Consumers' Valuation of Voluntary Carbon Offsets - A Choice Experiment in Switzerland

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Abstract

Voluntary carbon offsetting allows individual consumers to neutralise their emissions from various consumption activities, and thus to make an individual contribution to the global public good climate change mitigation. Conducting a choice experiment among more than a thousand Swiss consumers, we analyse the individual preferences for voluntary carbon offsets in different offsetting contexts. The analysis is used to identify the consumers' underlying motives for offsetting emissions, the context effects on their willingness to pay and the influence of the offset project attributes on consumers' propensity to offset. Furthermore, the characteristics of potential buyers as well as the relationship between offsetting and other voluntary mitigation activities are explored. To support our results, we assess whether the hypothetical preferences are consistent with revealed behaviour. The adopted latent class model accounts for heterogeneity of preferences with respect to offset products offered in the market. The results provide a quantitative assessment of consumers' marginal valuation of carbon offsets and a better understanding of their preferences. The observed heterogeneity among individuals favours targeted policy measures to induce voluntary contribution.

Key words: voluntary carbon offsets, willingness to pay, choice experiment, latent class model
JEL-Classification: D12, Q50, D64, H41

1 Introduction

With government climate policies deemed unsatisfactory in most parts of the world (Gupta et al. 2007; Burck et al. 2012), global climate change has become a pressing concern. Facing the stagnation of political processes, many companies and individuals get active and contribute to climate change mitigation either by committing themselves into voluntary measures for greenhouse gas abatement or by purchasing voluntary carbon offsets.

The idea of voluntary carbon offsetting was first applied in 1989 when the US electricity company AES paid Guatemalan farmers to plant 50 million trees to compensate for its carbon emissions (House of Commons 2007; Bellassen and Leguet 2007). Within two decades, neutralising carbon emissions has emerged as a retail service in a fairly sizeable market, open to firms as well as individuals. By purchasing voluntary carbon offsets (VCOs), one pays for a reduction of global carbon emissions by an amount equivalent to the emissions caused by own activities, hence rendering own consumption or production activities "climate neutral".

Globally, household consumption accounts for about 72% of greenhouse gas emissions. Housing, mobility and food are identified as the most emission-intensive of all consumption categories (Hertwich and Peters 2009). Voluntary carbon offsetting allows individuals to neutralise part of these emissions. Today's voluntary carbon markets provide opportunities to offset CO_2 emissions from a wide range of goods and activities such as traveling, daily energy use, social events and consumer goods. Still, the voluntary carbon market accounts for less than 0.1% of the market volume traded in the global carbon markets (including compliance carbon markets) and more than 90% of the volume traded in the voluntary carbon market is purchased by private companies (Peters-Stanley and Hamilton 2012). Although the demand for voluntary carbon offsets is currently dominated by private companies, individual consumers' demand has grown considerably in recent years, in particular in many European countries. Worldwide, individual offset purchases more than doubled between 2010 and 2011. In addition, idividual consumers' demand is also one of the drivers of private companies' offset activities, as the latter often follow the tastes of their clients at large, that is individual consumers (Peters-Stanley and Hamilton 2012). Overall, the interest in voluntary carbon offsetting seems to be stable, despite the recent financial and debt crises (Peters-Stanley and Hamilton 2012).

Given the limited market participation of individual buyers, choice experiments are helpful to assess the consumers' willingness to pay (WTP) for carbon offsets, and thus to identify the potential demand. In this paper, drawing on a choice experiment with a sample of more than a thousand Swiss consumers, we analyse the demand for VCOs in four different consumption contexts and with varying offset project characteristics. The adopted latent class model accounts for heterogeneity among consumers. The results are used to estimate the WTP for VCOs of different types of consumers and to identify the impact of different offset project attributes on VCO demand. Furthermore, we characterise potential offsetters and non-offsetters and draw conclusions about the implications of carbon offsetting for other voluntary mitigation behaviour.

Previous studies on voluntary carbon offsetting (Brouwer et al. 2008; MacKerron et al. 2009; Löschel et al. 2010; Diederich and Goeschl 2011; Lu and Shon 2012; Lange and Ziegler 2012) generally focused on a single specific context such as air travel, used indirect methods to deduce the consumer's WTP for offsetting or are based on non-representative samples.

In most studies, the implicit assumption is that the WTP for mitigating $1tCO_2$[1] is invariant to the context of the neutralised emissions and to the type of mitigation projects. However, insights from Conte and Kotchen (2010) suggest that from the consumer's standpoint VCOs are differentiated products. This is reflected in market prices for offsetting which ranged in 2011 from less than 1 USD/tCO_2 to more than 100 USD/tCO_2, with an average around 6 USD/tCO_2 (Peters-Stanley and Hamilton 2012).[2] This indicates that tastes and preferences with respect to carbon offsets might vary considerably among individuals. A major part of these differences could be related to unobserved heterogeneity among consumers in terms of differences in values, perceptions or past experiences.

Overall, the empirical findings documented in the literature point to a considerable potential demand for VCOs that might well exceed the one observed within existing VCO markets. In fact, virtually all WTP estimates are well above the minimum prices available in the VCO markets. The availability of VCOs at reasonably low prices contrasting with a relatively low observable demand from individual consumers suggests that the demand potentials are not realised. It is therefore interesting to explore the factors that drive individual VCO demand. Our analysis aims at revealing consumers' potential demand for carbon offsetting in a discrete choice setting. We focus on three particular aspects of voluntary carbon offsetting: (1) Consumers' underlying motivations, (2) the influences of offset context and offset project characteristics on willingness to offset (3) as well as the relationship between voluntary offsetting and other voluntary mitigation behaviour. Understanding consumers' motives for buying VCOs, the influence of offsetting context and offset project characteristics on the willingness to offset, as well as the implications of offsetting for other voluntary mitigation behaviour is a necessary prerequisite for drawing the correct policy conclusions. It remains to be shown to what extent voluntary carbon offsetting can be used as an instrument for climate change mitigation at the individual level and what role it can play in the landscape of mandatory government regulation.

The analysis of the data indicates a great deal of heterogeneity in preferences among individuals. We find that while about half of the respondents are willing to contribute to voluntary offsetting at least occasionally, only about a quarter show a high marginal WTP. Demand for voluntary carbon offsetting is highly context-dependent and strongly varies with the types of offered mitigation projects. Expressing the individual preferences in a single WTP measure would hence be misleading. Rather, the WTP for voluntary offsets greatly depends on the individual and the context. For a majority of respondents whose WTP is assessed as non-zero, the estimated marginal WTP varies from 1 to 21 CHF (currently equivalent to 1 to 23 USD) per ton of CO_2. Potential offsetters can be characterised as individuals with a relatively high income who feel morally obliged to participate in climate change mitigation and who perceive offsetting as the social norm. They tend to have a low CO_2 footprint, suggesting that carbon offsetting is complementary to other voluntary mitigation behaviour.

In summary, a considerable fraction of respondents are willing to offset at least part of their carbon emissions. This result indicates that the potential for individual voluntary carbon offsetting has not been fully exploited in Switzerland. Targeted government measures for promoting voluntary mitigation could probably activate the unexploited potentials and raise awareness for the negative impact of certain consumption activities on the climate.

[1] With unit t we designate *metric* tons throughout this paper.

[2] Price differences are largely driven by information about the project type and host country as well as the type of third-party certification by different project standards (Conte and Kotchen 2010).

The rest of the paper is organised as follows: Section 2 provides the theoretical background and the previous research. The data and the adopted methodology are presented in section 3. Section 4 provides the results and section 5 concludes the paper.

