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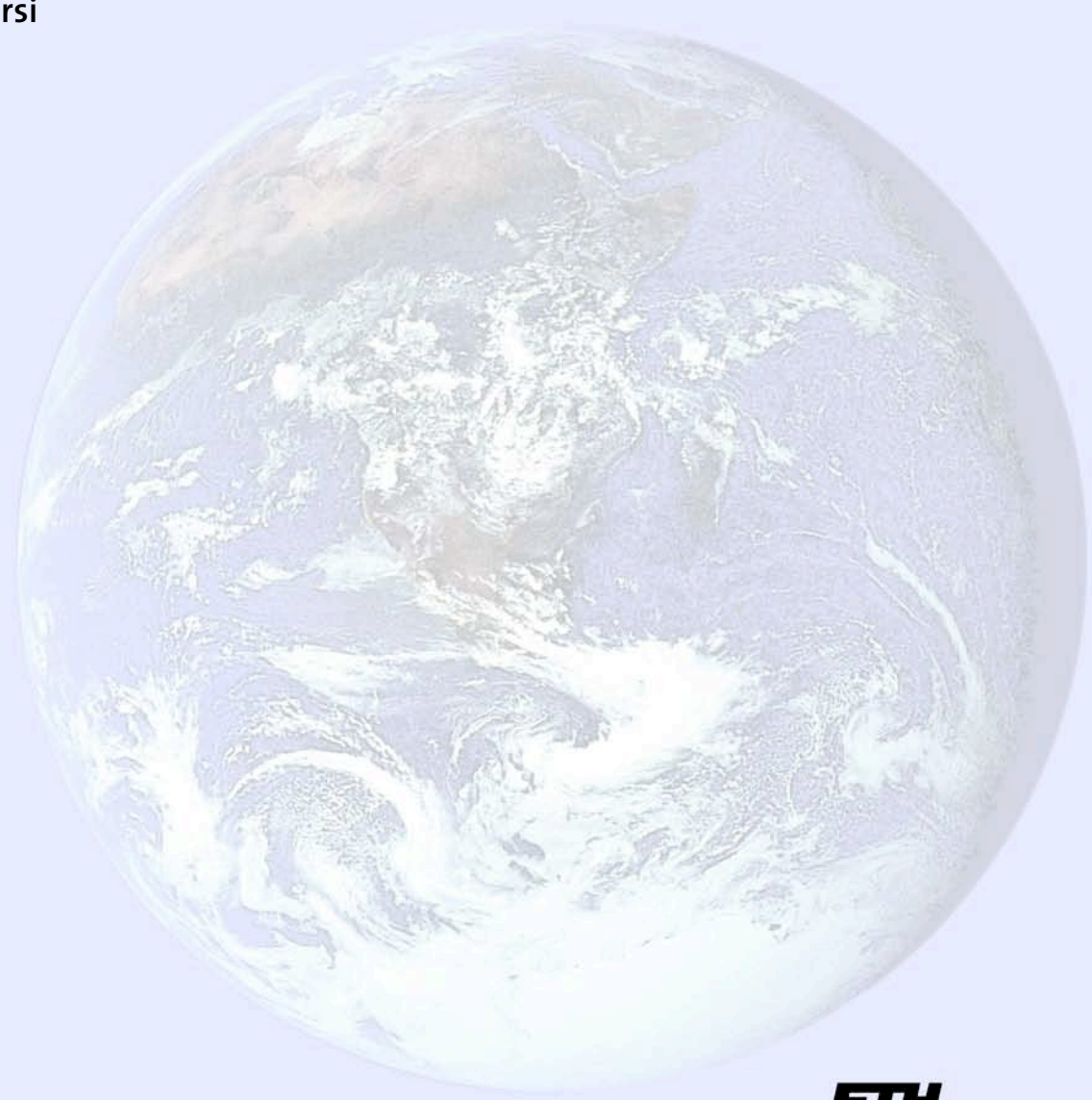

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Retail demand for voluntary carbon offsets - A choice experiment among Swiss consumers

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Abstract

Using a choice experiment conducted among more than a thousand Swiss consumers, we analyze the individual demand for voluntary carbon offsets in different 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 offsetting project characteristics on their propensity for contribution. Furthermore, the characteristics of potential buyers as well as the possibilities of behavioral rebound are explored. To support our results, we assess whether the hypothetical preferences are consistent with the revealed behavior. 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 individual preferences. The results also point to strong heterogeneity among individuals favoring targeted policy measures to induce voluntary contribution.

Keywords: Voluntary carbon offsets, Willingness to pay, Choice experiment, Latent class model

JEL classification: Q54, D03, D12

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1 Introduction

Within two decades after its first occurrence[1], neutralizing carbon emissions has emerged as a retail service in a sizable market open to firms as well as individual consumers. 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'. Today's carbon markets provide opportunities to offset CO_2 emissions from a wide range of activities such as traveling, daily energy use, social events and consumer goods.

The demand for carbon offsets is currently dominated by private companies with a share of more than 90 percent of purchased volumes (Peters-Stanley and Hamilton, 2012). Yet, individual consumers' demand has undergone a considerable growth, especially in many European countries. Worldwide, individual offset purchases more than doubled between 2010 and 2011 (Peters-Stanley and Hamilton, 2012). Despite their relatively minor market share, retail demand plays an important role in the potential development of the markets for voluntary offsets. Many of the driving factors and individual motivations for offsetting represent the society's overall preferences that should be reflected in companies' responses regarding carbon emissions. It is thus reasonable to assume that companies' environmental attitudes and their tendency towards 'green brands' follow the tastes of their clients at large, that is individual consumers who ultimately bear the additional costs (Peters-Stanley and Hamilton, 2012).

