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

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June 2012

**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 explore the consumers' underlying motives for offsetting emissions and to identify the behavioral patterns in a variety of contexts. The experiment also allows an assessment whether the hypothetical preferences are consistent with the revealed behavior. The adopted discrete choice models account for heterogeneity of preferences especially regarding the willingness to pay for various offset products offered in the market. The results provide a quantitative assessment of consumers' marginal valuation of carbon offsets as well as a better understanding of behavioral responses, which could be used to design more effective markets for voluntary offsets. The paper's findings are also used to derive some general insights into the private provision of public goods in Switzerland.

**JEL-Classification:** Q54, D03, D12
**Key words:** Carbon offsets, Willingness to pay, Choice experiment, Latent class model

*We are grateful to Renate Schubert for her supportive supervision of this research and helpful comments. We also thank Markus Ohndorf, Helga Fehr, William Greene, Jürgen Meyerhoff and Michel Handgraaf for their valuable suggestions.

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# 1 Introduction

About a decade after its first occurrence in 1989[1], neutralizing carbon emissions has emerged as a retail service in a sizable market. By purchasing Voluntary Carbon Offsets (VCO), both individuals and companies can contribute to an increasingly diverse set of mitigation projects. Today's carbon markets provide opportunities to offset $CO_2$ emissions of a wide range of activities from traveling and social events to consumer goods and daily energy use (House of Commons, 2007; Bellassen and Leguet, 2007). A VCO for a given consumption activity is an investment for reducing the global carbon emissions by an equivalent amount hence rendering the activity 'climate neutral'.

The demand for carbon offsets is currently dominated by private companies with a share of more than 90 percent of purchased volumes. Yet, the individual consumers' demand has undergone a considerable growth, especially in many European countries. Worldwide, individual offset purchases more than doubled between 2010 and 2011. The low market share of individual buyers can be explained by the small amounts individuals typically offset (usually for single activities rather than for their entire $CO_2$ footprint) and by the fact that individuals' transaction costs for offsetting are often relatively high, especially because offsetting opportunities at the point of sale are still rare (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. Moreover, many of the driving factors and individual motivations for offsetting represent the overall preferences that should be reflected in the development of companies' responses regarding carbon emissions. It is 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 (Peters-Stanley and Hamilton, 2012).

The potential development of retail demand for VCOs could be an important element of climate policies: 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 on individual consumers. Given the small share of individual consumers in purchased volumes, the existing markets do not seem to target retail buyers who might be interested in lower prices or more flexibility in offseting quantity. Therefore, the potential demand for VCOs can hardly be evaluated based on the existing markets. Identifying the extent of such market potentials is a crucial precondition for designing effective carbon markets and/or the required policy instruments to induce the private sector to take steps toward more effective markets.

On the other hand, voluntary offsetting is a complex benevolent contribution to a public good in that it is bundled with the consumption of a private good (Cornes and Sandler, 1986; Kotchen, 2006, 2009b). The alleviation of individuals' 'green guilt' can lead to an increase in those consumptions, thus creating a behavioral rebound effect (Kotchen and Moore, 2008; Kotchen, 2009a). An adequate policy in carbon markets must account for the possibility of such secondary effects. This can be rendered possible only through a better understanding of the consumers' motivation for offsetting carbon emissions.

In this context, a choice experiment can be helpful to assess the consumers' Willingness

[1] In 1989, the US electricity company AES paid Guatemalan farmers to plant 50 million trees to compensate for AES's carbon emissions and thus pioneered the concept of voluntary carbon offsetting.

To Pay (WTP) for carbon offsetting hence the potential demand. Previous studies generally have focused on a single specific context such as air travel or have used indirect methods to deduce the consumer's WTP. 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 suggests that VCOs are differentiated products from the individual consumers' standpoint. In fact, consumers might value projects differently with respect to co-benefits they provide. Therefore, the demand for VCOs is as complex and heterogeneous as the sources of carbon emissions and mitigation options. An adequate analysis of the WTP for carbon offsets should account for such heterogeneity in tastes and contexts. This paper is a first attempt in the literature to analyze the demand for VCOs with respect to various contexts and mitigation objectives.

