{il})'$ of l individual characteristics with the unknown parameter vector $\theta_q = (\theta_{q1},\ldots, \theta_{ql})'$, the probability that participant i belongs to class q is

$$H_{iq} = \frac{e^{\theta_q' z_i}}{\sum_{q=1}^{Q} e^{\theta_q' z_i}}.$$

In line with Train (2008), we use the Expectation-Maximization (EM) algorithm in the maximum likelihood method for the estimation of the parameters to guarantee numerical stability and convergence of the loglikelihood function to a local maximum. Based on the results for each class, we estimate the average WTP for the ASC and each attribute level of the three discrete attributes, if the price parameter is significantly different from zero.

4 Results

Tables 5 to 10 report the estimation results in the MLM and the LCLM with two classes. As discussed above, class 1 refers to participants with a higher probability of choosing the opt-out option and thus in most cases a higher estimated sensitivity to the price attribute (as the price for the opt-out option is zero), i.e. the non-offsetters, while class 2 comprises participants with a significantly higher probability of choosing one of the offsetting options, i.e. the offsetters. Since the latter group is of higher interest for policy makers and offsetting providers, our discussion of preferences and estimated WTP focuses on the results for the offsetters.

Tables 5, 7, and 9 also contrast the maximum value of the (simulated) loglikelihood function, the Akaike information criterion (AIC), and the Bayesian information criterion (BIC) of the MLM and the LCLM. According to these measures of fit, the MLM is superior in all cases although the estimation results in the MLM and class 2 of the LCLM are very similar.[6]

4.1 Framing effects

We first discuss the effects of framing in the four experiments on the participants' decisions. Comparing the ratios of choosing the opt-out option in the four experiments in Figure 2 indicates that such framing effects appear to be relevant. While in experiments (i) and (ii) (i.e. the bus trips) the opt-out option accounts for 26.4 and 26.0 percent of the choices,[7] these shares are significantly ($p < 0.01$) higher for experiments (iii) and (iv) (i.e. trips by plane) with 35.7 and 38.1 percent of the choices, respectively.[8]

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6 Please note that we decided not to estimate the LCLM with the statistically optimal number of classes, but chose an approach with two classes driven by our hypotheses, as discussed in Section 3. The optimal number of classes for the two bus experiment is six (holiday trips: BIC = 5553 and AIC = 5606, trips to professional training: BIC = 5442 and AIC = 5495). For holiday trips by plane, five classes would be statistically optimal (BIC = 5390, AIC = 5434), and seven classes for trips to professional training by plane (BIC: 4694, AIC: 4756).

7 The difference between the means is not statistically significant ($p = 0.77$).

8 These differences are also reflected by the shares of participants in class 2 (offsetters) across the experiments, which further suggest that framing effects appear to matter (see Table 5).

Interestingly, the difference in choosing the opt-out option between holiday trips and trips to a professional training is significantly different for air travels[9] but not for bus trips. We can only speculate that the price differences for bus journeys were not large enough to result in differences between travel occasions. Furthermore, traveling with long distance busses was still relatively rare at the time of our study in Germany, especially for business trips. For participants, air travels might have been the more realistic scenario, which caused them to more strongly respond to the variation in framing for air travels than for bus journeys.

Our analyses (see Table 6) further reveal that the WTP estimates for air travels are much lower compared to the bus trips, even though the latter are more emission intensive. This finding is contrary to the result in earlier studies,[10] but in line with the so called "low-cost hypothesis" from the social science literature. Many empirical studies exploring the impact of pro-environmental preferences on the adoption of energy-efficient technologies rely on (stated) environmental attitudes. These attitudes have been found to be positively correlated with the adoption of inexpensive measures like light bulbs (Di Maria et al., 2010; Mills and Schleich, 2014), but appear less relevant for predicting more expensive investments like thermal retrofit (e.g., Whitmarsh, 2009; Ramos et al., 2016). This finding suggests a trade-off between financial and environmental concerns. In a similar way, the "low-cost hypothesis" argues that individuals prefer to satisfy their environmental conscience with low-cost measures, which may in reality have little impact on environmental quality (Diekmann and Preisendörfer, 1998, 2003; Whitmarsh, 2009).

The higher WTP estimates for offsetting emissions from bus trips are particularly reflected in the estimated WTP for the ASC for the opt-out option of about 250 Euro in the MLM (159 Euro in class2 of the LCLM) for holiday trips by bus and 335 Euro in the MLM (201 Euro in class2 of the LCLM) per tCO_2e for bus trips to professional training.[11] This WTP is significantly lower for plane trips with about 40 Euro per tCO_2e on average across all participants in the MLM as well as 58

9 The difference between the means for holiday trips by plane and flights to a professional training is statistically significant (p = 0.0548).

10 Blasch and Farsi (2014), for example, find higher WTP estimates for the emission intensive contexts.

11 A significantly negative (positive) parameter estimate of the ASC for the opt-out option reflects a utility loss (gain) from choosing the ASC which cannot be explained by the included attributes. Excluding participants, who never undertook the respective type of travels (private or business travels), hardly changes these results.

Euro (holiday trips) and about 93 Euro (trips to professional training) per tCO_2e for the class of offsetters.

The parameter estimates for the attribute levels also reveal some (rather unsystematic) differences with regard to the travel occasions. In the bus experiments, participants (in the MLM and in class 2 of the LCLM) exhibit a significantly lower willingness to offset emissions from holiday trips if the offsetting option involves the development of renewable energies (compared to the re-/afforestation projects), which we do not find for trips to professional trainings. A contribution from the provider by one third of the offsetting amount significantly increases the willingness to offset emissions from bus trips to a professional training (in the MLM and in class 2 of the LCLM). For the plane trips, the willingness to offset emissions from trips to a professional training is significantly lower if the offsetting project is carried out in a European country outside Germany or involves the development of renewable energies.

4.2 The effects of provider contributions

Our second main interest refers to the contributions from the travel provider. Contributions at a rate of 100% (1:1) significantly enhance the participants' willingness to offset emissions in all four experiments. Again this finding is driven by the offsetters in class 2. For the non-offsetters in class 1, the effects of provider contributions are always insignificant. In the MLM, WTP estimates are slightly lower compared to the LCLM with 44 and 42 Euros for holiday trips and trips to professional training by bus (53 and 56 for offsetters in the LCLM) as well as 10 and 6 Euro per tCO_2e for the corresponding trips by plane (13 and 12 in the LCLM). A contribution by one third (1/3:1) significantly increases the estimated WTP only for bus trips to a professional training by 16 Euros in the MLM or 21 Euros per tCO_2e in class 2 of the LCLM, respectively. Our results for holiday trips by bus and trips by plane are in line with the revealed preferences from German bus travelers in Kesternich et al. (2016) who find that the 1:1 matching scheme significantly increases the share of passengers that offset their carbon emissions, whereas the 1/3:1 matching scheme does not significantly influence this share.