It is also important to note that the low market share of individual buyers could be explained by their relatively high transaction costs due to information and search costs. In fact compared to online providers, the offsetting opportunities at the point of sale are still rare, requiring many interested customers to invest additional time to search a relevant provider (Peters-Stanley and Hamilton, 2012). More importantly, the knowledge of voluntary carbon offsetting is often reported to be low, e.g. 33% of respondents in a German study (Lütters and Strasdas, 2010), 24% in a Swedish study (Gössling et al., 2009). Because of such market barriers, the existing demand might therefore represent an underestimation of the market potentials in the future.

The further development of retail demand for VCOs could be an important complementary element of national climate policies: Globally, household consumption accounts for about 72% of overall greenhouse gas emissions. Housing, mobility and food are identified as the most emission-intensive of all consumption categories (Hertwich and Peters, 2009). Adequately designed VCO markets could be effective instruments to transfer part of the mitigation burden to individual consumers. It is therefore important to have a better understanding of the consumers' motivation for offsetting carbon emissions and their preferences with respect to different mitigation options.

[1] In 1989, in order to compensate for its carbon emissions, the US electricity company AES paid Guatemalan farmers to plant 50 million trees and thus pioneered the concept of voluntary carbon offsetting (House of Commons, 2007; Bellassen and Leguet, 2007).

Given the small share of individual consumers and noting the limitations in existing VCO markets, the potential demand for VCOs can hardly be evaluated based on market data. In this context, a choice experiment can be helpful to assess the consumers' willingness to pay (WTP) for carbon offsets and to identify the potential demand. Previous studies (Brouwer et al., 2008; MacKerron et al., 2009; Achtnicht, 2009; Loeschel et al., 2010; Diederich and Goeschl, 2011b; Lu and Shon, 2012; Lange and Ziegler, 2012) generally have focused on a single specific context such as air travel or have used indirect methods to deduce the consumer's WTP for offsetting. In most studies the implicit assumption is that the WTP for mitigating $1tCO_2$ is invariant to the context of the neutralized emissions and to the type of mitigation projects. However, anecdotal evidence and previous research from Conte and Kotchen (2010) suggest that from the consumer's standpoint VCOs are differentiated products.

Furthermore, the tastes and preferences might vary considerably among individuals. Part of these differences might be explained by observed socioeconomic characteristics and environmental attitudes as in Mair (2011) and Diederich and Goeschl (2011a). However, it is likely that a major part of these differences could be related to unobserved heterogeneity. An adequate analysis of the WTP for carbon offsets should account for such heterogeneity in tastes and contexts. Econometric models that account for unobserved heterogeneity can be used to classify the potential buyers of VCOs into reasonably homogeneous groups.

In this paper, using an online survey conducted with a sample of more than a thousand Swiss consumers, we analyze the demand for VCOs in different consumption contexts. The adopted discrete choice models account for heterogeneity among consumers. The results are used to estimate the WTP for carbon offsets and to identify the impact of different offset project attributes in VCO demand. 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, only about a quarter show a high willingness to pay. Demand for voluntary carbon offsetting is highly context-dependent and strongly varies with the types of offered mitigation projects. The results indicate that we cannot summarize the individual preferences into a single WTP measure. 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 Swiss Francs (currently equivalent to 1 to 22 USD) per ton of CO_2.

Our results suggest that the potential for individual voluntary carbon offsetting has not been fully exploited. Targeted government measures for promoting voluntary mitigation could probably activate the unexploited potentials. The rest of the paper is organized 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 Theoretical underpinnings and previous research

Understanding people's motives for buying VCOs, the influence of context and possible behavioral implications can give insights into two important questions about voluntary offsetting, namely to what extent it can be used as an instrument for climate change mitigation at the individual level and what role it can take in the presence of mandatory governmental regulation. Yet, the existing empirical research is far from conclusive. Virtually all studies focus on single specific contexts and, excepting a few cases, they are based on the stated-preference approach.

For instance, in the context of air travel, Brouwer et al. (2008) used 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) assess the WTP of young adults in the UK for offsetting emissions from air travel. Overall, MacKerron et al. (2009) report an average WTP of 24 GBP per flight. Lu and Shon (2012) use a similar method to assess airline passengers' WTP at Tayuan International Airport and find a mean WTP of 5 to 29 USD per trip.

In the context of vehicle usage, we can cite Ziegler et al. (2012) and Lange and Ziegler (2012) who both used a survey among German and US consumers. In particular Ziegler et al. (2012) highlight the importance of prior knowledge of offsetting for the decision to purchase carbon offsets. Lange and Ziegler (2012) consider the relationship between voluntary offsetting and alternative mitigation activities based on the same dataset of German and US consumers utilized in Ziegler et al. (2012). They examine whether offsetting and alternative mitigation measures are influenced by the same factors, such as feelings of responsibility and income. They find that feelings of responsibility play an important role for both offsetting and alternative mitigation measures, though to a different extent. In a closely related study, Achtnicht (2009) conduct a survey among German consumers to estimate the WTP for climate-friendly cars, which they indirectly interpret as the WTP for reductions in CO_2 per kilometer driven. They report a marginal valuation of 68 EUR for one gram of carbon reduction per kilometer, which is approximately equivalent to an exceptionally high WTP of about 349 EUR per tCO_2.