In this paper, using an online survey including a choice experiment 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 attributes in VCO demand. The analysis of the data indicates a great deal of heterogeneity in preferences among individuals. This favors targeted policy measures rather than general instruments for promoting voluntary mitigation. 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 voluntary carbon offsets, the influence of context and possible behavioral implications can give important insights into what drives voluntary carbon markets, whether voluntary carbon offsetting can be an effective instrument for climate change mitigation and what would be the role of voluntary carbon markets in case of mandatory governmental regulation.

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 an impure public good combining a private good with a public good component (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). Our analysis aims at shedding light on 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. This can give valuable insights on the effectiveness of voluntary carbon offsetting as a means of reducing overall $CO_2$ emissions.

The existing empirical research on voluntary offsets is mostly based on the stated-preference approach. There are a few exceptions that used revealed preferences in experimental settings. For instance, Diederich and Goeschl (2011b) offered the respondents of an online survey in Germany either a guaranteed reduction of 1t$CO_2$ by retiring a European Union

emissions allowance (EUA[2]) or a guaranteed cash award, randomly drawn between 2 and 100 Euros. They report a mean WTP of 6.30 Euros per ton $CO_2$. Loeschel et al. (2010) conduct a field-experiment with a small sample of 202 individuals from Mannheim, Germany. They provide subjects with 40 Euros and let them choose to buy EUAs at different prices. They report an average WTP of 12 Euros per t$CO_2$.

Most empirical studies focus on single specific contexts. For instance, in the case of air travel, Brouwer et al. (2008) used the contingent valuation method to assess the WTP for a mandatory carbon tax among air travelers at Amsterdam's international airport. They report an average WTP of 25 Euros per t$CO_2$. 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 US-Dollars per trip. In the context of vehicle usage we can cite Ziegler et al. (2009) who used a survey among German and US consumers. Their findings suggest that consumers tend to overestimate the offset costs and that stated knowledge about offsetting doesn't allow predictions on actual purchases of carbon offsets. In a closely related study, Achtnicht (2009) conduct a survey among German consumers to estimate the WTP for climate-friendly cars, which can indirectly be interpreted as the WTP for $CO_2$ reduction. They find a marginal valuation of 68 Euros for one gram of carbon reduction per kilometer, which is approximately equivalent to a WTP of about 130 Euros per t$CO_2$.

## 2.1 Motives for the individual provision of public goods

Other than early theoretical studies on the provision of public goods which predicted voluntary contributions to be null (Olson, 1965; Hardin, 1971), recurring observations of altruistic behavior and the findings from public goods experiments (Ledyard, 1995; Dawes and Thaler, 1988; Camerer, 2003) suggest that some individuals have preferences for the provision of public goods. Starting in the 1970s, a whole strand of economics literature on altruism, philanthropy and donations, e.g. Becker (1974, 1976, 1981), Collard (1978), Phelps (1975) or Sugden (1982), emerged to explain these observations. Later, another line of research started to investigate specifically into the private provision of public goods (Bergstrom et al., 1986; Cornes and Sandler, 1984, 1986, 1994; Andreoni, 1988, 1990; Smith et al., 1995; Vicary, 1997, 2000).

One explanation for the private provision of public goods stems from the simple pure public goods model. In this model, it is assumed that individuals are *purely altruistic*, i.e. they derive utility from the aggregate provision of the public good, irrespective of what person or entity provides it. Therefore, also their own contribution to the public good increases their utility. The simple pure public goods model is based on the assumption that the good is entirely public with no private components, that individuals maximize utility and make the so called "Nash conjecture" that the contributions of other individuals are independent from their own contribution (Sugden, 1982; Cornes and Sandler, 1985; Bergstrom et al., 1986). Under these assumptions, both individuals' contributions and government contributions are perfect substitutes. Private contributions will therefore be fully crowded out by government provision.

However, the results from the pure altruism models were not fully in line with observations from public good experiments and field experiments. Models were thus adapted in a way such that not only the aggregate level of the public good but also the individual's contribution itself generated utility for the respective individuals. This framework is usually

[2]EUA=European Union Allowance

referred to as *warm glow* preferences or *impure altruism* (Andreoni, 1989, 1990). Under the assumption of impure altruism, private contributions are not perfect substitutes to government provision and will thus not be fully crowded out by government provision. Evidence for the existence of impure altruism has been found in various public goods experiments (Andreoni, 1995; Palfrey and Prisbrey, 1997).