4.3 Effects of further attributes

Our findings confirm the expected negative effects of the *price* attribute in all DCEs in the MLM and also in all classes but class 1 for holiday trips by bus in the LCLM. Participants in class 1 of the other three experiments exhibit the expected higher sensitivity to the price attribute since they are more likely to choose the opt-out option which implies a price level of zero. For bus trips, the estimated price parameters in class 2 are lower compared to the plane trips suggesting a lower attendance or smaller response to changes in the price of the offsetting option and resulting in the higher WTP estimates for offsetting emissions from bus trips as discussed above.

For the *place of compensation*, we find that compensation projects implemented in the participants' region significantly increase the willingness to offset emissions in all four experiments. It is striking that this even holds for the non-offsetters (class 2) in the LCLM in the plane experiments, but not in the bus experiments. For bus journeys, the estimated WTP is approximately 52 or 53 Euro per tCO_2e higher compared to projects carried out in developing countries (which is the base for this attribute) in the MLM and even 60 or 65 Euros for class 1 in the LCLM. The corresponding WTP estimates for plane trips range around 11 Euros per tCO_2e in the MLM and 13 as well as 17 Euros in class 2 of the LCLM. Compensations implemented in a European country outside Germany have a significantly negative impact on the probability that participants choose an offsetting option (with the exception of holiday trips by plane, as discussed above). Such offsetting projects reduce the estimated WTP by about 20 Euros for holiday trips by bus, by about 13 Euro for bus trips to a professional training, and by about 4 Euros per tCO_2e for trips to professional training by plane in both the MLM and class 2 of the LCLM.

Re-/afforestation (which is the base level in Tables 5 to 7) seems to be the most popular *compensation scheme*. In all four experiments, we find significantly negative parameter estimates for projects that increase energy efficiency. The corresponding estimated WTP reduction (compared to the base) ranges between 24 and 30 Euros for bus trips and between 7 and 11 Euro per tCO_2e for journeys by plane in the MLM. The parameter estimates for projects that develop renewable energies are also significantly negative for holiday trips by bus and professional training trips by plane with an estimated reduction in the WTP 14 and 5 Euros per tCO_2e in the MLM, respectively. For offsetters in class 2 in the LCLM, the WTP reduces by an estimated 10 and 5 Euros, respectively.

4.4 Characteristics of offsetters

In section 4.1 we find only slight and rather unsystematic differences for varying travel occasions. Therefore, we now pool the data of the two bus and the two plane trips, respectively, to receive more robust and efficient parameter estimates and at the same time facilitate the interpretation of the relevant characteristics of offsetters. In order to characterize the participants who are more likely to offset their emissions from traveling, we construct several explanatory variables which reflect the participants' preferences and beliefs (such as identifying with green and social politics, being religious, or believing that carbon offsetting is effective in protecting the climate) as well as their socio-demographic background.[12] Table 1 provides a description of these variables.[13]

Table 7 reports the results from the MLM including interactions of the ASC for the opt-out option with these explanatory variables as well as from the LCLM including characteristics that explain class membership (empty columns indicate the reference class in this analysis). On this basis, we discuss the characteristics of the offsetters who are less likely to choose the opt-out option in the MLM and are more likely to belong to class 2 in the LCLM. Parameter estimates for the offsetters are the negative values of the estimates reported in Table 7. Results for the attribute levels demonstrate that the findings from the previous sections are very stable when we pool the data for holiday trips and trips to professional trainings. Also, our WTP estimates (compare Tables 6 and 8) are, except for the ASC for the opt-out option, robust to pooling the data and including the characteristics of the participants.

In our latent class logit analysis about three quarters of our respondents are characterized as offsetters (i.e. belonging to class 2) in the bus experiments and about 61 percent in the plane experiment. These participants are significantly more likely to believe that carbon offsetting makes a high contribution to climate protection. Especially from the MLM, we also learn that offsetters are significantly less uncertain about this contribution (less likely to answer "don't know / no answer"). The offsetters are also significantly more likely to make donations for charitable purposes and identify with green or social politics. The likelihood of being an offsetter also significantly decreases with age. In the bus experiments (and only in the estimation results of the MLM), women as well as participants from the Northern and the Eastern federal states are significantly more likely to choose the opt-out option, whereas religious participants are significantly less likely to

12 We also tested further variables such as the marital status, the employment status and profession or the travel frequency of the participant, but none of the variables seemed to significantly characterize the offsetters.

13 Since excluding observations with missing values has significant effects on the estimation results, we additionally include six dummy variables which are one for missing data of high contribution of offsetting, identifying with green and social politics, at least one donation in the past 3 years, religious, and high individual income. This allows using (almost) all observations.

choose this option. In the plane experiments, offsetters are more likely to have a higher income and (only in the results of the LCLM) live in the Eastern part of Germany.

In addition to the characteristics mentioned in footnote 12, our variables that reflect the number of own children and education seem to be rather poor predictors of being characterized as an offsetter.

4.5 Restricted analysis excluding "always-offsetters"

In all analyses discussed above, our WTP estimates for the project attributes are relatively high compared to the market prices that can be observed for offsetting one tCO_2e. As a final step, we now exclude participants who, regardless of the attribute levels, never chose the opt-out option in the 12 choices they made in two experiments. This group involves about 50 percent of the participants in the bus experiments and approximately 45 percent in the plane experiments.[14] These participants show a low sensitivity to changes in the price attribute, which might drive the high WTP estimates. Never choosing to opt-out option is, however, quite unrealistic given the relatively small share of about 11 percent of our participants who compensated emissions in the past three years.[15]

Tables 9 and 10 summarize the results using this restricted sample. Regarding the characteristics of the offsetters, we still find highly significant effects of the belief that carbon offsetting makes a high contribution to climate protection, as well as identifying with green and social politics for trips by bus and plane. In addition, offsetters in the bus experiments are significantly more likely to have made at least one donation in the past three years, to be younger as well as less likely to not indicate their income in the survey and to live in the North of Germany.