Among the VCO empirical studies there are a few exceptions that used revealed preferences in experimental settings. For instance, in an online survey in Germany, Diederich and Goeschl (2011b) offered the respondents a guaranteed reduction of 1tCO_2 or a guaranteed cash award, randomly drawn from 2 to 100 EUR. Similarly, Loeschel et al. (2010) conduct a field-experiment in Mannheim, Germany. They provide subjects with 40 EUR and let them choose to purchase a VCO at different prices. Diederich and Goeschl (2011b) estimate a mean WTP of 6.30 EUR per ton CO_2 whereas Loeschel et al. (2010) report an average WTP of 12 EUR per tCO_2[2].

Overall, the empirical findings documented in the literature point to a considerable demand for VCOs that might go beyond the existing VCO markets. In fact, virtually all WTP estimates are well above the minimum prices available in the VCO markets. On the global markets in 2011, prices for VCOs ranged from 0.1 USD to more than

[2]At the current exchange rate the estimated WTP is respectively 5 and 8 USD. In both studies the offered emission reduction was a European Union emissions allowance.

120 USD per tCO_2 (Peters-Stanley and Hamilton, 2012). As Conte and Kotchen (2010) show, these huge price differences can be explained by the type of project, the location of the provider, the project's host country as well as the type of project certification. The availability of VCOs at reasonably low prices contrasting with a relatively low demand from individual consumers might suggest that the demand potentials are suppressed by market barriers and transaction costs.

However, given that VCOs are strongly differentiated products, the validity of such a conclusion depends on the variation in the consumer's WTP depending on the mitigation project behind specific VCOs. Moreover, to the extent that a VCO is a contribution in a public good, the consumer's decision depends on her public-good motivations. As we see later, the consumer's response to these motivations might arise differently in various contexts. Therefore, the consumer's decision in purchasing a VCO should depend on the price and the type of VCO but also on the consumption activity to which she relates a specific VCO. These variations and the related motivations will be discussed in the following sections.

2.1 Voluntary offsets as individual provision of public goods

From a theoretical point of view, carbon offsetting can be regarded as an altruistic donation, a 'morally motivated consumer self-regulation' by means of a voluntary Pigouvian tax (Baron, 2010), or as adding a public good component to a private good thus providing an impure public good (Cornes and Sandler, 1986; Kotchen, 2006, 2009b). In any case, as a contribution to a global public good, namely 'climate change mitigation', voluntary offsetting is subject to the free-rider problem. Hence, it cannot be easily reconciled with economic theories based on rational self-interested agents (Sugden, 1982; Dawes and Thaler, 1988; Nyborg and Rege, 2003). It is therefore interesting to analyze consumers' motivations for carbon offsetting and to explain how this voluntary act can be brought in line with recent findings about individual contributions to public goods.

In contrast with early theoretical studies on the provision of public goods predicting no voluntary contributions (Olson, 1965; Hardin, 1971), recurrent observation of altruistic behavior and the findings from public goods experiments (Ledyard, 1995; Dawes and Thaler, 1988; Camerer, 2003) provide ample evidence of voluntary contribution. The private provision of public goods has been explained by a strand of empirical and theoretical studies (Bergstrom et al., 1986; Cornes and Sandler, 1984, 1986, 1994; Andreoni, 1988, 1990; Smith et al., 1995; Vicary, 1997, 2000). In this literature, it is often assumed that an individual may derive an additional utility form a public good which is above and beyond her own consumption (altruism). In particular, an impure altruist is defined as an individual who derives utility, or a 'warm glow' of giving from her own contribution irrespective of the aggregate level of public good (Andreoni, 1989, 1990).

Recent work in behavioral economics as well as sociological and psychological literature brought further insights into what drives people's voluntary contributions in public goods. *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 behavior' of their 'reference group' (e.g. friends, family) in order to obtain social approval and not to be sanctioned by disapproval (Holländer, 1990;

Nyborg and Rege, 2003). 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; Fischbacher et al., 2001; Frey and Meier, 2004; Gächter, 2006; Camerer, 2003).

Finally, *internalized norms* and the desire for a *positive self-image* may guide people's behavior towards the private provision of public goods (Brekke et al., 2003; Nyborg et al., 2006; Bruvoll et al., 2002; Frey and Stutzer, 2006; Stern et al., 1995). Internalized norms are usually enforced by feelings of guilt and a bad conscience (Nyborg et al., 2006; Frey and Stutzer, 2006). The activation of internalized norms has been studied by social psychologists such as Schwartz and Howard (Schwartz, 1970a,b, 1977; Schwartz and Howard, 1984, 1981). They find that the activation of internalized norms is subject to an individual's *awareness of the interpersonal consequences* of a certain behavior as well as to an individual's *ascription of personal responsibility* for these consequences (Schwartz, 1970a). Amongst other studies, Clark et al. (2003) show that morally motivated consumers have a higher probability of participating in a green electricity program.