2 Previous research and theoretical underpinnings

2.1 Insights from previous research

In the context of air travel, Brouwer et al. (2008) use the contingent valuation method to assess the WTP for a mandatory carbon tax among flight passengers at Amsterdam's international airport. They report an average WTP of 25 EUR per tCO_2. In an online survey, MacKerron et al. (2009) elicit the WTP of young adults in the UK for offsetting emissions from air travel. They report an average WTP of 24 GBP per flight and a significant effect of offset project characteristics on WTP. Lu and Shon (2012) also use the contingent valuation method to assess airline passengers' WTP at Tayuan International Airport and find a mean WTP of 5 to 29 USD per trip, depending on the provenance of the passenger.

In the context of vehicle usage, Ziegler et al. (2012) and Lange and Ziegler (2012) use a survey among German and US consumers to assess consumer WTP for neutralising emissions from vehicle use. Lange and Ziegler (2012) consider the relationship between voluntary offsetting and alternative mitigation activities. They examine whether offsetting and alternative mitigation measures are influenced by the same factors, such as feelings of responsibility and income.

Other studies analyse revealed preferences in experimental settings, which are not embedded in a specific context. For instance, in an online survey in Germany, Diederich and Goeschl (2011) offered the respondents a guaranteed reduction of $1tCO_2$ or a guaranteed cash award, randomly drawn from 2 to 100 EUR. Similarly, Löschel et al. (2010) conducted a field-experiment in Mannheim, Germany. They provided subjects with 40 EUR and let them choose to purchase a VCO at different prices. Diederich and Goeschl (2011) estimate a mean WTP of 6.30 EUR per ton CO_2 whereas Löschel et al. (2010) report an average WTP of 12 EUR per tCO_2.[3]

2.2 Motivations for voluntary carbon offsetting

Knowing about consumers' motivations for offsetting allows drawing conclusions on how individuals can be induced to make a contribution in climate change mitigation and on whether voluntary carbon markets have the potential to effectively complement stringent mandatory regulation. From a theoretical point of view, carbon offsetting can be regarded as adding a public good component to a private good, thus providing an impure public good (Cornes and Sandler 1986; Kotchen 2006, 2009a). Alternatively, carbon offsetting can be interpreted as an altruistic donation or a form of "morally motivated consumer self-regulation" by means of a voluntary Pigouvian tax (Baron 2010). Like all voluntary contributions to public goods, voluntary offsetting is subject to the free-rider problem and cannot easily be reconciled with economic theories based on rational self-interested agents.

[3] At the current exchange rate, the estimated WTP is around 8 and 16 USD, respectively. In both studies, the offered emission reduction was a European Union emissions allowance (EUA).

It is therefore interesting to analyse consumers' motivations for carbon offsetting and to explain how this voluntary act can be brought in line with economic theory.

While the pure public goods model departs from the assumption that individuals derive utility from the aggregate provision of the public good irrespective of what person or entity provides it (Cornes and Sandler 1986), there is more and more support for the assumption that individuals are impure altruists who derive additional utility from their own contributions (Andreoni 1989, 1990). This "warm glow of giving" is additional to the utility gains associated with the individual consumption of the public good ultimately provided. Furthermore, recent work in behavioural economics as well as sociological and psychological research provides more explanations for voluntary contributions to public goods. Three of them will be in the focus of our analysis:

(1) *Social norms* and the need for social approval were found to be an important motive. The underlying theory assumes that individuals conform to the "rules of behaviour" of their "reference group" (e.g. friends, family) in order to obtain social approval (Holländer 1990; Nyborg and Rege 2003).

(2) Also preferences for fairness were identified to increase individual cooperation in public good situations. So called *conditional cooperators* were observed to contribute to the provision of public goods whenever they expect that the other individuals will contribute their "fair share" (Fehr and Schmidt 1999; Fehr and Gächter 2000).

(3) Finally, *internalised norms* and the desire for a positive self-image may guide people's behaviour towards the private provision of public goods (Brekke et al. 2003; Bruvoll et al. 2002; Stern et al. 1995). Internalised norms are usually enforced by feelings of guilt and a bad conscience (Nyborg et al. 2006; Frey and Stutzer 2006). The activation of internalised norms has been studied by social psychologists (e.g. Schwartz (1977), Schwartz and Howard (1981)) who find that the activation of internalised norms is subject to an individual's *ascription of personal responsibility* for the consequences of certain behaviours.

Whereas government provision of the public good will completely crowd out private contributions in the pure public goods model (Bergstrom et al. 1986; Andreoni 1988), a complete crowding out of voluntary markets is rather unlikely if consumers are impure altruists or are driven by social norms, "feelings of guilt" and expect others to cooperate.

2.3 Contextual influences on willingness to offset

As every ton of CO_2 emitted into the atmosphere has the same effect on the global climate, irrespective where and by whom it was emitted, the WTP for carbon offsetting should be independent of the offsetting context and the characteristics of the offset project. However, previous studies such as Conte and Kotchen (2010) and Lütters and Strasdas (2010) provide indicative evidence that the marginal WTP per tCO_2 strongly varies with the underlying consumption activities and the characteristics of the respective offset project. This implies that the WTP measures estimated in previous studies such as Brouwer et al. (2008), MacKerron et al. (2009) or Lu and Shon (2012) are restricted to their respective contexts and cannot be generalised. In the same vein, this would suggest that consumers might need context-specific support for engaging in climate change mitigation activities.

As to the drivers of context effects, we expect a substantial influence of the environmental impact of the underlying consumption activity. As the price for a voluntary carbon offset is directly related to the CO_2 emissions from the respective underlying activity, the price for

carbon offsetting increases with the environmental impact of the activity (at a given price per ton CO_2). As a result, the propensity to offset emissions might be lower for emissions-intensive activities such as heating or air travel. Such observations would be consistent with the so-called "low-cost hypothesis" (Diekmann and Preisendörfer 1998) which postulates that environmentally conscious consumers are more likely to act environment-friendly if the costs of such action are low. On the contrary, it is possible that consumers' propensity to offset is especially strong for highly polluting consumption activities. Such observations could be explained by stronger feelings of responsibility or "green guilt" (Kotchen and Moore 2008; Kotchen 2009b) on behalf of the consumers in case of emissions-intensive activities. A priori, it's unclear how context and WTP are interrelated.

Furthermore, from MacKerron et al. (2009) and Conte and Kotchen (2010) we learn that willingness to offset and WTP might vary with buyers' preferences for the characteristics of carbon offsets such as the type of mitigation project, the location of the provider, the project host country and the type of third-party certification of the offset project. These differences can be explained by associated co-benefits of certain types of projects (e.g. enhanced biodiversity in case of afforestation projects).

2.4 Offsetting and other voluntary mitigation behaviour

It also remains unclear how carbon offsetting interacts with other climate-friendly consumer behaviour such as using public transport instead of the private car or taking the train instead of a short-haul flight. It has often been argued that offsetting might be considered as a substitute to other climate-friendly behaviour which makes consumers care even less for their emissions (Kotchen and Moore 2008; Kotchen 2009a,b; The Economist 2007). In fact, the concept of voluntary carbon offsetting will only be effective for climate change mitigation if individuals' payments are "additional" or complementary to other climate-friendly behaviour and do not just substitute other mitigation activities. If people instead increase their level or carbon intensity of consumption because their feelings of "green guilt" have been reduced by the payment, the environmental effect of offsetting could be even negative. It is therefore important to gain insights into the relationship between offsetting and other voluntary mitigation activities.