The parameter estimates in Table 9 reveal some differences in the preferences of the restricted and the unrestricted sample. For the ASC for the opt-out option, we receive a significantly positive parameter estimate for air travels in the MLM reflecting the higher relative share of non-offsetters in the restricted sample. For the trips by plane, the offsetters in class 2 have a higher preference for projects in European countries outside Germany than for projects in developing countries

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14 That is 49.30% for holiday trips by bus, 53.69% for trips to professional training by bus, 45.13% for holiday trips by plane, and 45.33% for trips to professional training by plane.

15 Comparing the descriptive statistics in Table 2 suggests that the restricted sample is very similar in terms of socio-demographic and socio-economic characteristic, but particularly differs in the indicators reflecting the participants' beliefs and attitudes.

and their preferences for re-/afforestation projects do not significantly differ from those for projects that develop renewable energies. A 33% percent contribution from the provider has no significant effect on the willingness to offset emissions neither for bus trips nor for air travels.

WTP estimates in Table 10 are still very similar in the MLM and in class 2 of the LCLM, but significantly decrease compared to our estimates in Table 8. For example, a 100 percent contribution from the provider increases the estimated WTP by 17 Euros in the MLM (23 Euros in class 2 of the LCLM) for bus trips compared to 42 Euros (55 Euros in class 2 of the LCLM) for the unrestricted sample as well as 2 Euros in the MLM (3 Euros in class 2 of the LCLM) per tCO_2e for plane trips in contrast to 8 Euros (13 Euros in class 2 of the LCLM) for the unrestricted sample. Similarly, a project in the participant's region is now worth an additional 33 Euros in the MLM (42 Euros in class 2 of the LCLM) for bus trips and 8 Euros in the MLM (10 Euros in class 2 of the LCLM) Euros per tCO_2e instead of approximately 11 Euros (14 Euros in class 2 of the LCLM) for plane trips in the unrestricted sample.

5 Summary and conclusions

Climate protection activities of consumers play an important role in order to limit the dangerous impacts of anthropogenic climate change. This paper focuses on voluntary carbon offsetting and examines potential drivers and individuals' WTP for offsetting emissions that are produced by traveling. Our empirical analyses rely on data from four DCEs collected during a representative online-survey among a total of about 1000 consumers from Germany. We apply MLM and LCLM with 2 classes (i.e. offsetters and non-offsetters) for relevant determinants of offsetting projects and characteristics of consumers who are more likely to offset emissions produced by traveling. Overall, our findings from the MLM and LCLM are rather consistent.

Our study is particularly novel in two respects. First, we use different frames of the compensation context, i.e. two modes of transportation (bus vs. plane) that differ in the emission intensity and two travel occasions (holiday and professional training) that are either internally or externally motivated. Second, we use provider contributions as an attribute to describe the offsetting options. Such contributions are comparable to matching grants, which have been extensively analyzed in the literature on charitable giving, but have not been considered in DCEs so far.

Our results show only small and rather unsystematic differences with the variation in travel occasion, while the willingness to offset emissions and the WTP estimates differ significantly with our framing of the mode of transportation. This suggests that the perceived responsibility to offset varies with some external factors (see also Brekke et al., 2010). The willingness to offset emissions produced by bus journeys (74 percent of the choices) is significantly higher compared to journeys by plane (about 63 percent of the choices). In contrast to Blasch and Farsi (2014), we find a much higher estimated WTP for offsetting emissions produced by journeys by bus which are less emission intensive than air travels. This might be due to the low overall costs of offsetting for bus trips and is in line with the "low cost hypothesis".

Participants also show a significantly higher willingness to offset and WTP if their compensations are matched by the travel provider according to the 1:1 matching scheme. This finding is in line with revealed preferences in the existing literature (e.g., Karlan and List, 2007; Kesternich et al., 2016). Former studies also indicate that people are more willing to contribute to charities and public goods if others are also willing to participate ('conditional cooperation') (e.g., Fischbacher and

Gächter, 2010; Kocher et al., 2008; Khadjavi and Lange, 2013). This finding might be attributed to specific fairness preferences of the participants. If the participants perceive the travel provider as (co-)responsible for the produced emissions, the 1:1 matching rate may be interpreted as a positive signal that providers are willing to equally share the burden of offsetting. In addition, participants may be more willing to compensate their carbon emissions due to the higher effectiveness of their compensation under the 1:1 matching rate.

Moreover, our results indicate that re-/afforestation projects carried out in the participants' region are preferred to compensations implemented in European countries outside Germany or in developing countries and also to compensations that increase energy efficiency and develop renewable energies. A potential explanation for these findings might be that participants expect additional benefits from such compensation activities or that they are more tangible. Projects in the participants' region might, for example, stimulate the regional economy and lower the emissions of local pollutants. Re-/afforestation measures may have the advantage that they serve as additional recreation areas (e.g., Pittel and Rübbelke, 2008), while energy-related projects had a somewhat negative image at the time of our survey, arguably because of high energy prices in Germany and negative media coverage about the costs of the German energy transition. Additionally, they might be perceived as more transparent or trustworthy by the consumer.

Our analyses further suggest factors that characterize participants that are more likely to choose an offsetting option in order to compensate emissions from traveling. These "offsetters" are mostly younger, more often female (only for bus trips), and have a higher income (only for plane trips). Offsetters also have significantly stronger environmental and social preferences, more often believe that carbon offsetting makes a high contribution to climate protection, and are significantly less uncertain about this contribution. These findings are largely in line with the determinants of individuals' willingness to engage in VCO found in Schwirplies and Ziegler (2016). We also observe some regional heterogeneity, indicating, in particular, that consumers from the Eastern part of Germany are significantly less willing to offset emissions.

About half of our participants never chose the opt-out option regardless of the variation in the attribute levels. This is rather surprising given the size of the voluntary carbon market and the small share of 11 percent of our participants who reported to actually have paid for carbon offsets in the past three years. Since these participants are insensitive to changes in the price attribute, they might drive the high WTP estimates. Excluding this group of "always-offsetters", significantly decreases our WTP estimates to arguably more realistic values. Also, for bus trips the class of offsetters now involves 27% of the participants in the whole sample who are sensitive to changes in the attributes, which is largely in line with the findings from the field (see Kesternich et al., 2016). For plane trips, the share of offsetters is only slightly smaller (about 25%). Contrasting these results to the present share of offsetters in our sample suggests a rather large potential for VCO. Increasing the use of VCO, however, probably requires providers of polluting activities, especially of activities which produce a low amount of emissions, to inform their customers about the emissions produced by their consumption and actively offer carbon offsets within the purchase process. Still, further research in the field is needed that tests and identifies successful strategies to enhance the demand for VCO.