Recent work in behavioral economics as well as sociological and psychological literature brought further insights into what drives people's voluntary contributions to public goods. *Social norms* and the need for social approval were found to be an important motive (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 *awareness of the consequences (AC)* of some behavior as well as the *ascription of personal responsibility (AR)* are necessary preconditions for the activation of internalized norms. The prevalence of social and internalized norms in societies may result in higher levels of private public goods provision as predicted by early public goods theories and prevent complete crowding out in case of government interventions.

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.

## 2.2 Contextual influences and behavioral implications

The contextual influences on the WTP for offsets and the behavioral implications of voluntary offsetting on the individuals' consumptions are among the challenging issues that remain to be investigated more closely. Marginal WTP for voluntary carbon offsetting is an indicator for individual's valuation of own contributions to climate change mitigation thus an interesting quantity from a public policy perspective. Although it could be assumed that individuals with positive WTP for own contributions to climate change mitigation place the same value on every ton of $CO_2$ emissions, some indicative findings suggest that individual WTP per t$CO_2$ strongly varies with the underlying consumption activities and the characteristics of the respective offset project.

Furthermore, the tastes and preferences and hence the WTP for offsetting 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. Econometric models that account for unobserved heterogeneity can be used to classify the potential buyers of VCOs into various groups.

The literature 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. Overall, MacKerron et al. (2009) report an average WTP of 24 British Pounds per flight. 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. This may be explained by the fact that the activities, for which carbon offsets are currently offered (e.g. air travel, residential energy consumption, etc.), differ strongly in price, frequency of consumption, and environmental impact (in terms of $CO_2$ emissions).

With respect to 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 have extensively been studied by Thaler (1985), Thaler (1999) and Kahneman (1992). They could partly explain why the propensity to offset and the marginal WTP vary with the offsetting context.

In the same vein, a substantial influence of the environmental impact of the underlying consumption activity on WTP can be assumed. 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 t$CO_2$ 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 environmentally friendly if the costs of the action (either monetary costs and/or 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, heating or car use, 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.

Finally, it 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 offsetted the corresponding emissions (Kotchen, 2009a; 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. Previous research from Kotchen (2009b) implies that if consumers consider offsetting and climate-friendly consumption as complements, the overall private provision of the public good climate protection may increase. In case offsetting is considered as a substitute for climate-friendly consumption, 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 the 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 (Ziegler et al., 2009; Achtnicht, 2009). 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. Out 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 Samples

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 Swiss Francs (about 6.6 US-Dollars) that can be used 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. 22% of the respondents claimed to have offset their own emissions at least once before participating in the survey. This is a relatively high share compared to studies in Germany and Australia that report shares around or below 10% (Lütters and Strasdas, 2010; Mair, 2011). Most of these reported offsets 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 measures instead (e.g. using energy efficient appliances, etc.).

Each respondent was offered 8 choice cards. In each choice card, there were three offset options with different attributes followed by a fourth option with no offset at all (for details see figure 1 in the Appendix). 156 respondents have systematically chosen the no-offset option over all their choice tasks. As we see later these respondents are excluded from the latent class analysis of the choice experiment. Moreover, among the 1,010 respondents who completed the survey, 139 have reported missing values for the follow-up questions that are used in our complementary analyses. Therefore, the final regression samples are subsamples of the initial sample. The sample used for the analysis of the choice experiment includes 854 respondents whereas the sample used in the rest of the analysis consists of 871 respondents. All samples are roughly representative samples 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 the Swiss population[3]. A more detailed description of the samples is given in table 1.

Table 1: Sampling distribution of the respondents

| | Percentage in the sample | | | |
|---|---|---|---|---|
| **Sample** | **N=1010** | **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 | 11.0 |
| Heard about offsetting | 62.8 | 64.2 | 62.7 | - |
| Were offered to offset before | 31.7 | 33.1 | 31.5 | - |
| Offseted 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 Frs.** | | | | |
| less than 3000 Frs | 4.65 | 4.8 | 4.4 | - |
| 3001 to 4500 Frs | 9.90 | 9.3 | 9.3 | - |
| 4501 to 6000 Frs | 20.10 | 20.5 | 20.6 | - |
| 6001 to 9000 Frs | 28.61 | 28.3 | 29.9 | - |
| 9001 to 12000 Frs | 19.21 | 19.4 | 19.1 | - |
| 12001 to 15000 Frs | 9.90 | 10.4 | 10.0 | - |
| more than 15000 Frs | 7.23 | 7.3 | 6.9 | - |
| not indicated | 0.40 | 0.0 | 0.0 | - |
| **Donation at beginning of survey** | | | | |
| $<$3 Frs | 46.6 | 43.6 | 47.3 | - |
| $>$3 Frs | 53.4 | 56.4 | 52.7 | - |
| **General WTP for offsetting part of own $CO_2$emissions** | | | | |
| Defenitely 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 | - |
| Defenitely 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 (data from 2000 on 25 to 64 year old residents); gross household income(data from 2009)