The majority of previous research focuses on offsets for specific consumption activities and uses very specific samples. To our knowledge, there is hardly any study on the WTP for voluntary carbon offsetting that systematically explores motivations and the influence of offsetting contexts in a discrete choice framework based on a broad sample of consumers. Our paper aims at filling this gap.

Throughout the analysis, we abstract from the fact that part of the unrealised demand might be due to transaction costs. Voluntary offsets are relatively new and complex products with high information and search costs. In empirical studies, consumers' knowledge of voluntary carbon offsetting is reported to be low or inexistent (Lütters and Strasdas 2010; Gössling et al. 2009). Furthermore, accessibility is low as the offsetting opportunities at the points of sale are still rare. This requires many interested customers to invest additional time to search a suitable provider (Peters-Stanley and Hamilton 2012).

Finally, there is a lack of trust in voluntary offsets as it is hard to trace the actual emission reductions without signals from third-party certification. It can be assumed that these factors suppress part of the potential demand. Yet, with the exception of the influence of third-party certification, these factors are not in the focus of our analysis.

3 Data and methods

3.1 Sample

The empirical analysis is based on data from an online survey conducted in the German speaking part of Switzerland in September 2011. The sampling was carried out by a marketing research firm (*Intervista*) that has a permanent and representative panel of 30,000 members throughout Switzerland. The survey questionnaire was sent to 2,553 individuals aged 14 or older with a neutral invitation to participate, not indicating the topic of the survey. 1,010 panelists completed the questionnaire with valid answers, which corresponds to a response rate of 40%. Each respondent that completed the questionnaire received a credit coupon of 6 CHF (currently corresponding to about 6.50 USD or 5 EUR) that can be exchanged for a variety of goods.

Among the respondents who completed the survey, 63% stated that they have heard about the opportunity to offset individual carbon emissions before the survey (see table 1). This is a high share when compared to studies from Germany and Sweden where knowledge of offsetting is reported to be 33% and 24% of survey participants, respectively (Lütters and Strasdas 2010; Gössling et al. 2009). 22% of the respondents claimed to have offset their own emissions at least once before participating in the survey. Again, this is a relatively high share of consumers, compared to studies in Germany and Australia where around or less than 10% of consumers state to have purchased voluntary carbon offsets (Lütters and Strasdas 2010; Mair 2011).

In the choice experiment, each respondent was offered 8 choice cards. Each choice card comprised three offset options with different attributes followed by a fourth option that allowed not to choose any offset option but to remain in the status quo. 156 respondents, that is 15% of the sample, have systematically chosen the no-offset option across all their choice tasks. These respondents can be considered as a class of respondents whose willingness to offset is quite limited, leading to a subsample of 854 respondents who chose to offset emissions at least once in the choice experiment.

Moreover, among the 1,010 respondents who completed the survey, 139 have reported missing values for the questions on attitudes and behaviours that are used in our complementary analyses. Therefore, the final regression samples are different from each other. The two samples used for the analysis of the choice experiment (latent class analysis) include 1010 and 854 respondents, respectively, whereas the sample used in the rest of the analysis (probit models) consists of 871 respondents (see table 1). All samples are roughly representative for the German speaking part of Switzerland, with respect to age, gender and income. In fact, the characteristics of these samples do not differ significantly from each other and closely resemble the characteristics of the Swiss population.[4]

[4]One exception is the share of respondents with an academic degree: according to the Swiss Statistics Office (BFS) only around 25% of the Swiss population received tertiary education (including degrees from universities, universities of applied sciences and advanced technical or pedagogical colleges (e.g."College of Professional Education and Training" or "School of Engineering").

Table 1: Sampling distribution of the respondents.

	Percentage of the sample			
Sample	**Full sample N=1010**	**Subsamples N=854**	**N=871**	**Swiss population***
Female	43.5	47.0	42.7	50.7
14 to 18	0.3	0.2	0.2	5.6
19 to 25	11.3	12.5	11.6	8.6
26 to 35	19.4	20.0	19.1	13.5
36 to 45	19.9	20.6	19.4	15.5
46 to 55	14.1	15.0	13.9	15.1
56 to 65	14.4	13.5	14.2	11.8
older than 65	20.7	18.2	21.6	15.8
Married/Registered partnership	49.7	47.7	49.9	43.9
With children	51.8	49.3	52.5	54.1
With academic degree	35.5	35.7	36.6	24.7
Heard about offsetting	62.8	64.2	62.7	-
Offered to offset before	31.7	33.1	31.5	-
Offset emissions in the past	22.7	26.1	22.3	-
Always 'no offset' in experiment	15.5	0.0	15.0	-
Gross household income; Swiss average: 9369 CHF				
less than 3000 CHF	4.65	4.8	4.4	-
3001 to 4500 CHF	9.90	9.3	9.3	-
4501 to 6000 CHF	20.10	20.5	20.6	-
6001 to 9000 CHF	28.61	28.3	29.9	-
9001 to 12000 CHF	19.21	19.4	19.1	-
12001 to 15000 CHF	9.90	10.4	10.0	-
more than 15000 CHF	7.23	7.3	6.9	-
not indicated	0.40	0.0	0.0	-
Donation at beginning of survey				
$<$ 3 CHF	46.6	43.6	47.3	-
$\geq$ 3 CHF	53.4	56.4	52.7	-
General willingness to offset part of own CO_2emissions				
Definitely no	8.0	0.9	8.3	-
Rather no	11.6	6.6	11.3	-
Maybe	25.5	28.1	25.8	-
Rather yes	41.5	48.8	41.1	-
Definitely yes	13.4	15.6	13.6	-

*Data extracted from Swiss Statistics Office (BFS): age (data from 2010); gender, marital status (data from 2011); persons with children (data from 2009); persons with academic degree (including degrees from university/university of applied sciences/technical college; data from 2011 on 25 to 64 year old residents); gross household income (data from 2009)

3.2 Survey design

The survey questionnaire has been developed based on Dillman et al. (2009) as well as on insights from several focus groups and "think aloud protocols". It was tested with a pre-test sample during 2011. The questionnaire started with a decision task in which respondents could donate part of their participation remuneration to a mitigation project in Switzerland. This revealed preferences decision task was followed by questions on respondents' consumption habits (e.g. frequency of air travels, yearly number of hotel overnight stays, yearly mileage with personal car, frequency of weekly meat consumption) and on their prior knowledge and experience with respect to carbon offsetting. In order to enable all participants to take an informed decision in the choice experiment, we shortly introduced the concept of voluntary carbon offsetting.

The core of the survey was the discrete choice experiment. Respondents were confronted with eight different consumption situations in which they had to choose whether to buy an offset or not. In each situation, we offered three different types of offsetting opportunities differing in project type, project country, type of provider, type of certification and price. We presented the choice situations in four different consumption contexts, namely air travel, space heating, hotel overnight stays and rental car use.

In order to account for the experiment's hypothetical setting we reminded people of their budget constraint in a short *cheap talk script* (Cummings and Taylor 1999) before the choice tasks. Furthermore, after each choice we asked the respondents how certain they were about their choice considering that similar options were offered to them in real purchase situations. We opted for a 6-point-Likert scale ranging from "absolutely unsure" (1) to "absolutely sure" (6). Levels 1 to 3 correspond to "unsure" decisions whereas levels 4 and above represent "sure" states. Asking a follow-up question on choice certainty is one of the methods used in stated preferences surveys to capture respondent uncertainty. This information can be used for either recoding or weighting the answers in the choice situations in order to reduce the hypothetical bias inherent to answers in stated choice experiments (Ready et al. 1995; Champ et al. 1997; Akter et al. 2008; Martínez-Espiñeira and Lyssenko 2012).