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7 Tables

Table 1: Description of explanatory variables

Variable	Description
High contribution of offsetting	1 if the participant chose the categories “ rather effective” or “very effective” on a five-point scale in response to the question "How effective do you consider carbon offsetting in protecting the climate?", 0 otherwise
At least one donation in past 3 years	1 if participant answered “yes” to the question “Did you make donations in the past three years that you paid for yourself?”
Identifying with green politics	1 if the participant chose the categories “ somewhat agree” or “agree” on a five-point scale indicating her agreement to the statement "I identify myself with green politics", 0 otherwise
Identifying with social politics	1 if the participant chose the categories “ somewhat agree” or “agree” on a five-point scale indicating her agreement to the statement "I identify myself with social politics", 0 otherwise
Religious	1 if participant answered “rather strongly” or “very strongly” to the question "How religious do you consider yourself?", 0 otherwise
Age	Age of the participant in years
Female	1 if participant is a woman, 0 otherwise
Number of children	Number of the participant’s own children
Highly educated	1 if the participant received a higher secondary school qualification ("Abitur") or higher, 0 otherwise
High individual income	1 if the individual monthly net income of the participant is above the median category “1500 to less than 2000 Euro”, 0 otherwise
North, East, West, South	1 if participant lives in a Northern, Eastern, Western or Southern federal state of Germany.

Table 2: Attitudes and socio-demographic profile of the participants

Characteristic and description	Percentages for whole sample (N = 1005)	Percentages for restricted sample excl. "Always-offsetter" (N = 519)
High contribution of offsetting		
rather effective, very effective	47.9	37.2
very uneffective, rather uneffective, neither nor	44.8	51.3
don't know / no answer	7.4	11.5
At least one donation in past 3 years		
yes	51.2	44.1
no	45.3	52.2
don't know / no answer	3.5	3.7
Identifying with green politics		
somewhat agree, agree	35.8	27.4
disagree, somewhat disagree, neither nor	60.5	68.8
don't know / no answer	3.7	3.8
Identifying with social politics		
somewhat agree, agree	77.1	72.1
disagree, somewhat disagree, neither nor	20.3	25.6
don't know / no answer	2.6	2.3
Religious		
very strongly, rather strongly	13.6	11.0
very weakly, rather weakly, neither nor	81.4	83.4
don't know / no answer	5.0	5.6
Age		
18-20	9.4	7.9
21-30	12.8	12.1
31-40	16.2	16.0
41-50	18.6	18.1
51-60	14.4	13.9
61-99	28.6	32.0
Female		
Women	51.5	53.4
Men	48.5	46.6
Number of children		
0	42.1	40.9
1	18.0	17.9
2	28.2	29.1
3 or more	11.7	12.1
Highly educated		
yes	50.7	47.2
no	49.2	52.8
don't know / no answer	0.1	0
Individual monthly net income		
less than 500 Euro	11.6	11.9
500 to less than 1.000 Euro	14.2	15.6
1.000 to less than 1.500 Euro	11.8	11.4
1.500 to less than 2.000 Euro	13.0	13.3

2.000 to less than 3.000 Euro	16.8	14.1
3.000 to less than 4.500 Euro	7.1	7.3
4.500 Euro or more	3.4	3.1
don't know / no answer	22.0	23.3

Table 3: Overview of DCEs

Travel occasion / Means of transportation (travel distance, carbon emissions)	Holiday	Professional training
Bus (250 km, 20 kg)	(i) Holiday trip by bus	(ii) Trip to professional training by bus
Plane (1000 km, 700 kg)	(iii) Holiday trip by plane	(iv) Trip to professional training by plane

Table 4: Attributes and attribute levels in the DCEs

Attributes	Attribute levels
Price (in Euro) per tCO_2e	10, 20, 30, 40, 50
Place of compensation	In your region, in a European country outside Germany, in a developing country
Compensation scheme	Re-/afforestation, renewable energies, energy efficiency
Contribution from the provider	None, + 33 percent (1/3:1), + 100 percent (1:1)

Table 5: Simulated ML estimates in the MLM with 1000 Halton draws and ML estimates in the LCLM with 2 classes