[3]One exception is the share of respondents with an academic degree: around 36% of respondents 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 11% of the Swiss population holds an academic degree.

## 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 previous knowledge and experience regarding carbon offsetting. In order to enable all participants to take an informed decision in the choice experiment, we showed respondents short paragraphs introducing the VCO concept. 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.

To take into account the hypothetical setting of our choice experiment, we reminded people of their budget-constraint in a short *cheap talk script* (Cummings and Taylor, 1999) before the choice tasks. Furthermore, we asked respondents how certain they were about their choice after each decision. We opted for a 6-point-Likert scale ranging from "absolutely unsure" (1) to "absolutely sure" (6). 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; Samnaliev et al., 2006; 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. To avoid order effects, the order of the choice experiment and the section with questions on attitudes and behaviors was randomized. The questionnaire ended with questions on socioeconomic characteristics such as age, gender and income.

From the items in the survey questionnaire we built three index/scale variables in order 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 7 in the Appendix. Their reliability and validity can be expressed in values of Cronbach's alpha 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 or lowering this average value in case respondents run their heatings on gas or fuel, are travelling business class, never participate in carpooling and do not 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

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

profit-providers, certified and uncertified projects [5] and six different offset prices per t$CO_2$ (see table 2).

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 t$CO_2$ | 1.6 t$CO_2$ | 0.25 t$CO_2$ | 0.25 t$CO_2$ |
| Cost of activity | 1200 Frs | 520 Frs | 1200 Frs | 520 Frs |
| Type of offset project | renewable energy, (re-)afforestation, energy efficiency, methane reduction | | | |
| Project 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 of offset (Frs/t$CO_2$) | 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.

## 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 ($\epsilon_{ij}$) 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 $\epsilon_{ij}$ captures all the unobserved heterogeneity across the individuals and alternatives.

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

[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.

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

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

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 offseting behavior. This is recorded by several proxies. The first measure is a qualitative 5-point scale variable for the respondent's general willingness to pay for offsetting 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 the choice experiment's offset offers proposed to them. The second measure is an indicator for the respondents who had never any previous offset experience. Finally the respondent's actual donnation during the survey out of their 6-Francs remuneration is used to construct a bianry indicator for respondents who did not contribute much in carbon offsetting. The first variable is a purely stated-preference measure based on a hypothetical experiment. The second one represents the revealed behavior but might be subject to reporting errors. The third varaible (the actual 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 assese 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 distictively 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 critera such as the Aikaike 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:

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

where $H_{iq}$ is the prior probability that individual $i$ belongs to latent class $q$. If individual $i$ has $T_i$ choices, assuming that these choices are independent of each other, the contribution of $i$ to the likelihood will be the joint probability of the sequence $y_i = [y_{i1}, y_{i2}, ..., y_{iT}]$, that is:

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

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):

$$H_i q = \frac{exp(z'_i\theta_q)}{\sum_q exp(z'_i\theta_q)}$$

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 types, certification and location of mitigation projects and also the type of provider (for details see table 2). The utility derived corresponding to 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 in voluntary offsetting. In line with Bech and Gyrd-Hansen (2005), we used effect 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.