The adopted attributes in the choice experiment are shown in table 2. The description of the four offsetting contexts differed in terms of related CO_2 emissions as well as in terms of the price of the underlying consumption activity. With respect to the offsetting options, we differentiated between four types of mitigation projects (afforestation, renewable energy, energy efficiency and methane reduction), two different types of project host countries (either developing countries or newly industrialising countries), either for profit- or non-profit providers, certified and uncertified projects[5] and six different offset prices per tCO_2. Prices varied between 5 CHF per tCO_2 and 35 CHF per tCO_2 (currently corresponding to 5.25 USD resp. 36.80 USD per tCO_2), thus roughly representing actual market prices for voluntary carbon offsets in Switzerland.

[5] Our pre-tests revealed that the existing certification schemes such as the Verified Carbon Standard or the CDM Gold Standard are unknown to many people. Therefore, we decided to inform respondents about the type of certification body (see table 2). While UN and NGO certifications are currently available, there is no Swiss government certification to date. However, the UK had launched the so called Government's Quality Assurance Scheme for Carbon Offsetting in 2009. Although the scheme was closed in 2011 (Pure 2011), it can serve as an example for a government certification scheme.

Table 2: Attributes used in the choice experiment.

Offset attributes	**Levels**			
Context	Air travel	Space heating	Hotel stay	Car rental
CO_2 emissions	3.6 tCO_2	1.6 tCO_2	0.25 tCO_2	0.25 tCO_2
Cost of activity	1200 CHF	520 CHF	1200 CHF	520 CHF
Type of offset project	Renewable energy, Re-/afforestation, Energy efficiency, Methane reduction			
Project's host country	Developing country, Newly industrialising country			
Type of provider	For-profit, Non-profit			
Certification	by Swiss government, by an NGO, by the UN, no certification			
Price (CHF/tCO_2)	5,11,17,23,29,35			

The design of the choice experiment has been generated using the software Ngene. Using prior parameters estimated from our pre-test data, we created a Bayesian D-efficient design in line with Ferrini and Scarpa (2007), Rose and Bliemer (2009) and Bliemer and Rose (2011). In total, we created 48 choice sets divided in 6 blocks of 8 choice sets. The context attribute was not included in the Bayesian D-efficient design but was later randomly assigned to the 48 choice tasks. This was done to achieve attribute level balance with respect to the contexts. Each context was assigned exactly two times per block, so that every respondent was offered two choice cards in each of the four contexts. The 6 blocks were randomly assigned to the subjects. Figure 1 in the Appendix shows one of the choice sets in the air travel context.

In addition to the choice experiment, we included a brief section with questions on attitudes and behaviours with respect to environmental protection and climate change mitigation. These items were used in our analysis to account for respondents' motivations for voluntary carbon offsetting. To avoid order effects, the order of the choice experiment and the section with questions on attitudes and behaviours was randomised. The questionnaire concluded with questions on socioeconomic characteristics such as age, gender and income.

From the items in the survey questionnaire we built two scales to use them as proxies to measure *ascription of responsibility* and *adherence to social norms*. These scales are based on inter-item correlation, i.e. they are built of a combination of items that maximises internal consistency (Carmines and Zeller 1979). For a description of the items included in the two scales for measuring *ascribed responsibility* and *adherence to social norms*, see table 7 in the Appendix. The reliability of these scales can be expressed in values of Cronbach's α of 0.82 and 0.79, respectively. To get an indicator of a respondent's carbon footprint we calculated the average value of the variables indicating frequency of air travels, yearly number of hotel overnight stays, yearly mileage with personal car, frequency of weekly meat consumption[6] and by increasing this average value in case respondents run their heatings on fossil fuels and are traveling business class, while lowering the average value in case respondents claimed to participate in carpooling and to buy green electricity.

[6] All four variables take values from 1 to 6 and are weighted equally.

3.3 Econometric framework

The econometric models used in this paper are based on the random utility framework as in Marschak (1960) and McFadden (1974). In this framework, individual preferences are evaluated based on observed choices and a random utility function. This function is generally specified as an additive combination of a stochastic term (ϵ_{ij}) and a deterministic component (V_{ij}). The latter is generally defined as a linear index that can vary across individuals and comprises alternative-varying attributes x_j as well as individual-specific characteristics z. The random utility function can therefore be written as:

$$U_{ij}(x_{ij}, z_i) = V_{ij} + \epsilon_{ij} = x'_{ij}\beta + z'_i\gamma_j + \epsilon_{ij}$$

where subscripts i and j denote the individual and the alternative, respectively. The random term ϵ_{ij} captures all the unobserved heterogeneity across the individuals and alternatives.

The probability that the decision maker chooses alternative j is thus specified as:

$$P_{ij} = Prob\ (U_{ij} > U_{ik} \quad \forall j \neq k)$$

$$P_{ij} = Prob\ (\epsilon_{ij} - \epsilon_{ik} > V_{ik} - V_{ij} \quad \forall j \neq k)$$

Different choice models can be derived under different specifications of the probability density of the unobserved factors $f(\epsilon_{ij})$. The most widely used models are logit and probit. Our main model is a latent class logit model that is used for the analysis of choice-experiment data.

3.4 Latent class model

To be able to distinguish different people's preferences with respect to voluntary carbon offsetting we need an econometric model that can capture unobserved heterogeneity in the marginal utility across individuals. Widely used models are latent class and mixed models that allow a probabilistic distribution of the model parameters. Compared to the mixed logit model, the latent class model does not make a specific assumption about the distribution of the parameter values across individuals but only approximates the underlying distribution by a discrete form (Hensher and Greene 2003). In addition to the model's relative robustness in terms of distribution, the discrete distribution is especially appealing in our case because it allows a classification of individuals in distinctively separate groups with potentially opposing preferences. It might be difficult to model such contrasting differences with continuous distributions. Therefore, we favoured the latent class logit model that has also been widely used in the economic valuation of non-market goods (Morey et al. 2006; Scarpa et al. 2007).

In the latent class model, choice observations are assigned to a discrete number of K classes. Class affiliation is thereby unknown to the researcher. The prior probability of individuals being in one of the K classes is estimated as a model parameter, together with the class-specific utility parameters. The utility functions are thus specified accordingly.

To find the appropriate number of classes, information criteria such as the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC) or the Hannan-Quinn Information Criterion (HQIC) can be considered (Hensher and Greene 2003).

Taking a logit model as a basis, the probability that alternative j is chosen by individual i in choice situation t is given by:

$$P_{it,q}(j) = \sum_q H_{iq} \frac{exp(x'_{it,j}\beta_q)}{\sum_j exp(x'_{it,j}\beta_q)}$$

where H_{iq} is the prior probability that individual i belongs to latent class q. In our application, the alternative j might be either a particular carbon offset or the no-offset alternative.

If individual i has repeated choices labeled by t, the contribution to the likelihood will be the joint probability:

$$P_{i,q}(j) = \prod_t (P_{it,q}(j))$$

Class affiliation can be specified as a multinomial logit function of observed variables giving the probability for individual i belonging to class q as a function of some individual-specific characteristics z_i (Hensher and Greene 2003):

$$H_{iq} = \frac{exp(z'_i\theta_q)}{\sum_q exp(z'_i\theta_q)}$$

As we see in section 4, vector $x_{it,j}$ includes four cost variables related to each of the four offsetting contexts, the amount of CO_2 emissions as well as indicators for project types, certification and location of mitigation projects and also the type of provider (for details see table 2). The utility derived from the no-offset option, namely the status-quo, is represented by a dummy variable. The corresponding coefficient measures the status-quo inertia, representing the consumers' reluctance for voluntary offsetting. In line with Bech and Gyrd-Hansen (2005), we used effects coding as opposed to dummy coding of choice attributes in order to avoid induced biases in the status-quo parameter. As variables for estimating group affiliation z_i we considered the respondent's age and two proxies for the person's adherence to social norms and their expectations about the cooperative behaviour of others in voluntary offsetting.