	Holiday trip by bus				Trip to professional training by bus				Holiday trip by plane				Trip to professional training by plane			
	MLM		LCLM		MLM		LCLM		MLM		LCLM		MLM		LCLM	
Variables	Mean	SD	Class1	Class2	Mean	SD	Class1	Class2	Mean	SD	Class1	Class2	Mean	SD	Class1	Class2
Price (in Euro) per tCO_{2e}	-0.02***		0.00	-0.01***	-0.02***		-0.07***	-0.01***	-0.06***		-0.09***	-0.04***	-0.05***		-0.14***	-0.03***
	(-7.13)		(0.02)	(0.00)	(-7.81)		(0.02)	(0.00)	(-18.89)		(0.01)	(0.00)	(-16.20)		(0.01)	(0.00)
ASC for opt-out option	-4.22***	9.69***	5.75***	-1.81***	-6.27***	12.98***	2.44***	-2.29***	-2.26***	6.84***	1.51***	-2.37***	-1.85***	6.84***	0.48	-2.46***
	(-4.43)	(9.00)	(0.78)	(0.13)	(-6.99)	(7.92)	(0.58)	(0.16)	(-5.73)	(11.81)	(0.37)	(0.15)	(-5.09)	(11.80)	(0.31)	(0.16)
Place of compensation (base: in developing country)																
In your region	0.90***	1.53***	1.18	0.67***	0.98***	1.70***	0.50	0.74***	0.58***	1.20***	1.01***	0.51***	0.55***	1.40***	1.00***	0.46***
	(8.49)	(12.24)	(0.78)	(0.05)	(8.57)	(13.45)	(0.43)	(0.05)	(6.02)	(10.88)	(0.30)	(0.06)	(5.28)	(11.37)	(0.23)	(0.06)
In European country	-0.34***	0.64***	0.87	-0.22***	-0.24***	-0.81***	-0.06	-0.15**	0.03	-0.63***	0.48	0.04	-0.17**	-0.69***	0.31	-0.13*
outside Germany	(-3.90)	(4.57)	(0.83)	(0.06)	(-2.65)	(-5.67)	(0.48)	(0.06)	(0.35)	(-4.64)	(0.32)	(0.07)	(-1.98)	(-5.16)	(0.26)	(0.07)
Compensation scheme (base: re-/afforestation)																
Renewable energies	-0.24***	0.82***	0.32	-0.11**	-0.11	0.65***	-0.09	-0.05	-0.08	-0.51***	-0.21	-0.03	-0.23***	-0.66***	-0.06	-0.14**
	(-2.87)	(7.11)	(0.51)	(0.05)	(-1.43)	(5.48)	(0.40)	(0.05)	(-1.04)	(-3.88)	(0.24)	(0.06)	(-2.89)	(-5.72)	(0.20)	(0.06)
Energy efficiency	-0.51***	0.59***	-1.28	-0.30***	-0.46***	0.75***	-0.94*	-0.24***	-0.38***	-0.29	-0.85***	-0.23***	-0.52***	0.59***	-0.61***	-0.33***
	(-6.21)	(4.30)	(0.86)	(0.06)	(-5.31)	(6.27)	(0.54)	(0.06)	(-4.80)	(-1.19)	(0.32)	(0.06)	(-6.13)	(4.19)	(0.23)	(0.06)
Contribution from provider (base: none)																
+ 33 percent (1/3 : 1)	0.06	-0.31	0.03	0.05	0.30***	0.05	-0.10	0.24***	0.10	-0.20	-0.04	0.09	0.06	-0.32	-0.16	0.06
	(0.83)	(-1.60)	(0.67)	(0.06)	(4.08)	(0.22)	(0.45)	(0.06)	(1.40)	(-0.62)	(0.29)	(0.07)	(0.72)	(-1.50)	(0.22)	(0.07)
+ 100 percent (1 : 1)	0.74***	1.49***	0.68	0.60***	0.78***	1.37***	0.24	0.64***	0.53***	1.12***	-0.05	0.55***	0.26***	-1.09***	-0.08	0.32***
	(7.02)	(12.39)	(0.59)	(0.05)	(7.53)	(11.89)	(0.41)	(0.06)	(5.65)	(10.36)	(0.28)	(0.06)	(2.78)	(-9.85)	(0.21)	(0.06)
Constant				1.20***			-1.09***					0.61***			-0.38***	
				(0.11)			(0.10)					(0.10)			(0.10)	
Loglikelihood	-2753.6		-2996.3		-2637.1		-2864.1		-2713.1		-2874.3		-2753.7		-2891.8	
AIC	5537.2		6026.6		5304.2		5762.3		5456.1		5782.5		5537.4		5817.5	
BIC	5648.2		6152.4		5415.1		5888.0		5567.1		5908.3		5648.4		5943.3	
Participants	503				501				503				503			
Class share			23.1%	76.9%			25.2%	74.8%			35.3%	64.7%			40.5%	59.5%

Notes: The dependent variable is the participants' choice. Estimated standard errors in parentheses. * (**, ***) means that the parameter estimate is different from zero at the 10% (5%, 1%) significance level.

Table 6: WTP estimates in the MLM and LCLM according to Table 5

	Holiday trip by bus		Trip to professional training by bus			Holiday trip by plane			Trip to professional training by plane		
	MLM	LCLM	MLM	LCLM		MLM	LCLM		MLM	LCLM	
Variables		Class2		Class1	Class2		Class1	Class2		Class1	Class2
ASC for opt-out option	-250.30***	-159.85***	-334.83***	35.51**	-200.78***	-40.38***	16.75***	-58.45***	-39.34***	3.52	-92.94***
	(65.40)	(22.97)	(61.23)	(15.21)	(30.29)	(6.97)	(5.95)	(4.25)	(7.65)	(2.47)	(8.86)
Place of compensation (base: in developing country)											
In your region	53.58***	59.50***	52.17***	7.27	65.20***	10.40***	11.20***	12.61***	11.65***	7.38***	17.22***
	(9.38)	(10.15)	(8.65)	(6.58)	(10.95)	(1.74)	(3.80)	(1.62)	(2.24)	(1.83)	(2.60)
In European country outside Germany	-20.09***	-19.44***	-12.79**	-0.87	-13.14**	0.53	5.32	1.00	-3.66**	2.28	-4.80*
	(5.76)	(6.31)	(5.08)	(7.11)	(5.93)	(1.50)	(3.62)	(1.65)	(1.84)	(1.88)	(2.58)
Compensation scheme (base: re-/afforestation)											
Renewable energies	-14.03***	-9.94**	-5.94	-1.27	-4.17	-1.41	-2.32	-0.78	-4.99***	-0.43	-5.37**
	(5.17)	(5.00)	(4.19)	(5.79)	(4.79)	(1.35)	(2.73)	(1.50)	(1.73)	(1.47)	(2.31)
Energy efficiency	-30.03***	-26.67***	-24.40***	-13.67*	-21.18***	-6.80***	-9.43**	-5.61***	-10.99***	-4.46**	-12.34***
	(6.18)	(6.49)	(5.38)	(7.76)	(5.94)	(1.39)	(3.90)	(1.59)	(1.80)	(1.74)	(2.54)
Contribution from provider (base: none)											
+ 33 percent (1/3 : 1)	3.72	4.86	16.15***	-1.39	20.79***	1.87	-0.39	2.15	1.17	-1.15	2.36
	(4.49)	(5.39)	(4.37)	(6.66)	(6.14)	(1.34)	(3.19)	(1.65)	(1.64)	(1.62)	(2.46)
+ 100 percent (1 : 1)	43.92***	53.36***	41.56***	3.48	55.94***	9.50***	-0.55	13.45***	5.60***	-0.57	12.20***
	(8.54)	(9.55)	(7.44)	(6.00)	(9.90)	(1.69)	(3.12)	(1.62)	(2.03)	(1.58)	(2.54)

Note: Estimated standard errors in parentheses. * (**, ***) means that the WTP is different from zero at the 10% (5%, 1%) significance level.