# 4 Results

## 4.1 Results from the latent class models

For the latent class analysis the observations for 156 respondents who always opted not to offset in the choice experiment (i.e. who always chose option 4) were dropped from the dataset. They account for 15% of the sample and can be assumed to build a class of their own with a stated WTP for offsetting of zero. As their choices did not deliver any information about trade-offs between attributes, including them in the model would not improve results[6]. The remaining sample consisted of 854 respondents (for sample characteristics, see table 1). To make use of the information about choice (un-)certainty, we followed a similar approach to the ones in Ready et al. (1995) and Champ et al. (1997) and recoded all choices for which respondents indicated a certainty level below 4 (out of 6 levels) to a "no offset" decision. Following Champ et al. (1997), we asymmetrically recoded uncertain answers to "no offset" without doing the reverse to uncertain "no offset"-choices. This can be justified by the fact that respondents indicated a certainty level above 4 in 87% of the "no offset"-choices while a certainty level above 4 was indicated for only 78% of the choices of offsets. However, we recode only answers with a certainty level lower than 4, while Champ et al. (1997) recode all answers below the highest possible certainty level (which is 10 in their case). The latter defines a lower bound for willingness to pay. We follow Ready et al. (1995) by using a uncertainty scale with only 6 levels expressed verbally rather than numerically (from "no, not at all sure" (1) to "yes, very sure" (6)).

Applying the latent class multinomial logit model to this sample of 854 respondents with recoded choices leads to 4 latent classes with different preferences for voluntary carbon offsetting (see table 3), in addition to the alread defined class of 'no offsetters'. Regarding respondents' general willingness to participate in voluntary carbon offsetting, our data suggest that about 52% of the respondents have a clear propensity to participate in offsetting schemes while 48% seem to be reluctant when it comes to the decision to offset or not. This can be derived from the parameter values of the status quo variable (see table 3) which measures the effect of remaining in the status quo (i.e. no voluntary offsetting) on utility as well as from the parameter values indicating the utility from the amount of emissions reduced. This result is more or less in line with respondents' stated general willingness to pay for carbon offsetting measured on a 5-point Likert scale (ranging from 'definitely no' to 'definitely yes'). 55% of respondents, both of the 1,010 sample and the 871 sample, state that they are rather or very sure that they will (sometimes) compensate own emissions in the future, some 25% are undecided and 20% of the sample state that they are rather or very sure not to offset in the future.

As a general result, 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. 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

[6] For comparison, the results from the latent class model based on the full sample can be found in table 6 in the Appendix.

consistent with the concerns expressed by many of the participants in our focus groups.

Table 3: Latent class model (uncertain positive responses coded as negative responses)

Number of obs.: N = 6832; Number of resp.: n = 854; Number of param.: p = 68
Pseudo $R^2$: 0.224
Information criteria: AIC/N = 2.17; BIC/N = 2.24; HIC/N = 2.20

| | **LC 0** | **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) | 15 | 16 | 25 | 17 | 27 |
| **Attributes** | | | | | |
| Cost (in Frs) air travel | | -0.022*** | -0.005*** | -0.052*** | -0.021*** |
| | | *(0.006)* | *(0.001)* | *(0.004)* | *(0.002)* |
| Cost (in Frs) heating | | -0.038** | -0.003 | -0.101*** | -0.031*** |
| | | *(0.016)* | *(0.002)* | *(0.006)* | *(0.002)* |
| Cost (in Frs) hotel | | -0.154 | 0.087*** | -0.071*** | -0.129*** |
| | | *(0.118)* | *(0.013)* | *(0.015)* | *(0.013)* |
| Cost (in Frs) rental car | | -0.205 | 0.053*** | -0.086*** | -0.070*** |
| | | *(0.125)* | *(0.013)* | *(0.016)* | *(0.012)* |
| Emissions reduced (in t$CO_2$) | | 0.463*** | 0.391*** | -0.007 | 0.144*** |
| | | *(0.168)* | *(0.087)* | *(0.078)* | *(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)* | *(0.149)* | |
| 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 |

Respondents who seem to be rather skeptic towards the concept of carbon offsetting and

thus less likely to offset their emissions can be found in *latent classes 1 and 3*. 16% of the 1,010 sample can be assigned to class 1, and 17% to class 3 (see table 3). Together with the group of 15% of respondents who never chose to offset in the choice experiment *(latent class 0)*, 48% of respondents can generally be assigned to the larger group of "no offsetters".

Individuals affiliated with *latent class 1 (16%)* seem to be better off without offsetting, as the parameter indicating utility from keeping up the status-quo (no offset) is highly positive and significant. With respect to the project type, they strongly prefer afforestation projects to all other project types. They also seem to trust only in non-profit providers and projects certified by the Swiss government. Although this group prefers not to offset in most cases, their cost sensitivity for offsetting seems to reduce in situations where the underlying consumption activity is associated with high $CO_2$ emissions and when this consumption activity comes at a high cost, such as in the case of long-haul flights. Latent class 1's willingness to pay per t$CO_2$ ranges from 20.97 Frs in the air travel context to 2.26 Frs in the rental car context.