We also used the information about choice (un-)certainty from the follow-up question after each choice card (see figure 1 in the Appendix). Following a similar approach to Ready et al. (1995), we recoded all positive responses with certainty level below 4 (out of 6 levels) to a no-offset response.[7] This implies that uncertain responses, regardless of whether they are positive or negative, are considered as negative, whereas the no-offset responses remain negative even if the respondent was unsure about them. This asymmetric treatment should partly account for the hypothetical nature of the choice experiment and lead to more conservative estimates.

[7] For comparison, Champ et al. (1997) consider only the adoptions with the highest certainty level (which is 10 in their case) as a positive response in order to identify a lower bound for WTP.

The latent class analysis has been conducted on two samples, the full sample and a subsample that excludes the respondents who have systematically rejected all offset offers. By their rejection of all offers, this group, which accounts for about 15% of the respondents, have shown that their interest in offsetting is quite limited. Therefore, they can be considered as a class of their own. Exclusion of these respondents from the estimation of the latent class model allows for a better identification of the remaining respondents' classification, especially as these respondents for the most part are absorbed by latent class 1 when the model is run on the full sample (for results on the full sample see table 6 in the Appendix). In both analyses, the optimal number of latent classes giving the minimum level of information criteria was four.[8]

4 Results

4.1 Latent class analysis

The results from the latent class analysis shed light on the motivations and preferences different consumer subgroups have with respect to carbon offsetting. The parameter estimations on the sample of 854 respondents, i.e. excluding respondents always rejecting offset offers in the experiment, are provided in table 3.[9] As has been mentioned, the model identifies four latent classes of consumers. Considering the sign and size of the coefficient of the status quo dummy (indicating the utility from not offsetting), latent classes 1 and 4 are rather reluctant to offsetting, while classes 2 and 3 seem to be generally willing to offset their emissions.

Individuals in *latent class 1* (16% of the respondents) show the strongest reluctance to offsetting, as the status-quo parameter of this class is highly positive and significant. These respondents have a close to zero probability of purchasing VCOs. Their cost sensitivity for offsetting is lower in situations where the underlying consumption activity is associated with high CO_2 emissions and high cost, such as in the case of long-haul flights. Their WTP reaches 12 CHF per tCO_2 for space heating and 21 CHF per tCO_2 for air travel.

Individuals belonging to *latent class 4* (27% of the respondents) show both a low probability to offset and a limited WTP, ranging from 1 CHF per tCO_2 in the hotel context and 2 CHF per tCO_2 in the car rental context up to 4.60 CHF and 6.90 CHF per tCO_2 for space heating and air travel, respectively. These respondents can be classified as "occasional low-cost offsetters".

In contrast, classes 2 and 3 both represent respondents with a relatively high propensity to offset their CO_2 emissions, but still differ strongly regarding their preferences and WTP. Respondents belonging to *latent class 2* (25% of the respondents) can be regarded as the group of respondents who are most likely to offset emissions. This can be derived from the positive utility parameter for the amount of emissions reduced and the negative and

[8] We used AIC and BIC criteria. Both criteria show a rapid decline between 3 and 4 classes. While AIC still slightly declines from 4 to 5 classes, BIC rises by adding the fifth class. The model did not converge with more than five (four) classes for the sample with 854 (1010) respondents.

[9] For comparison, the results of the latent class analysis on the entire sample of 1010 respondents are provided in table 6 in the Appendix. Comparing those results with the results listed in table 3 indicates that a strong majority of the excluded respondents can be associated to latent class 1, that is the non-offsetting class. The rest of the results, regarding both the distribution of classes and the patterns of preferences, are very similar regardless of the sample. This strong similarity indicates that the excluded 15% of respondents can be safely classified as a "non-offsetting" group.

significant status-quo effect. With 78 CHF per tCO_2 in the air travel context, respondents affiliated with latent class 2 show by far the highest WTP. They seem to be especially interested in offsetting activities associated with high emissions such as air travel. Most interestingly, individuals in latent class 2 do not seem to care about the costs of offsetting in the low emission contexts (hotel stay, car rental) as the cost parameters for both these contexts are positive. This again shows that these individuals derive utility from making particularly high contributions.

For *latent class 3* (17% of the respondents), the amount of emissions has an insignificant and negligible effect, suggesting that these respondents are indifferent to offsetting. However, their significantly negative effect of the status quo implies that, compared to others, this group has a higher propensity to offset. As the marginal WTP is identified only in cases where the cost coefficient is significantly negative and the emission coefficient is positive and significant, we cannot identify the marginal WTP of class 3 in any of the four contexts. Still, it is interesting to note that even though it is not possible to estimate a meaningful WTP for this group, these respondents are among those who are more likely to offset their emissions systematically and without much sensitivity to the amount of emissions. Similar to latent classes 1 and 4, they also show a lower cost sensitivity for offsetting in contexts associated with high emissions and high cost such as air travel.

Overall, the range of WTP values varies considerably across different latent classes and offsetting contexts. Latent classes 2 and 4 show the highest and lowest values, respectively. In particular latent class 2 has an excessively high WTP for air travels. This can be explained by the peculiar responsiveness of this group to costs with a low sensitivity to costs in air travel while avoiding cheap VCOs in other contexts.

Table 3 also shows that the identified classes vary with respect to respondents' preferences for other VCO attributes. Throughout, afforestation and renewable energy projects have the highest popularity. However, their ordering differs among different classes. In general, the projects in developing countries are preferred. Moreover, the respondents favour VCOs certified by governments and show an aversion to for-profit providers. It is also interesting to note that our data show a higher frequency of offset choices in low-cost contexts. This implies that while involving relatively high WTP per ton, the high emission contexts entail a lower propensity to offset.

The parameters for individual-specific characteristics (lower panel of table 3) can be helpful for a better description of the latent classes. In particular, among the respondents with a relatively high propensity to offset, latent class 3 can be characterised as a relatively young group, possibly budget-constrained, which might be an explanation for their low responsiveness to emission reductions. The respondents in class 2 with the highest willingness to pay show a relatively strong adherence to social norms. This suggests that the attitudes of a consumer's social contacts have a strong influence on the decision to offset.

Table 3: Results of latent class model.