Table 7: Simulated ML estimates in the MLM with 1000 Halton draws including interactions of the ASC with participant characteristics and ML estimates in the LCLM with 2 classes including participant characteristics that explain class membership

	Trips by bus				Trips by plane			
	MLM		LCLM		MLM		LCLM	
Variables	Mean	SD	Class1	Class2	Mean	SD	Class1	Class2
High contribution of offsetting								
1	-5.83***		-1.23***		-3.37***		-1.26***	
	(0.72)		(0.21)		(0.59)		(0.18)	
Don't know / no answer	2.88**		0.18		2.87***		0.59*	
	(1.19)		(0.33)		(0.98)		(0.33)	
At least one donation in past 3 years								
1	-3.48***		-0.97***		-1.69**		-0.48***	
	(0.57)		(0.20)		(0.68)		(0.18)	
Don't know / no answer	-1.11		-0.42		-0.43		-0.23	
	(1.25)		(0.51)		(1.23)		(0.46)	
Identifying with green politics								
1	-3.97***		-1.11***		-2.79***		-0.84***	
	(0.59)		(0.23)		(0.60)		(0.18)	
Don't know / no answer	-1.32		0.13		-0.78		0.65	
	(1.74)		(0.61)		(0.97)		(0.52)	
Identifying with social politics								
1	-4.21***		-0.81***		-1.86***		-0.63***	
	(0.82)		(0.21)		(0.57)		(0.20)	
Don't know / no answer	-2.43		-0.63		-3.31**		-1.91**	
	(2.28)		(0.72)		(1.54)		(0.75)	
Religious								
1	-2.00***		-0.26		-1.40		-0.12	
	(0.68)		(0.33)		(1.07)		(0.27)	
Don't know / no answer	1.25		0.23		-0.64		0.25	
	(2.28)		(0.40)		(0.81)		(0.38)	
Age	0.06***		0.02***		0.05**		0.02***	
	(0.02)		(0.01)		(0.02)		(0.01)	
Female	2.03***		0.27		0.98		0.12	
	(0.66)		(0.20)		(0.67)		(0.18)	
Number of own children	0.11		0.05		0.13		0.01	
	(0.22)		(0.08)		(0.25)		(0.07)	
Highly educated	0.68		-0.01		-0.01		-0.08	
	(0.61)		(0.19)		(0.60)		(0.17)	

Table 7 (continued)

High individual income								
1	-0.28		-0.10		-1.37**		-0.45**	
	(0.67)		(0.24)		(0.67)		(0.22)	
Don't know / no answer	0.83		0.33		0.66		0.05	
	(0.73)		(0.23)		(0.70)		(0.21)	
North	2.01**		0.29		0.04		0.20	
	(0.98)		(0.28)		(0.86)		(0.25)	
East	1.55*		0.34		0.32		0.56**	
	(0.82)		(0.27)		(0.78)		(0.24)	
West	-0.00		-0.16		0.08		0.35	
	(0.80)		(0.24)		(0.61)		(0.21)	
Price (in Euro) per tCO2e	-0.02***		-0.03***	-0.01***	-0.05***		-0.10***	-0.03***
	(0.00)		(0.01)	(0.00)	(0.00)		(0.01)	(0.00)
ASC for opt-out option	-0.80	8.40***	3.28***	-2.12***	0.06	5.71***	1.08***	-2.52***
	(1.22)	(0.64)	(0.29)	(0.11)	(1.08)	(0.38)	(0.32)	(0.16)
Place of compensation (base: in developing								
In your region	0.97***	1.69***	0.84***	0.70***	0.56***	1.32***	0.98***	0.47***
	(0.09)	(0.09)	(0.30)	(0.04)	(0.07)	(0.08)	(0.18)	(0.04)
In European country outside Germany	-0.28***	-0.74***	-0.22	-0.18***	-0.06	-0.67***	0.46**	-0.05
	(0.06)	(0.09)	(0.35)	(0.04)	(0.06)	(0.10)	(0.18)	(0.05)
Compensation scheme (base: Re-/Afforestation)								
Renewable energies	-0.17***	0.79***	-0.10	-0.08**	-0.15***	0.58***	-0.05	-0.09**
	(0.06)	(0.07)	(0.26)	(0.04)	(0.06)	(0.09)	(0.14)	(0.04)
Energy efficiency	-0.48***	0.68***	-0.16	-0.28***	-0.45***	0.52***	-0.55***	-0.28***
	(0.06)	(0.08)	(0.27)	(0.04)	(0.06)	(0.10)	(0.16)	(0.05)
Contribution from travel provider (base: none)								
+ 33 percent (1/3 : 1)	0.18***	-0.29**	-0.07	0.15***	0.07	0.38***	0.03	0.07
	(0.05)	(0.13)	(0.27)	(0.04)	(0.06)	(0.11)	(0.16)	(0.05)
+ 100 percent (1 : 1)	0.76***	1.44***	0.47*	0.62***	0.39***	-1.07***	0.02	0.44***
	(0.08)	(0.08)	(0.25)	(0.04)	(0.07)	(0.08)	(0.16)	(0.04)
Constant			-0.69*				0.12	
			(0.39)				(0.34)	
Loglikelihood	-5181.83		-5774.71		-5265.76		-5680.44	
AIC	10431.66		11621.42		10599.53		11432.87	
BIC	10706.68		11912.62		10874.61		11724.14	
Observations	24,072				24,120			
Class share			24.6%	75.4%			39.3%	60.7%

Notes: The dependent variable is the participants' choice. Estimated standard errors in parentheses. * (**, ***) means that the parameter estimate is different from zero at the 10% (5%, 1%) significance level.

Table 8: WTP estimates in the MLM and LCLM according to Table 7

	Bus trips			Plane trips		
	MLM	LCLM		MLM	LCLM	
Variables		Class1	Class2		Class1	Class2
ASC for opt-out option	-44.09	111.11***	-188.06***	1.16	10.91***	-76.64***
	(66.62)	(39.26)	(20.46)	(20.88)	(4.02)	(7.26)
Place of compensation (base: in developing country)						
In your region	53.24***	28.47***	62.40***	10.93***	9.98***	14.35***
	(6.50)	(10.94)	(7.60)	(1.47)	(2.26)	(1.51)
In European country outside Germany	-15.59***	-7.52	-15.88***	-1.19	4.64**	-1.66
	(3.78)	(12.67)	(4.35)	(1.19)	(1.94)	(1.46)
Compensation scheme (base: Rere-/Afforestationafforesta-tion)						
Renewable energies	-9.58***	-3.39	-7.10**	-2.84***	-0.53	-2.76**
	(3.35)	(8.89)	(3.48)	(1.08)	(1.39)	(1.32)
Energy efficiency	-26.32***	-5.47	-25.20***	-8.76***	-5.56***	-8.48***
	(3.99)	(9.49)	(4.54)	(1.13)	(1.74)	(1.43)
Contribution from provider (base: none)						
+ 33 percent (1/3 : 1)	10.02***	-2.53	13.23***	1.30	0.28	1.98
	(3.07)	(9.37)	(4.07)	(1.07)	(1.57)	(1.43)
+ 100 percent (1 : 1)	41.59***	15.76*	55.06***	7.55***	0.24	13.27***
	(5.57)	(9.25)	(7.03)	(1.35)	(1.62)	(1.51)

Note: Estimated standard errors in parentheses. * (**, ***) means that the WTP is different from zero at the 10% (5%, 1%) significance level.