All these explanations can be assumed to drive voluntary carbon offsetting to some extent. Yet, it remains to be seen, which explanation dominates in the specific case of carbon offsetting. In this study, the survey data allow us to derive proxies for the respondent's adherence to social norms, ascribed responsibility and their expectation of others' contributions. These proxies are used to identify which effect is relevant in the case of voluntary offsets.

2.2 Contextual influences and behavioral implications

Previous studies such as Conte and Kotchen (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. An important context factor is the price of the underlying consumption activity. Lütters and Strasdas (2010) suggest that WTP for carbon offsetting is bound to the price of the respective underlying consumer good or service. In other words, the price is used as an anchor for an individual's overall WTP for offsetting the emissions of the respective activity. Anchoring effects, extensively studied by Thaler (1985), Thaler (1999) and Kahneman (1992), could partly explain why the propensity to offset and the marginal WTP vary with the offsetting context.

In the same vein, the environmental impact of the underlying consumption activity could have a substantial influence on voluntary offsetting. As the price for a voluntary carbon offset is usually directly related to the CO_2 emissions from the respective underlying consumption activity, the price for carbon offsetting increases with the environmental impact of the underlying consumption activity (at a given price per ton CO_2). As a result, the propensity to offset emissions might be lower for highly emitting activities such as heating or air travel. WTP per tCO_2 for these activities might be disproportionately low. 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 if the

costs of the action (including transaction costs) are low. On the contrary, it is possible that consumers' propensity to offset is especially strong in highly polluting consumption activities such as air travel or heating, which are tied to relatively high offsetting costs. Such observations could be explained by stronger feelings of responsibility or 'green guilt' (Kotchen and Moore, 2008; Kotchen, 2009a) on behalf of the consumers in case of highly emitting activities.

Conte and Kotchen (2010) report that market prices for voluntary carbon offsets strongly differ depending on the type of mitigation project, the location of the provider, the project host country and the type of certification of the offset project. They explain these differences in market prices with buyers' preferences for these characteristics of carbon offsets and the associated co-benefits of certain types of projects (e.g. enhanced biodiversity in case of afforestation projects). The literature on related willingness to pay is rather scant. We have found only two studies that consider differences in WTP with respect to offsetting contexts and mitigation projects. MacKerron et al. (2009) use a choice experiment to assess the WTP of young UK residents for offsetting emissions from air travel. The choice tasks are differentiated with respect to different attributes of the offset projects, in particular the co-benefits such as improved biodiversity or human development. The findings suggest significant differences in WTP for varying offset attributes. Similarly, Lütters and Strasdas (2010) conduct a survey among German respondents and provide indicative findings that people's WTP varies between offsetting contexts and offsetting projects.

It also remains unclear how opportunities for carbon offsetting influence actual consumer behavior in the sense that people either may decrease or increase their consumption after having offset the corresponding emissions (Kotchen and Moore, 2008; Kotchen, 2009b,a; The Economist, 2007). The concept of voluntary carbon offsetting can only be effective for climate change mitigation if individuals' payments are "additional" or complementary to other climate-friendly behavior and if there is thus no behavioral rebound. If people instead increase their consumption because their feelings of "green guilt" have been reduced by the payment, the environmental effect could be null or even negative. In other words, if consumers consider offsetting and reducing consumption as substitutes, either direct or indirect behavioral rebound may occur and the overall effect for the climate could be either positive or negative.

To our knowledge, there is hardly any study on the WTP for voluntary carbon offsetting that systematically explores motivations and offsetting contexts in a discrete choice framework based on a broad sample of consumers. The majority of previous research focuses on offsets for specific consumption activities and uses very specific samples. So far, WTP for carbon offsetting has only been elicited separately for air travel (Brouwer et al., 2008; MacKerron et al., 2009; Lu and Shon, 2012) or vehicle use (Achtnicht, 2009; Ziegler et al., 2012; Lange and Ziegler, 2012). Diederich and Goeschl (2011b) assess WTP for individual greenhouse gas emission reductions in a setting that is neutral to different consumption contexts, though on a relatively large sample that is representative for the German offset market. Our paper aims at filling the gap by exploring WTP for voluntary carbon offsetting in different contexts and with various mitigation options in a representative sample.

3 Data and methods

3.1 Sample

The empirical analysis presented in this paper is based on data from an online survey in the German speaking part of Switzerland. The sampling was conducted by a marketing research firm (*Intervista*) that has a permanent panel of 30,000 members throughout Switzerland. The survey questionnaire was sent to 2,553 individuals aged 14 or older. 1,010 panelists completed the questionnaire with valid answers, which corresponds to a response rate of 40%. The survey was conducted in September 2011. Each respondent that completed the questionnaire received a credit coupon of 6 CHF (currently corresponding to about 6.30 USD or 5 EUR) that can be exchanged for a variety of goods.

Among the respondents who completed the survey, 63% stated that they had heard about the opportunity to offset individual carbon emissions before the survey. 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). Most of the offsets reported by the participants of our study have been made in the air travel context (70%), followed by car use, space heating and food contexts (around 20% each). It is also interesting to note that a small share (7%) of the respondents stated that they did not believe in the scientific validity of global climate change. 21% of respondents stated not to believe in the effectiveness of carbon offsetting and 36% of respondents claim to care for the climate with other mitigation measures.

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 (for details see figure 1 in the Appendix). 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 behaviors 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 consists of 871 respondents. All samples are roughly representative for the German speaking part of Switzerland, with respect to age, gender and income (table 1). In fact, the characteristics of these samples do not differ significantly from each other and closely resemble the characteristics of the Swiss population[3].