Respondents assigned to *latent class 3* also seem to be reluctant when it comes to the decisions to offset or not as the utility of the amount of emissions reduced is negative. However, compared to *latent class 1*, the utility of keeping up the status quo is negative and significant. This group of people can therefore be described as undecided. They might opt to offset emissions from their consumption rather randomly than systematically. 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. Other than respondents belonging to *latent class 1*, they accept projects certified by a government agency or a UN body, while NGO certification is valued negatively. As the utility parameter for the amount of emissions reduced is insignificant in *latent class 3*, willingness to pay is not defined for this latent class. From the parameters of respondent characteristics, we learn that this group are younger people than those in *latent class 1*.

*Classes 2 and 4* both represent respondents with a relatively high propensity to voluntarily offset their $CO_2$ emissions, but still differ regarding their preferences. *Latent class 2* (25% of the 1,010 sample) stands for respondents with a clear preference for offsetting which can be derived from the positive utility parameter for the amount of emissions reduced and the negative parameter for the status-quo variable. *Latent class 4* (27% of the 1,010 sample) seems to have a more limited preference for offsetting, indicated by the small but positive utility from keeping up the status-quo.

Respondents belonging to *latent class 2* can be regarded as the group of respondents who are most likely to offset emissions from their consumption. They also show by far the highest willingness to pay per t$CO_2$ and seem to be especially interested in offsetting activities associated with high emissions such as air travel and space heating. Their WTP per t$CO_2$ ranges from 142 Frs in the heating context, to 79.81 Frs in the air travel context to 4.47 Frs and 7.39 Frs in the hotel and car rental contexts, respectively. Respondents in this group also highly value project certification by the Swiss government. With respect to project type, they show a clear preference for renewable energy projects, followed by afforestation projects. Other than *latent classes 1 and 3*, they 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.

Individuals belonging to *latent class 4* (27% of the 1,010 sample) show a limited willingness

to offset part of their emissions. Their cost sensitivity seems to be lower in contexts with high emissions such as air travel and heating. However, willingness to pay reaches only 6.88 Frs per t$CO_2$ for air travel and 4.60 Frs per t$CO_2$ for space heating. This might also partly be due to budget constraints. For rental car use and hotel stays willingness to pay lies in the range of 1 to 2 Frs per t$CO_2$. Similiar to *latent class 2*, also respondents belonging to *latent class 4* prefer renewable energy projects in developing countries, offered by non-profit providers and certified by the Swiss government.

Overall, it can be stated that people belonging to latent class 2, i.e. approximately 25% of the 1,010 sample, are the ones that are 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 t$CO_2$, especially for high-emission contexts. People in latent classes 1, 3 and 4 might be more reluctant to compensate for their emissions, either because of general doubts towards the concept or because of budget constraints.

For comparison, we also estimated the utility parameters of the same model estimated on the 854 sample without recoding uncertain answers to "no offset" decisions. The group of potential "offsetters" (latent classes 2 and 4) increases slightly. Preferences in the unrecoded model resemble the results of the recoded model, but are more pronounced. If not accounting for choice (un)certainty, also respondents from latent classes 1 and 3 seem to prefer renewable energy projects to afforestation projects. Preferences for projects in developing countries, by non-profit providers and certified by the Swiss government remain stable across all latent classes. The parameters for individual-specific characteristics allow for a more detailed description of the four classes. While latent class 1 seem to be older respondents, latent classes 2, 3 and 4 seem to be younger respondents who are guided by social norms. Latent class 4 members could even be classified as "conditional cooperators" as they are more likely to expect others to offset part of their emissions, i.e. they expect others' cooperation in this social dilemma situation.

## 4.2 Characterization of offsetters and non-offsetters

To identify those people that are either most likely or highly unlikely to participate in voluntary offsetting schemes we ran a separate ordered probit regression and two bivariate probit regressions. Because of missing values in some of the variables, the sample for these regressions had to be reduced to 871 respondents (for a sample description see table 1). The dependent variable in the ordered probit regression (see table 4) is the response to the question 'Are you generally willing to offset part of your $CO_2$ emissions from consumption in the future?'. Response options ranged from 'definitely no' to 'definitely yes' on a 5-point Likert scale. Regressors were age, gender (dummy for being female), dummies for both being married and having children, dummies 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.