Number of obs.: N = 6832; Number of resp.: n = 854
Pseudo R^2: 0.22
Information criteria: AIC/N = 2.17; BIC/N = 2.24; HIC/N = 2.19

	LC 1	**LC 2**	**LC 3**	**LC 4**
Average class probabilities in model	0.19	0.29	0.21	0.31
Share (%) of all respondents (n=1010)	16	25	17	27
Attributes				
Cost (in CHF) air travel	-0.022***	-0.005***	-0.052***	-0.021***
	(0.006)	*(0.001)*	*(0.004)*	*(0.001)*
Cost (in CHF) heating	-0.038**	-0.003	-0.101***	-0.031***
	(0.016)	*(0.002)*	*(0.006)*	*(0.002)*
Cost (in CHF) hotel	-0.154	0.087***	-0.071***	-0.129***
	(0.118)	*(0.013)*	*(0.015)*	*(0.013)*
Cost (in CHF) rental car	-0.205	0.053***	-0.086***	-0.069***
	(0.125)	*(0.013)*	*(0.016)*	*(0.012)*
Emissions reduced (in tCO_2)	0.463***	0.391***	-0.007	0.144***
	(0.168)	*(0.087)*	*(0.077)*	*(0.035)*
Afforestation project	0.738***	0.110***	0.423***	0.329***
	(0.218)	*(0.030)*	*(0.048)*	*(0.039)*
Renewable energy project	-0.062	0.285***	0.068	0.426***
	(0.292)	*(0.029)*	*(0.054)*	*(0.041)*
Methane reduction project	-0.484*	-0.331***	-0.468***	-0.656***
	(0.279)	*(0.033)*	*(0.056)*	*(0.053)*
Project in developing country	0.263*	0.088***	0.027	0.056**
	(0.140)	*(0.017)*	*(0.028)*	*(0.024)*
For-profit provider	-0.526***	-0.263***	-0.420***	-0.403***
	(0.172)	*(0.018)*	*(0.032)*	*(0.025)*
Certified by government agency	0.701***	0.255***	0.658***	0.428***
	(0.231)	*(0.031)*	*(0.056)*	*(0.042)*
Certified by UN body	-0.256	-0.007	0.390***	0.056
	(0.260)	*(0.030)*	*(0.047)*	*(0.041)*
Certified by NGO	0.011	0.003	-0.253***	-0.074
	(0.234)	*(0.034)*	*(0.056)*	*(0.045)*
Status quo (no offset)	3.593***	-1.700***	-2.336***	0.515***
	(0.474)	*(0.143)*	*(0.163)*	*(0.071)*
Class probability as a function of respondent characteristics				
Intercept	-0.583***	-0.263**	-0.398***	0.00
	(0.140)	*(0.121)*	*(0.134)*	
Age group (10y-intervals)	0.112	0.084	-0.158**	0.00
	(0.075)	*(0.065)*	*(0.078)*	
Adherence to social norms	0.013	0.755***	0.175	0.00
	(0.147)	*(0.130)*	*(0.148)*	
Expected cooperation	-1.319	-0.147	0.411	0.00
	(0.845)	*(0.704)*	*(0.831)*	
Average posterior class probabilities				
	0.94	0.92	0.81	0.87

*** = significant at 1%-level ** = significant at 5%-level * = significant at 10%-level

4.2 Characterisation of respondents based on stated and revealed choices

We also used a series of probit models to analyse the effect of characteristics of different groups of respondents on their reported offsetting behaviour. This is recorded by several proxies. The first measure is a qualitative 5-point scale variable for the respondent's general willingness to offset part of own carbon emissions.[10] We analysed this variable with an ordered probit model to identify the effect of different underlying motivations for carbon offsetting. Table 4 provides the results. Because of missing values in some of the control variables the probit regressions are based on a subsample of 871 respondents (see table 1).

Table 4: Results of ordered probit regression.

Number of obs.:	N=871	
Log Likelihood:	-1036.34	
Pseudo R^2:	0.17	
Dep. var.: General willingness to offset	**Parameter**	**Standard error**
Age group (10y-intervals)	-0.084***	0.031
Female	0.025	0.088
Married	0.026	0.094
With children	-0.111	0.099
Academic degree	-0.112	0.083
Monthly gross income (in 7 income groups)	0.095***	0.028
Carbon footprint	-1.050***	0.319
Ascribed responsibility	0.659***	0.051
Adherence to social norms	0.394***	0.047
Expected cooperation	1.196***	0.260
Knowledge of offsetting	0.100	0.081
Cut 1	-2.148***	0.247
Cut 2	-1.388***	0.238
Cut 3	-0.370	0.236
Cut 4	1.178***	0.238

*** = significant at 1%-level ** = significant at 5%-level * = significant at 10%-level

In addition to sociodemographic variables, the explanatory variables include a dummy for respondents' prior knowledge of voluntary carbon offsetting as well as several variables used to identify the respondent's motivation for offsetting. These include an indicator for the respondent's CO_2 footprint, a scale for adherence to social norms and a scale for ascribed responsibility to account for internalised norms[11] as well as a variable that measures people's expectations about the percentage of Swiss consumers that participate in voluntary carbon offsetting schemes. The latter variable captures respondents' expectations about others' cooperation. Hence, it can be used to test whether people are conditional cooperators.

[10] Answer to the question "If you were to have the opportunity to pay for a carbon offset in the future, would you generally be willing to neutralise part of your emissions from consumption?"

[11] For a detailed description of the two scales see table 7 in the Appendix.

Age has a significantly negative influence on willingness to offset which is consistent with the results from the latent class analysis discussed above and also in line with findings from Mair (2011) in that potential buyers of VCOs are likely to be younger than non-buyers. Also Kotchen and Moore (2008) report that participants of a green electricity scheme in Michigan (US) are likely to be younger than non-participants and Achtnicht (2009) find that car buyers in Germany under the age of 45 have a higher WTP for climate-friendly vehicle technologies than those over 45. On the contrary, gender, being married or having children do not have a significant influence on the stated propensity to offset in our analysis, while Mair (2011) finds that potential buyers of offsets in Australia and the UK are more likely to be male.

In line with Kotchen and Moore (2008), monthly gross household income does have a significant effect on the propensity to compensate emissions. On the one hand, this is not surprising as people with a higher monthly income are less budget-constrained. On the other hand, several other studies find that the general willingness to contribute to environmental public goods is not dependent on income, whereas only the amount of WTP is income-dependent (see e.g. Liebe et al. (2011) or Kotchen and Moore (2007)). Our results do not confirm this finding.

We find that potential offsetters can rather be characterised by their behaviours in other climate-relevant contexts and by their attitudes than by their socioeconomic characteristics. In fact, there seems to be a strong connection between offsetting and a respondents' carbon footprint: Respondents with a higher CO_2 footprint, i.e. who are more frequently engaged in emissions-intensive behaviours such as air travel, driving, staying in hotels, consuming meat and meat products etc., are less likely to offset part of their emissions. Inversely, respondents with a low carbon footprint seem to be more likely to offset their remaining emissions. This hints to the fact that reducing GHG emissions from consumption and purchasing voluntary carbon offsets are considered as complements rather than substitutes. This is supported by findings presented in Lange and Ziegler (2012) who show that purchasing voluntary carbon offsetting and engaging in other mitigation activities are largely driven by the same underlying motivations, especially by feelings of personal responsibility to contribute to climate change mitigation. The relevance of feelings of responsibility is also reported in previous studies on voluntary carbon offsetting, such as in Brouwer et al. (2008), and is as well confirmed by our analysis (see positive and significant effect of *ascribed responsibility* in table 4). Furthermore, our data suggests that offsetting is also driven by a strong adherence to social norms and high expectations about others' cooperation in this social dilemma situation. Which of these influencing factors dominates the decision to offset is individual-specific, as suggested by the results of our latent class analysis (table 3).

To assess the reliability of the choice experiment with respect to real behaviour, we ran a series of bivariate probit models using three binary indicators for non-contributing behaviour. The first variable indicates the respondents who have systematically rejected all offset offers proposed to them in the choice experiment. The second measure is an indicator for those respondents who have never offset emissions before taking part in the choice experiment.[12] Finally the respondent's actual donation during the survey out of their 6 CHF remuneration is used to construct a binary indicator for respondents who did not contribute much to the mitigation project in Switzerland.[13].

[12]Based on the question "Have you ever made a CO_2 compensation payment for your personal consumption?"