[3]One exception is the share of respondents with an academic degree: around 36% of respondents

Table 1: Sampling distribution of the respondents

	Percentage in the sample			
Sample	**Full sample N=1010**	**Subsamples N=854**	**N=871**	**Swiss population***
Male	56.5	53.0	57.3	49.3
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
Single	36.6	39.3	36.4	43.2
Married/Registered partnership	49.7	47.7	49.9	43.9
Divorced/Separated	11.2	10.7	11.0	7.8
Widowed	2.3	2.2	2.4	5.1
Not indicated	0.2	0.1	0.2	0.0
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'-option	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	-
$>$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)

hold a degree from either a university, a university of applied sciences or an advanced technical college ((Poly-)Technikum), while 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 ("Höhere Fachschulen HWV, HFG, HFS, Ingenieurschule HTL")).

3.2 Survey design

The survey questionnaire has been developed based on insights from several focus groups and "think aloud protocols" and was tested with a pre-test sample. The questionnaire started with a decision task in which respondents could donate part of their participation remuneration to a mitigation project in Switzerland. This decision task was followed by questions on respondents' consumption habits 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 minimize 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 if similar options were offered to them in real 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).

In addition to the discrete choice experiment, we included a brief section with questions on attitudes and behaviors related to the protection of the environment 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 behaviors was randomized. The questionnaire concluded with questions on socioeconomic characteristics such as age, gender and income.

From the items in the survey questionnaire we built three index/scale variables to use them as proxies to measure *ascription of responsibility*, *adherence to social norms* and the respondent's *carbon footprint*. For a description of the items included in the two scales for measuring ascribed responsibility and adherence to social norms, see table 8 in the Appendix. The reliability and validity of these scales can be expressed in values of Cronbach's α of 0.82 and 0.79 respectively. The index of respondents' carbon footprints was built from the average value of the variables indicating frequency of air travels, yearly number of hotel overnight stays, yearly milage with personal car, frequency of weekly meat consumption[4] and by increasing this average value in case respondents run their heatings on gas or fuel and are

[4] All four variables took values from 1 to 6 and were weighted equally.

traveling business class, while lowering the average value in case respondents claim to participate in carpooling and to buy green electricity.

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 industrializing countries), either for profit- or non profit-providers, certified and uncertified projects[5] and six different offset prices per tCO_2 (see table 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.

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 industrializing 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. Each choice set contained three different alternatives to offset emissions and the option not to offset. 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.

[5]Our pre-tests revealed that the existing certification schemes are unknown to many people. Therefore, we decided to use a simple classification, i.e. the Swiss government, a non-governmental organization (NGO) or the United Nations (UN). While UN and NGO certifications are currently available, there is no Swiss government's certification in today's voluntary carbon markets. 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 (Quality Assurance Scheme, 2011), it could serve as an example for government certification schemes in other countries.

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. The logit model is based on Extreme Value distribution whereas the probit model is based on the normality assumption (Train, 2003). Our main model is a latent class logit model that is used for the analysis of choice-experiment data. This model will be explained in the following section.

We also used a series of probit models to analyze the effect of characteristics of different groups of respondents on their reported offsetting behavior. 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. We analyzed this variable with an ordered probit model to identify the effect of different underlying motivations for carbon offsetting.

The remaining variables are three binary indicators that are used as a proxy for the propensity of non-contributing behavior. 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 (i.e. before the choice experiment). 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 in carbon offsetting. 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 behavior but might be subject to reporting errors. The third variable *(donation)* can be considered as a relatively valid measure

of revealed behavior. We applied a bivariate probit model to different pairs of these three variables. This analysis has a twofold purpose: First, it allows us to identify the important characteristics driving no-offset behavior. Secondly and more importantly, a simultaneous analysis of these variables allows us to assess the reliability of the choice experiment with respect to real behavior.

3.4 The 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. Comparing the two specification in a logit model Hensher and Greene (2003) report that while both specifications allow the researcher to get sufficient information about respondent's preferences, the heterogeneity across individual behavior is captured differently. 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 favored 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 different classes. Class affiliation is thereby unknown to the researcher. The prior probability of individuals being affiliated to 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 later, 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 constant parameter. This parameter, if correctly estimated, measures the status-quo inertia, representing here the consumers' reluctance to 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 behavior of others in voluntary offsetting.

To make use of the information about choice (un-)certainty we get from the follow-up question after each choice card (see figure 1 in the Appendix), following a similar approach as Ready et al. (1995), we recoded all positive responses with certainty level below 4 (out of 6 levels) to a "no offset" response[6]. This implies that uncertain responses regardless 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.

As noted before, 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 that accounts for about 15% of the respondents have shown that their interest in offsetting is quite limited. Therefore, they can be considered as one of the latent classes. Exclusion of these respondents might allow 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 7 in the Appendix). In both analyses, the optimal number of latent classes giving the minimum level of information criteria was four[7].