Table 9: Simulated ML estimates with restricted sample excluding “always-offsetters” in the MLM with 1000 Halton draws including interactions of the ASC with participant characteristics and in the LCLM with 2 classes including participant characteristics that explain class membership

	Trips by bus				Trips by plane			
	MLM		LCLM		MLM		LCLM	
Variables	Mean	SD	Class1	Class2	Mean	SD	Class1	Class2
High contribution of offsetting								
1	-2.47***		-1.06***		-1.66***		-1.05***	
	(0.62)		(0.26)		(0.34)		(0.24)	
Don't know / no answer	-0.42		-0.43		0.50		0.08	
	(1.04)		(0.37)		(0.58)		(0.37)	
At least one donation in past 3 years								
1	-2.20***		-0.97***		-0.52		-0.22	
	(0.57)		(0.25)		(0.33)		(0.23)	
Don't know / no answer	-1.49		-1.01		-0.72		-0.39	
	(1.74)		(0.67)		(0.78)		(0.57)	
Identifying with green politics								
1	-2.04***		-1.03***		-1.27***		-0.97***	
	(0.57)		(0.28)		(0.34)		(0.25)	
Don't know / no answer	-2.35		0.13		-0.17		0.02	
	(2.46)		(0.79)		(1.06)		(0.70)	
Identifying with social politics								
1	-1.44**		-0.63**		-0.85**		-0.52**	
	(0.63)		(0.26)		(0.38)		(0.26)	
Don't know / no answer	2.15		0.14		-0.68		-0.52	
	(2.98)		(1.00)		(1.56)		(0.94)	
Religious								
1	-0.55		-0.37		-0.64		-0.43	
	(0.83)		(0.40)		(0.50)		(0.38)	
Don't know / no answer	1.44		0.57		-0.68		-0.40	
	(1.33)		(0.49)		(0.67)		(0.48)	
Age	0.04**		0.02***		0.02		0.01*	
	(0.02)		(0.01)		(0.01)		(0.01)	
Female	0.50		0.29		-0.03		0.11	
	(0.59)		(0.24)		(0.33)		(0.23)	
Number of children	0.35		0.01		0.10		-0.02	
	(0.23)		(0.09)		(0.14)		(0.09)	
Highly educated	0.24		0.12		-0.37		-0.16	
	(0.61)		(0.24)		(0.33)		(0.23)	

Table 9 (continued)

High individual income								
1	0.07		0.09		-0.58		-0.32	
	(0.74)		(0.31)		(0.41)		(0.29)	
Don't know / no answer	1.50**		0.54*		0.30		0.26	
	(0.74)		(0.29)		(0.40)		(0.28)	
North	2.17**		0.46		0.79		0.51	
	(0.85)		(0.35)		(0.50)		(0.33)	
East	1.25		0.13		0.31		0.17	
	(0.79)		(0.33)		(0.45)		(0.32)	
West	1.10		0.05		0.37		0.22	
	(0.77)		(0.30)		(0.39)		(0.27)	
Price (in Euro) per tCO2e	-0.03***		-0.03**	-0.02***	-0.08***		-0.10***	-0.07***
	(0.00)		(0.02)	(0.00)	(0.00)		(0.03)	(0.00)
ASC for opt-out option	0.75	5.26***	3.83***	-0.80***	2.45***	2.70***	2.23***	-0.89***
	(1.09)	(0.45)	(0.50)	(0.13)	(0.66)	(0.18)	(0.51)	(0.13)
Place of compensation (base: in developing country)								
In your region	0.94***	1.59***	0.47	0.89***	0.62***	1.05***	0.78	0.71***
	(0.13)	(0.15)	(0.55)	(0.07)	(0.12)	(0.12)	(0.81)	(0.09)
In European country outside Germany	-0.24**	0.44**	-0.04	-0.16*	0.15	-0.22	-1.18	0.20**
	(0.10)	(0.23)	(0.68)	(0.09)	(0.10)	(0.34)	(1.17)	(0.09)
Compensation scheme (base: re-/afforestation)								
Renewable energies	-0.26***	0.49***	-0.49	-0.15**	0.02	0.32*	-0.40	0.06
	(0.09)	(0.16)	(0.42)	(0.07)	(0.09)	(0.18)	(0.50)	(0.08)
Energy efficiency	-0.59***	0.78***	-0.93*	-0.33***	-0.40***	0.36*	-1.21	-0.27***
	(0.11)	(0.14)	(0.50)	(0.07)	(0.10)	(0.21)	(0.84)	(0.09)
Contribution from provider (base: none)								
+ 33 percent (1/3 : 1)	0.12	-0.15	0.09	0.11	0.03	0.03	-0.57	0.07
	(0.09)	(0.32)	(0.70)	(0.08)	(0.09)	(0.29)	(0.60)	(0.09)
+ 100 percent (1 : 1)	0.49***	1.14***	0.84	0.50***	0.18*	0.37*	-0.10	0.21**
	(0.12)	(0.13)	(0.62)	(0.07)	(0.10)	(0.19)	(0.54)	(0.09)
Constant			-0.09				0.66	
			(0.46)				(0.42)	
Loglikelihood	-2198.6		-2339.2		-2241.8		-2259.0	
AIC	4465.2		4750.5		4551.7		4589.9	
BIC	4715.7		5015.7		4806.3		4589.9	
Participants	487				551			
Class share			45.5	54.5			53.1	46.9

Notes: The dependent variable is the participants' choice. Estimated standard errors in parentheses. * (**, ***) means that the parameter estimate is different from zero at the 10% (5%, 1%) significance level.