[13]We tested several ways to include this information into the model and finally chose the median (donation <3 CHF) for our reporting

Table 5: Bivariate probit models characterising non-offsetters.

Model	**Probit**	**Bivar. probit 1**	**Bivar. probit 2**
Number of observations:	871	871	871
Log Likelihood:	-265.70	-668.39	-810.03
		No offset in experiment	
Age group (10y-intervals)	0.175***	0.179***	0.177***
	(0.049)	*(0.049)*	*(0.049)*
Female	-0.110	-0.114	-0.113
	(0.150)	*(0.151)*	*(0.151)*
Married	0.001	-0.018	-0.002
	(0.153)	*(0.153)*	*(0.153)*
With children	0.010	0.012	-0.001
	(0.160)	*(0.160)*	*(0.160)*
Academic degree	0.075	0.033	0.073
	(0.135)	*(0.134)*	*(0.135)*
Monthly gross income	-0.032	-0.021	-0.030
	(0.046)	*(0.046)*	*(0.046)*
Carbon footprint	0.490	0.462	0.484
	(0.531)	*(0.533)*	*(0.530)*
Ascribed responsibility	-0.476***	-0.481***	-0.478***
	(0.070)	*(0.070)*	*(0.070)*
Adherence to social norms	-0.593***	-0.594***	-0.596***
	(0.086)	*(0.086)*	*(0.085)*
Expected cooperation	-1.260***	-1.196***	-1.224***
	(0.468)	*(0.464)*	*(0.465)*
Constant	-2.015***	-2.050***	-2.027***
	(0.378)	*(0.381)*	*(0.378)*
		No previous offset	**Donation <3 CHF**
Age group (10y-intervals)		0.094**	-0.170***
		(0.043)	*(0.037)*
Female		0.020	-0.147
		(0.115)	*(0.105)*
Married		0.130	-0.123
		(0.126)	*(0.112)*
With children		-0.084	0.025
		(0.134)	*(0.118)*
Academic degree		-0.350***	0.038
		(0.105)	*(0.096)*
Monthly gross income		-0.130***	-0.038
		(0.037)	*(0.033)*
Carbon footprint		0.925**	0.838**
		(0.423)	*(0.384)*
Ascribed responsibility		-0.345***	-0.363***
		(0.075)	*(0.058)*
Adherence to social norms		-0.145**	-0.087
		(0.059)	*(0.054)*
Expected cooperation		-0.429	-0.391
		(0.338)	*(0.304)*
Constant		0.709**	0.655**
		(0.302)	*(0.271)*
ρ		0.444	0.153
		(0.101)	*(0.078)*

The first variable *(no offset in experiment)* is a purely stated-preference measure based on a hypothetical experiment. The second one *(no previous offset)* represents the revealed behaviour but might be subject to reporting errors. The third variable *(donation)* can be considered as a relatively valid measure of revealed behaviour. We applied a bivariate probit model to different pairs of these three variables. Besides assessing the reliability of our experiment with respect to real behaviour, this analysis allows us to identify the important characteristics driving no-offset behaviour.

The bivariate probit results are listed in table 5. They largely confirm the results from the ordered probit model (table 4). Moreover, the significant correlation of the error terms in both bivariate probit models indicates a consistence between revealed behaviour and stated preferences. With respect to education, we find that having an academic degree does not have a significant correlation with the stated preferences for offsetting (see table 4). However, our results show that the respondents with an academic degree are relatively more likely to have offset emissions in the past. Also Kotchen and Moore (2008) find that participants in a green electricity program tend to be more educated than non-participants and Achtnicht (2009) reports that car buyers with higher education have a higher WTP for climate-friendly vehicles.[14]

Using the analysis of the no-offset behaviour in combination with the latent-class analysis we can characterise the respondents that are not interested in voluntary offsets. These are likely to be relatively old. The also show relatively low measures of ascribed responsibility for climate change mitigation and adherence to social norms. Moreover, their expectation about the cooperative behaviour of others is low.

5 Discussion and conclusions

Overall, we find a substantial willingness to contribute to voluntary carbon offsetting among Swiss consumers. The adopted latent class model indicates several distinctive patterns of preferences among the respondents. While a relatively large group of respondents (about 30 percent of the sample) are not likely to ever purchase voluntary offsets, the majority of respondents are willing to contribute in financing the offsetting process at least occasionally. Both the WTP and the propensity to offset vary considerably among these individuals. In particular, three distinctive subgroups can be identified: About 25% of the respondents show a relatively high propensity to offset and also a high marginal WTP for neutralising emissions. This group's WTP is in the upper part of the range of VCO market prices in Switzerland. We label this class as "generous buyers." This group can be characterised as relatively high-income individuals who are likely to feel a moral obligation to contribute to climate change mitigation, and to perceive it as a social norm to offset emissions.

On the other hand, about 17 % of the respondents are classified as being interested in offsetting but only to the extent that it is accessible at a low cost. This group's valuation of neutralising emissions is quite low compared to their sensitivity to costs, which implies a negligible marginal WTP. Yet they show a significant tendency to purchase inexpensive voluntary offsets. Considering the relatively low age of the respondents in this group, we can interpret their responsiveness to prices as an indication of tight budget constraints. We label this group as "low-income selective buyers."

[14] Note that having a university degree and having heard about offsetting before the survey is slightly correlated ($\rho = 0.29$), so that knowledge of offsetting might partly mediate this effect.

Finally, about 27% of the respondents show a relatively low yet positive WTP for neutralising emissions. This group has a moderate propensity to offset. Hence, we consider this group to be "occasional low-cost buyers."

As expected, WTP is in most cases strongly context-dependent. While the propensity to offset is highest in low-cost situations, the WTP per tCO_2 is highest in high-impact situations such as air travel. Values for WTP per tCO_2 range from 1 to 21 CHF (currently corresponding to 1 to 23 USD) for the average consumer. These values are on the lower end of the range of carbon prices we used in the experiment. They are also at the lower end of WTP measures reported in other studies, especially those reported in Brouwer et al. (2008) or MacKerron et al. (2009). Only the above mentioned 25% of respondents show exceptionally high WTP values such as 78 CHF per tCO_2 (currently corresponding to around 85 USD per tCO_2) in the air travel context. These individuals seem to be willing to pay nearly any price currently offered in the market, provided the VCO satisfies their strict preferences about non-price attributes.

The propensity to offset seems strongly dependent on the types of mitigation projects that were offered. Afforestation and renewable energy projects seem to be generally preferred to energy efficiency projects and methane reduction projects. This can be explained by the ancillary benefits respondents associate with these types of projects. Furthermore, projects implemented in developing countries and those offered by non-profit offset providers were always preferred to projects implemented in newly industrialising countries or by for-profit providers. Most importantly, the respondents strongly value government certification of VCOs and have a preference for non-profit providers. Considering that such certifications do not exist in Switzerland, our results show that the government's backing could strongly increase the consumers' participation in voluntary carbon offsets. About 52% of the survey respondents indicated some kind of suspicion and distrust about the use (or potential abuse) of the proceeds of VCO sales. Our choice experiment shows that the Swiss government is considered as particularly trustworthy when it comes to certification of mitigation projects.

Furthermore, we find that potential offsetters are more likely to have a relatively low CO_2 footprint. This result is particularly important when it comes to evaluating the effectiveness of voluntary carbon offsetting on the individual level. Only if consumers consider offsetting and reducing consumption as complements, private provision of the public good climate protection may increase. Our results can be interpreted in a way that most people participating in voluntary carbon offsetting schemes have adopted environmental- and climate-friendly behaviour in various fields of their life and consider carbon offsetting as a complement to such behaviours. This result could thus dispel general fears that voluntary carbon offsetting leads to an overall higher level of CO_2 emissions. Yet, this proposition needs further clarification within future research.