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

[7] We used AIC and BIC criteria. Both criteria show a rapid decline before four classes. While AIC still slightly declines from 4 to 5 classes, BIC rises by adding the fifth class. The model did not

4 Results

4.1 Latent class analysis

The results of the latent class analysis on the sample of 854 respondents are provided in table 3. Regarding respondents' general willingness to participate in voluntary carbon offsetting, the results suggest that about 42% of the respondents (latent classes 2 and 3) have a clear propensity to participate in offsetting schemes while 58% seem to be reluctant when it comes to the decision to offset or not (latent classes 1 and 4 as well as those respondents who never chose to offset in the choice experiment). These 58% can be considered as either "non-offsetters" or "occasional offsetters" at best. This can be derived from the parameter values of the status quo variable which measures the valuation of "no voluntary offsetting" (positive value reflects positive utility from remaining in the status quo, i.e. from not purchasing an offset) and is more or less in line with respondents' stated general willingness to participate in voluntary offsetting measured on a 5-point Likert scale (see table 1).

As a general result, the propensity to offset seems strongly dependent on the types of mitigation projects that were offered. The parameter values of the different project types show that 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. For example, afforestation projects may be perceived as having positive effects on biodiversity, air quality and landscape aesthetics, while renewable energy projects can be associated with technological progress and improved air quality[8]. In contrast, methane reduction projects do not seem to provide any perceptible ancillary benefits to respondents as they have a significant negative effect on utility across all latent classes. Furthermore, projects implemented in developing countries and those offered by non-profit offset providers were always preferred to projects implemented in newly industrializing countries or by for-profit providers. Possible explanations for this result might be that people worry that their money will not be used purposefully when handled by for-profit providers and that most people believe that newly industrializing countries such as China and Brazil have sufficient own resources to implement mitigation measures. These explanations are consistent with the concerns expressed by many of the participants in our focus groups.

converge with more than five (four) classes for the sample with 854 (1010) respondents.

[8] Interestingly, the clear preference for afforestation projects is at odds with experts' opinions about forestry carbon projects, because these often raise questions about additionality, permanence, and leakage of carbon emissions (UNEP Finance Initiative, 2008; MacKenzie et al., 2012).

Table 3: Latent class model

Number of obs.: N = 6832; Number of resp.: n = 854
Pseudo R^2: 0.224
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

Our results suggest that individuals affiliated with *latent class 1 (16% of the sample)* show a strong reluctance to offsetting, as the status-quo parameter (indicating the utility from not offsetting) is highly positive and significant. These respondents have a close to zero probability of purchasing voluntary carbon offsets. Although this group prefers not to offset in most cases, these respondents show a decided preference for afforestation projects compared to all other project types. They also seem to trust only in non-profit providers and projects certified by the Swiss government. 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.

Individuals belonging to *latent class 4 (27% of the sample)* show both a low probability to offset and a limited willingness to pay. These respondents can be classified as "occasional offsetters". Similar to class 1, their cost sensitivity seems to be lower in contexts with high emissions such as air travel and heating. Other than individuals affiliated with latent class 1 respondents belonging to latent class 4 prefer renewable energy projects to afforestation projects. They also value projects implemented in developing countries, offered by non-profit providers and certified by the Swiss government.

Classes 2 and 3 both represent respondents with a relatively high propensity to voluntarily offset their CO_2 emissions, but still differ strongly regarding their preferences and willingness to pay. Respondents belonging to *latent class 2 (25% of the sample)* can be regarded as the group of respondents who are most likely to offset emissions from their consumption. This can be derived from the positive utility parameter for the amount of emissions reduced and the negative and significant status-quo effect. Respondents affiliated with latent class 2 show by far the highest willingness to pay per tCO_2 and 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. Respondents in this group also highly value project certification by the Swiss government. With respect to the project type, they show a clear preference for renewable energy projects, followed by afforestation projects. Furthermore, respondents belonging to latent class 2 seem to have a clear country preference, valuing projects in developing countries offered by non-profit project providers. The parameters for individual-specific characteristics suggest that people belonging to this group act on the assumption that they follow a social norm when they decide to offset their emissions.

For *latent class 3 (17% of the sample)* the amount of emission 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. 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 class 1*, they also show a lower cost sensitivity for offsetting in contexts associated with high emissions and high cost such as air travel. From the parameters

of respondent characteristics, we can characterize this group as a relatively young population.

Table 4 lists the estimated marginal WTP per tCO_2 for the four latent classes as estimated in table 3. In each context the marginal WTP is obtained as the negative of the ratio of the coefficient of reduced emissions *(emissions reduced in tCO_2)* to the corresponding cost coefficient. The marginal WTP are identified only in cases where both coefficients are significantly different from zero. As seen in this table, the range of WTP values varies considerably across different contexts. Overall, latent classes 2 and 4 show the highest and lowest values respectively.

Table 4: Marginal WTP per one ton reduction of CO_2 emissions by context.

Context	**LC 1**	**LC 2**	**LC 3**	**LC 4**
Air travel	21 CHF	78 CHF	*ni*	6.90 CHF
Space heating	12 CHF	*ni*	*ni*	4.60 CHF
Hotel stay	*ni*	*ni*	*ni*	1 CHF
Car rental	*ni*	*ni*	*ni*	2 CHF

ni=not identified as coefficient of cost or emissions reduced not signif. different from zero

Overall, it can be stated that people belonging to latent class 2, i.e. approximately 25% of the full sample, are the ones most likely to neutralize part of their CO_2 emissions in voluntary offsetting schemes. They not only show a high willingness to participate but also a relatively high willingness to pay per tCO_2, especially for high-emission contexts. People in the other latent classes seem to be more reluctant to compensate for their emissions, either because of doubts towards the effectiveness of offsetting, because of a general refusal of the concept or because of budget constraints. While willingness to pay per tCO_2 is definitely higher in the high emission contexts (air travel, space heating) across all latent classes, the general propensity to offset seems to be higher in low-cost contexts, as our data shows a higher frequency of offset choices in low-cost contexts.