Table 4: 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 WTP** | **Parameter** | **Standard error** |
| Age group (10y-intervals) | -0.084*** | 0.031 |
| Being female | 0.025 | 0.088 |
| Being married | 0.026 | 0.094 |
| Having own children | -0.111 | 0.099 |
| Having academic degree | -0.112 | 0.083 |
| Monthly gross income | 0.095*** | 0.028 |
| $CO_2$ 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 |

As referred to in section 2, there are several theories that explain the private provision of public goods. To test the importance of these theories for willingness to participate in voluntary carbon offsetting, we used an index for adherence to social norms and an index for ascribed responsibility. 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, capturing respondents' expectations about others' participation in offsetting schemes (i.e. expected cooperation). Finally, a dummy for respondents' previous knowledge of voluntary carbon offsetting was included. For a description of the items included in the different scales see table 7 in the Appendix.

As in the latent class model, also in the ordered probit regression age has a significantly negative influence on the propensity to offset. This is in line with findings of Mair (2011) who also find that potential buyers of voluntary carbon offsets in Australia and the UK are likely to be younger than non-buyers. On the contrary, gender, being married or having children do not seem to have a significant influence on the propensity to offset in our analysis, while Mair (2011) finds that potential buyers of offsets are more likely to be male. 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 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 and attitudes than by their socioeconomic characteristics. 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 than respondents who practice emission-intensive consumption activities less frequently. Potential offsetters can as well be characterized by a strong feeling of personal responsibility to contribute to climate change mitigation, by a strong adherence of social norms and high expectations about others' cooperation in this social dilemma situation.

These results are generally confirmed by the results of a probit regression and two bivariate probit regressions we ran on the propensity to always choose not to offset in the discrete choice experiment *(No offset in DCE)*, the propensity to have offsetted in the past, i.e. before the survey *(previous offset)* and on the propensity to having donated less than 3 Frs to the migitation project at the beginning of the questionnaire (see table 5). An additional result from these models is that people are more likely to have offsetted in the past if they have an academic degree[7]. We also tested the effect of individuals' belief that offsetting is not an effective way to mitigate climate change[8] 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.

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

[8] 20% of the individuals in the sample with 871 respondents stated not to believe in the effectiveness of carbon offsetting.

Table 5: 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** | **No offset in experiment** | **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)* |
| Having own children | 0.010 | 0.012 | -0.001 |
| | *(0.160)* | *(0.160)* | *(0.160)* |
| University education[9] | 0.075 | 0.033 | 0.073 |
| | *(0.135)* | *(0.134)* | *(0.135)* |
| Gross income (7 categ.) | -0.032 | -0.021 | -0.030 |
| | *(0.046)* | *(0.046)* | *(0.046)* |
| $CO_2$ 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)* |
| Expectations about coop. | -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 Frs** |
| 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)* |
| Having own children | | -0.084 | 0.025 |
| | | *(0.134)* | *(0.118)* |
| Academic degree | | -0.350*** | 0.038 |
| | | *(0.105)* | *(0.096)* |
| Gross income (7 categ.) | | -0.130*** | -0.038 |
| | | *(0.037)* | *(0.033)* |
| $CO_2$ 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 coop. | | -0.429 | -0.391 |
| | | *(0.338)* | *(0.304)* |
| Pr. knowledge of offsetts | | | -0.144 |
| | | | *(0.097)* |
| Constant | | 0.709** | 0.655** |
| | | *(0.302)* | *(0.271)* |
| Rho | | 0.444 | 0.153 |
| | | *(0.101)* | *(0.078)* |
| $\chi^2(1)$: | | 16.792 | 3.721 |
| Prob $> \chi^2$: | | 0.000 | 0.054 |

# 5 Discussion and conclusions

Overall, a quite substantial share of residents of the German speaking part of Switzerland seem to be generally willing to offset some part of their consumption, although willingness to pay is in most cases strongly context-dependent (with a general preference for high-emission contexts) and limited in size. About half of the population shows a relatively strong interest for carbon offsetting opportunities, though part of these people seem to be strongly budget-constrained. WTP ranges from 1 to 21 Frs per t$CO_2$, depending on context and consumer class, thus being on the lower end of the range of carbon prices we used in the experiment. Only latent class 2 shows exceptionally high WTP values ranging from 4.50 up to 142 Frs per t$CO_2$. These individuals seem to be willing to pay any price currently offered in the market[10] and therefore offsetting schemes might want to target this group of consumers. According to the results from the ordered probit, probit and bivariate probit regressions, individuals assigned to class 2 tend do be younger people with relatively high monthly household income who feel a moral obligation to contribute to climate change mitigation. These individuals also seem to perceive offsetting their emissions as a social norm and expect that other consumers cooperate and do their 'fair share' in climate change mitigation.