The existence of preferences for certain co-benefits of offset projects as well as the observable influence of internalised and social norms on the decision to offset suggests that WTP for carbon offsetting will prevail even if governments introduce stricter mandatory climate regulations (e.g. through an increased CO_2 tax or a tighter cap on emissions). To the extent that consumers get additional personal benefits from carbon offsetting, they may be willing to make voluntary contributions in addition to government policies. Thus, we expect that even in the face of mandatory climate policies the market for voluntary carbon offsets would not be fully erased, though the potential demand and WTP would probably be downscaled.

In conclusion, this paper suggests that individual contributions to climate change mitigation by means of carbon offsets, although they are low in size, should be considered as an effective complement to mandatory regulation. Furthermore, a growing number of opportunities to offset own CO_2 emissions from consumption may raise awareness among consumers about the adverse effects of certain consumption activities on the climate. While offsetting in high emissions situations seems to be generally supported among consumers, offsetting in low emission contexts is less valued. This also shows that the awareness of the negative impact of certain consumption activities on the climate is still in its early stages. Voluntary offsetting schemes can thus prepare the ground for the acceptance of more stringent governmental climate policy in the future.

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Appendix

Table 6: Results of latent class model (full sample).

Number of obs.: N = 8080; Number of resp.: n = 1010
Pseudo R^2: 0.32
Information criteria: AIC/N = 1.89; BIC/N = 1.95; HIC/N = 1.91

	LC 1	**LC 2**	**LC 3**	**LC 4**
Average class probabilities	0.28	0.25	0.20	0.27
Attributes				
Cost (in CHF) air travel	-0.022*	-0.005***	-0.050***	-0.020***
	(0.012)	*(0.001)*	*(0.004)*	*(0.001)*
Cost (in CHF) heating	-0.045*	-0.003	-0.091***	-0.030***
	(0.024)	*(0.002)*	*(0.005)*	*(0.002)*
Cost (in CHF) hotel	-0.269	0.086***	-0.084***	-0.125***
	(0.164)	*(0.013)*	*(0.014)*	*(0.014)*
Cost (in CHF) rental car	-0.322	0.054***	-0.083***	-0.074***
	(0.224)	*(0.013)*	*(0.015)*	*(0.013)*
Emissions reduced (in tCO_2)	0.133	0.362***	-0.017	0.222***
	(0.292)	*(0.080)*	*(0.066)*	*(0.035)*
Afforestation project	0.811*	0.111***	0.407***	0.349***
	(0.437)	*(0.030)*	*(0.044)*	*(0.040)*
Renewable energy project	-0.248	0.286***	0.130***	0.398***
	(0.578)	*(0.028)*	*(0.094)*	*(0.042)*
Methane reduction project	-0.652	-0.331***	-0.512***	-0.633***
	(0.506)	*(0.032)*	*(0.053)*	*(0.055)*
Project in developing country	0.466*	0.087***	0.016	0.072***
	(0.248)	*(0.017)*	*(0.026)*	*(0.025)*
For-profit provider	-0.717**	'-0.263***	-0.445***	-0.382***
	(0.341)	*(0.017)*	*(0.029)*	*(0.026)*
Certified by government agency	1.001**	0.255***	0.624***	0.439***
	(0.465)	*(0.030)*	*(0.051)*	*(0.043)*
Certified by UN body	-0.495	-0.002	0.383***	0.020
	(0.505)	*(0.030)*	*(0.044)*	*(0.043)*
Certified by NGO	-0.222***	-0.001	-0.228***	-0.072
	(0.481)	*(0.033)*	*(0.052)*	*(0.047)*
Status quo (no offset)	4.645***	-1.621***	-2.036***	0.878***
	(0.668)	*(0.135)*	*(0.134)*	*(0.070)*
Class probability as a function of respondent characteristics				
Intercept	-0.281**	-0.283**	-0.290**	0.000
	0.116	*(0.118)*	*(0.123)*	
Age group (10y-intervals)	0.237***	0.076	-0.160**	0.000
	0.059	*(0.062)*	*(0.072)*	
Adherence to social norms	-0.548***	0.721***	0.146	0.000
	0.121	*(0.123)*	*(0.136)*	
Expected cooperation	-1.541**	0.222	0.807	0.000
	0.708	*(0.680)*	*(0.769)*	
Average posterior class probabilities				
	0.96	0.92	0.83	0.89

*** = significant at 1%-level ** = significant at 5%-level * = significant at 10%-level

Table 7: Scales used in the analysis.

Ascribed responsibility (Cronbach's $\alpha = 0.82$)

How strongly do you agree with the following statements?
(strongly disagree/disagree/neutral/agree/strongly agree)

Every single citizen has to take responsibility towards the climate.
I feel morally obliged to protect the climate.
In my opinion, every single contribution to climate protection is effective.

Social norms (Cronbach's $\alpha = 0.79$)

Do you think that your family expects that you make voluntary payments to offset some of your CO_2 emissions from consumption?
(do not expect it at all/rather do not expect it/maybe expect it/rather expect it/clearly expect it)

Do you think that your friends expect that you make voluntary payments to offset some of your CO_2 emissions from consumption?
(do not expect it at all/rather do not expect it/maybe expect it/rather expect it/clearly expect it)

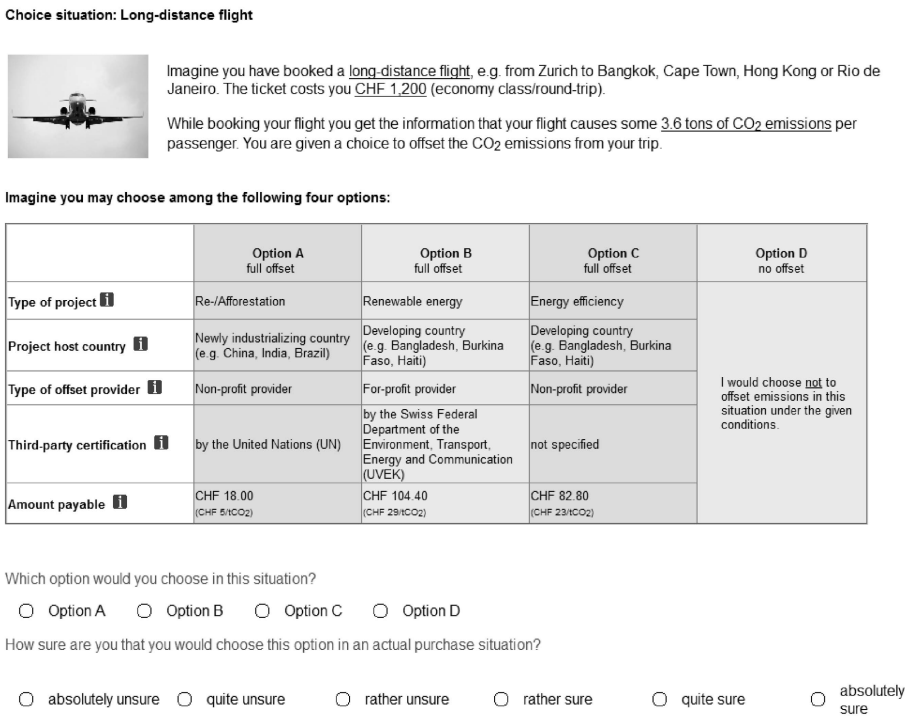

Figure 1: Example of a choice set in the air travel context.