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 characterized as a relatively young group. The respondents in class 2 show a relatively high adherence to social norms. For comparison, we also estimated a comparable latent class model without considering the respondents' uncertainty weights. The results (not reported) suggest a slight increase in the size of latent classes 2 and 4. The remaining results, in particular the preferences about project type and location, indicate quite similar patterns.

The posterior probabilities of affiliation of specific respondents to their respective groups are also listed at the end of table 3. These probabilities are on average fairly close to 1. This implies that for a given respondent identified as a member of a specific latent class, the probability of mis-identification is relatively low. It is interesting to note that the posterior probability of correct identification is the highest in latent class 1 and the lowest in latent class 3. This result suggests that while non-offsetters (typical of class 1) are easily identifiable, the identification

of systematic offsetters (typical of class 3) is relatively difficult. This contrasting difference could be associated with uncertainty in offsetting even if the individual is expected to offset as opposed to a relative certainty in not offsetting, when the tendency is against offsetting. This asymmetry of behavior is quite intuitive because the outcome of voluntary offsetting entails more uncertainty and risk than that of not offsetting. In fact, even if one's expectation is that the offsets will be effective and beneficial, due to imperfect knowledge about the process and its effectiveness, the perceived benefits are subject to a considerable variation.

The results of the latent class analysis on the entire sample of 1010 respondents are provided in in table 7 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 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.

4.2 Characterization of respondents based on stated and revealed choices

To get a more detailed characterization of the respondents who are more likely to offset, we extended our analysis to an ordered probit and two bivariate probit regressions. Because of missing values in some of the control variables this part of the analysis was done based on the subsample of 871 respondents (see table 1). The results of the analysis of the respondents' general willingness to offset[9] are provided in table 5. The included variables in the ordered probit regression are age, gender (dummy for being female), marital status (dummies for both being married and having children), education (dummy for having an academic degree), monthly gross household income (in 7 income groups) as well as an index for the respondent's CO_2 footprint. In order to assess the respondents' motivations for the private provision of public goods, in this context CO_2 emission reductions, we used an index for adherence to social norms and an index for ascribed responsibility to account for internalized norms. For a description of the items included in the two scales see section 3.2 as well as table 8 in the Appendix. To test whether people are conditional cooperators (Fehr and Schmidt, 1999; Fehr and Gächter, 2000) we included a variable that measures people's expectations about the percentage of Swiss consumers that participates in voluntary carbon offsetting schemes, thereby capturing respondents' expectations about others' cooperation in this social dilemma situation (i.e. expected cooperation). Finally, a dummy for respondents' prior knowledge of voluntary carbon offsetting was included.

As shown in table 5, age has a significantly negative influence on the stated willingness to offset. This is consistent with the results from the latent class analysis discussed above (see table 3) and also in line with findings from Mair (2011) in that potential buyers of voluntary carbon offsets in Australia and the UK are likely to be

[9] 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 neutralize part of your emissions from consumption?', with answer options ranging from 'definitely no' to 'definitely yes' on a 5-point-Likert scale (see also table 1).

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 willingness to pay 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.

Table 5: Ordered probit regression

Number of obs.:	N=871	
Log Likelihood:	-1036.3421	
Pseudo R^2:	0.1725	
LR $\chi^2(11)$:	431.95	
Prob $> \chi^2$:	0.0000	
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 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 willingness to pay is income-dependent (see e.g. Liebe et al. (2011) or Kotchen and Moore (2007)). Our results do not confirm this finding.

Instead, we find that potential offsetters can rather be characterized by their behaviors 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 emission-intensive behaviors 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 at 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 of 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 5). This is not in line with expectations that voluntary carbon offsetting leads to behavioral rebound and to an overall higher level of CO_2 emissions. 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 check for plausibility and consistency of our findings, we relate our analysis of stated preferences to revealed preferences data collected in the survey. The first RP variable we use is a dummy indicating whether respondents have ever offset before taking part in the survey[10]. The second RP variable we include is respondents' decision to give part or all of their participation remuneration of 6 CHF to a climate change mitigation project[11]. We relate these two RP variables to the dummy indicating systematic rejection of offset offers in the choice experiment using bivariate probit regressions.

As can be seen in table 6, the results from the ordered probit model (table 5) above are largely confirmed and a significant correlation of the error terms exists in both bivariate probit models. 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 5). However, our results show that the respondents with an academic degree are relatively more likely to have offset emissions in the past (see table 6). 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 willingness to pay for climate-friendly vehicles[12].

In addition, we also tested the effect of respondents' beliefs that offsetting is not an effective way to mitigate climate change[13] on the probability to have offsetted previously and on the probability to always choose not to offset in the choice experiment. This variable has a relatively strong and highly significant influence in both cases, but especially on the decision not to offset in the choice experiment. Therfore, we excluded the variable from the probit models in order to avoid endogeneity bias.

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

[11] The decision whether to give to the climate change mitigation project was made at the beginning of the survey when the subject matter of the survey was still unknown to the participants. We tested several ways to include this information into the model and finally chose the median (donation <3 CHF) for our reporting.