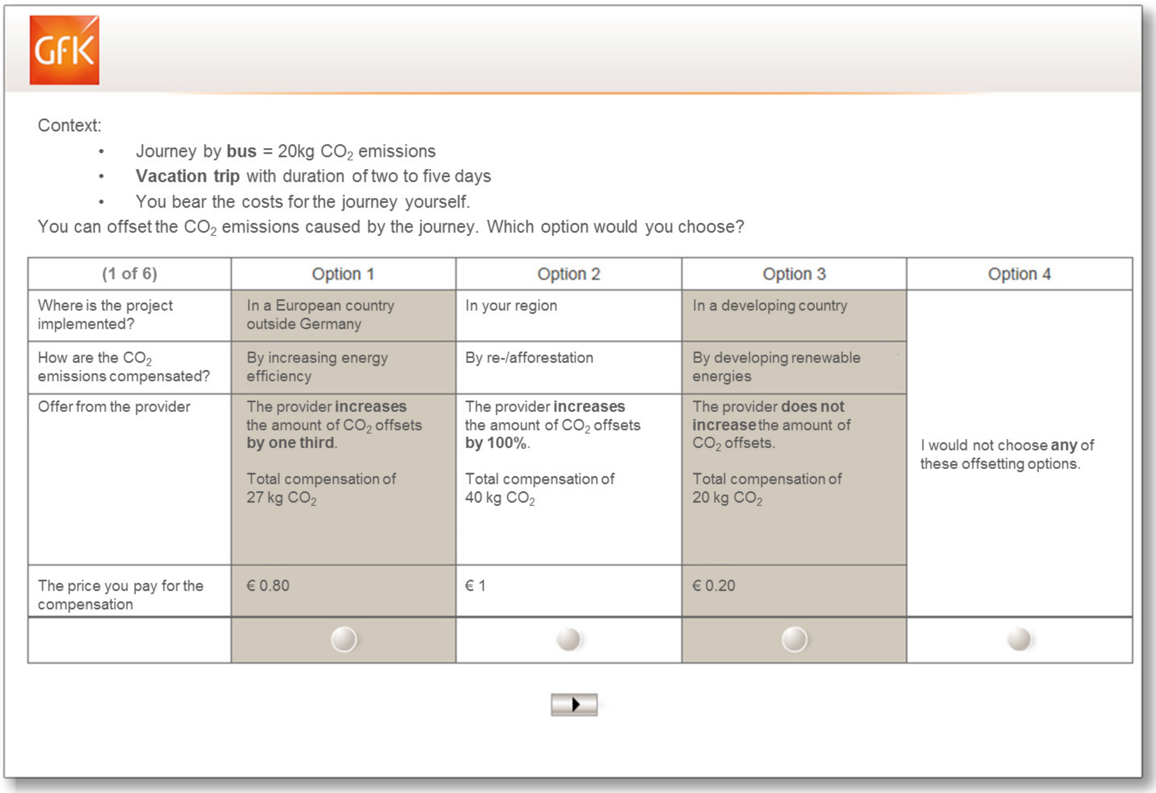
Table 10: WTP estimates in the MLM and LCLM excluding "always-offsetters" according to Table 9

	Bus trips			Plane trips		
	MLM	LCLM		MLM	LCLM	
Variables		Class1	Class2		Class1	Class2
ASC for opt-out option	25.79	118.07*	-37.19***	31.29***	23.03**	-13.00***
	(38.06)	(66.59)	(5.53)	(8.71)	(11.22)	(1.76)
Place of compensation (base: in developing country)						
In your region	32.58***	14.63	41.52***	7.94***	8.07	10.44***
	(5.42)	(17.06)	(5.35)	(1.54)	(7.54)	(1.35)
In European country outside Germany	-8.33**	-1.19	-7.70*	1.94	-12.20	2.91**
	(3.58)	(21.00)	(4.10)	(1.29)	(14.11)	(1.44)
Compensation scheme (base: Rere-/Afforesta-tionafforestation)						
Renewable energies	-8.90***	-15.12	-6.87**	0.23	-4.18	0.89
	(3.23)	(14.44)	(3.39)	(1.20)	(5.47)	(1.23)
Energy efficiency	-20.52***	-28.75	-15.26***	-5.12***	-12.53	-3.98***
	(4.14)	(21.04)	(3.79)	(1.32)	(9.34)	(1.40)
Contribution from provider (base: none)						
+ 33 percent (1/3 : 1)	4.22	2.79	5.25	0.43	-5.89	1.05
	(3.15)	(21.29)	(3.69)	(1.17)	(6.31)	(1.31)
+ 100 percent (1 : 1)	16.93***	25.94	23.29***	2.31*	-1.03	3.02**
	(4.29)	(19.64)	(4.17)	(1.25)	(5.54)	(1.30)

Note: Estimated standard errors in parentheses. * (**, ***) means that the WTP is different from zero at the 10% (5%, 1%) significance level.

8 Figures

Figure 1: Translated screenshot of one original DCE



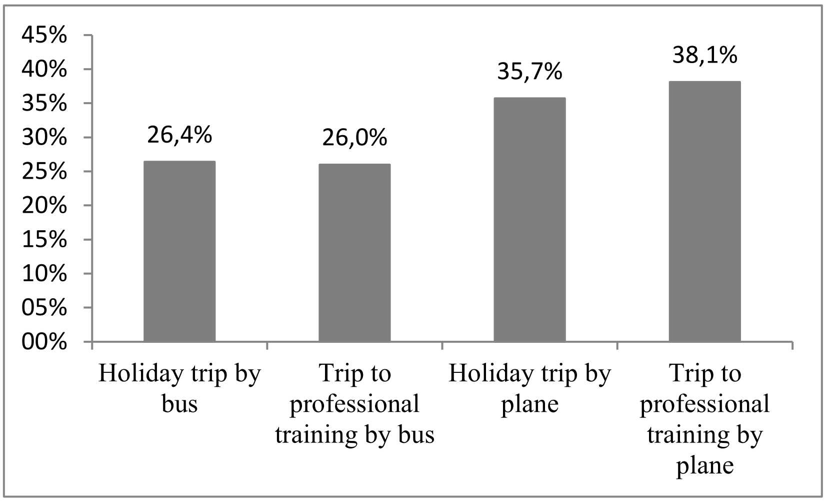
Context:

- Journey by **bus** = 20kg CO_2 emissions
- **Vacation trip** with duration of two to five days
- You bear the costs for the journey yourself.

You can offset the CO_2 emissions caused by the journey. Which option would you choose?

(1 of 6)	Option 1	Option 2	Option 3	Option 4
Where is the project implemented?	In a European country outside Germany	In your region	In a developing country	I would not choose **any** of these offsetting options.
How are the CO_2 emissions compensated?	By increasing energy efficiency	By re-/afforestation	By developing renewable energies	
Offer from the provider	The provider **increases** the amount of CO_2 offsets **by one third**. Total compensation of 27 kg CO_2	The provider **increases** the amount of CO_2 offsets **by 100%**. Total compensation of 40 kg CO_2	The provider **does not increase** the amount of CO_2 offsets. Total compensation of 20 kg CO_2	
The price you pay for the compensation	€ 0.80	€ 1	€ 0.20	

Figure 2: Ratios of choosing the opt-out option in the four DCEs



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