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

[13] 20% of the individuals in the sample with 871 respondents stated not to believe in the effectiveness of carbon offsetting.

Table 6: Bivariate probit models characterizing non-offsetters

Model	**Probit**	**Bivar. probit 1**	**Bivar. probit 2**
Number of observations:	871	871	871
Log Likelihood:	-265.703	-668.387	-810.025
Prob $> \chi^2$:	0.000	0.000	0.000
		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)*
Pr. knowledge of offsets			-0.144
			(0.097)
Constant		0.709**	0.655**
		(0.302)	*(0.271)*
ρ		0.444	0.153
		(0.101)	*(0.078)*

5 Discussion and conclusions

The analysis of choice experiment data used in this paper suggests that overall a considerable fraction of respondents are willing to offset at least part of their carbon emissions. 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 willingness to pay and the propensity of offsetting vary considerably among these individuals. In particular, three distinctive groups can be identified: About 25% of the respondents show a relatively high propensity to offset and also a high marginal WTP for neutralizing emissions. This group's WTP even exceeds the range of VCO market prices. We label this class as "generous buyers." This group can be characterized by relatively high monthly household incomes. Among other characteristics we can mention that these respondents are likely to feel a moral obligation to contribute to climate change mitigation, and to perceive it as a social norm. Part of them also trust in cooperation and expect that other consumers do their 'fair share' in climate change mitigation.

On the other hand, about 17 percent 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 neutralizing 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." Finally, about 27% of the respondents show a relatively low yet positive WTP for neutralizing emissions. This group has a fairly large propensity to offset. Hence, we consider this group as "occasional buyers."

Using the analysis of the no-offset behavior in combination with the latent-class analysis we can characterize 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 and adherence to social norms. Moreover, their expectation about the cooperative behavior of others is relatively low.

As expected, willingness to pay 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 22 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 willingness to pay measures reported in other studies, especially those reported in Brouwer et al. (2008), Achtnicht (2009) 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 82 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.

Our results also point to important patterns of preferences regarding many VCO attributes. 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. Government certification could therefore mitigate suspicion and distrust of potential offset customers.

We also can draw conclusions about the behavioral implications of offsetting from our data. We find that potential offsetters are more likely to have a relatively low CO_2 footprint. This result is especially important when it comes to evaluating the effectiveness of voluntary carbon offsetting on the individual level. Offsetting could lead to higher overall CO_2 emissions if consumers consider carbon offsetting and reducing consumption as substitutes. Only if consumers consider offsetting and reducing consumption as complements, private provision of the public good climate protection may increase. As our results suggest, carbon offsetting is most likely adopted by people that have a comparably low CO_2 footprint. This can be interpreted in a way that most people participating in voluntary carbon offsetting schemes have adopted environmental- and climate-friendly behavior in various fields of their life and consider carbon offsetting as a complement to such behaviors. This result could thus dispel general fears that voluntary carbon offsetting leads to behavioral rebound and to an overall higher level of CO_2 emissions.

The existence of preferences for certain co-benefits of offset projects suggests that willingness to pay 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 benefits from carbon offsetting, they may be willing to make voluntary contributions in addition to government provision schemes. Given the presence of ancillary benefits suggested by this analysis, 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 willingness to pay would probably be downscaled.

In conclusion, this paper suggests that individual contributions to climate change mitigation by means of carbon offsets 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 also raise awareness among consumers about the adverse effects of certain consumption activities on the climate. Voluntary offsetting schemes can thus prepare the ground for the acceptance of more stringent governmental climate policy in the future.

A Appendix

Table 7: Latent class model

Number of obs.: N = 8080; Number of resp.: n = 1010
Pseudo R^2: 0.324
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 8: Indices and scales used in the analysis

Ascribed responsibility (Cronbach's α = 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 α = 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)*

Choice situation: Long-distance flight

Imagine you have booked a long-distance flight, e.g. from Zurich to Bangkok, Cape Town, Hong Kong or Rio de Janeiro. The ticket costs you CHF 1,200 (economy class/round-trip).

While booking your flight you get the information that your flight causes some 3.6 tons of CO_2 emissions per passenger. You are given a choice to offset the CO_2 emissions from your trip.

Imagine you may choose among the following four options:

	Option A full offset	Option B full offset	Option C full offset	Option D no offset
Type of project	Re-/Afforestation	Renewable energy	Energy efficiency	I would choose not to offset emissions in this situation under the given conditions.
Project host country	Newly industrializing country (e.g. China, India, Brazil)	Developing country (e.g. Bangladesh, Burkina Faso, Haiti)	Developing country (e.g. Bangladesh, Burkina Faso, Haiti)	
Type of offset provider	Non-profit provider	For-profit provider	Non-profit provider	
Third-party certification	by the United Nations (UN)	by the Swiss Federal Department of the Environment, Transport, Energy and Communication (UVEK)	not specified	
Amount payable	CHF 18.00 (CHF 5/tCO2)	CHF 104.40 (CHF 29/tCO2)	CHF 82.80 (CHF 23/tCO2)	

Which option would you choose in this situation?

○ Option A ○ Option B ○ Option C ○ Option D

How sure are you that you would choose this option in an actual purchase situation?

○ absolutely unsure ○ quite unsure ○ rather unsure ○ rather sure ○ quite sure ○ absolutely sure

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

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