Furthermore, potential offsetters seem to be respondents with a relatively low $CO_2$ footprint. This results gets important when it comes to evaluating the effectiveness of voluntary carbon offsetting. According to Kotchen (2009b) and Kotchen and Moore (2008) offsetting could lead to higher overall $CO_2$ emissions if consumers consider carbon offsetting and a climate-friendly lifestyle as substitutes. Only if consumers consider offsetting and climate-friendly consumption as complements, private provision of the public good climate protection may increase. Our results suggest that carbon offsetting is most likely adopted by people that have a comparably low $CO_2$ footprint. This could be interpreted in a way that most people participating in voluntary carbon offsetting schemes have adopted environmental- and climate-friendly behavior and consider carbon offsetting as a complement to such behaviors. This result could dispel general fears that voluntary carbon offsetting leads to behavioral rebound effects and to an overall higher level of $CO_2$ emissions.

Another interesting result is that respondents trust very much in government certification. This was a hypothetical attribute as to date no such government certification of offset projects exists in Switzerland. Our results show that such a certification could strongly increase willingness to pay for voluntary carbon offsetting of Swiss people. About 52% of the survey respondents indicated some kind of suspicion and distrust about the use (or potential abuse) of the money they give to carbon offsetting projects. Our choice experiment shows that the Swiss government is considered as particularly trustworthy and reliable when it comes to certification of mitigation projects. A government certification scheme could thus raise the level of participation in offsetting schemes substantially.

An example for such a government certification scheme could be the UK Government's Quality Assurance Scheme for Carbon Offsetting launched in 2009. However, the scheme was closed in 2011 (Quality Assurance Scheme, 2011). One of the official explanations was that the voluntary carbon market has evolved and a number of reliable quality standards has emerged (Bateman, 2011). In principle, this is true. However, private consumers might not have enough knowledge about these quality schemes and so a government scheme may

[10] In 2011, prices on the voluntary carbon market ranged between 0.1 and more thane 120 dollars (Peters-Stanley and Hamilton, 2012).

have a higher effect on people's trust in carbon offsetting schemes. Some countries provide consumers with guidebooks for choosing the right carbon offset providers and projects (e.g. UBA/DEHST (2008)), but this requires that people actively search for information about quality criteria which may already be too much effort for the average consumer. Compared to this solution, a government certification scheme would lower transaction costs for consumers.

The existence of preferences for certain co-benefits of offset projects suggests that willingness to pay for carbon offsetting will not be fully crowded-out in case government sets up a general $CO_2$ price. Because of political opposition, an effective environmental regulation in the form of a substantial $CO_2$ tax or an emissions trading system has not been established so far. Yet, it is highly plausible that additional and stronger governmental regulations on $CO_2$ emissions will successively be introduced within the next 5 to 10 years in Switzerland and other countries. The introduction of stronger government regulation could thus either increase or undermine existing voluntary schemes for internalization of consumption externalities. Under the assumption of individuals with purely altruistic preferences, Andreoni (1988, 1990) assumes that private contributions will be fully crowded out by governmental subsidization or direct provision of the public good *('neutrality hypothesis')*. However, if certain consumers have additional benefits from carbon offsetting, they might be willing to make voluntary contributions even though government has introduced some mandatory scheme. Our results show, that this is clearly the case. We would thus expect, that the introduction of some mandatory $CO_2$ tax would not fully erase the market for voluntary carbon offsetting, though probably downscale the potential buying public and their willingness to pay.

In conclusion, it seems to be adequate to consider individual contributions to climate change mitigation by means of carbon offsets as a complement to mandatory governmental regulation. The voluntary carbon market provides useful information about consumers preferences regarding different offset projects. Indirectly, this could be interpreted as information about their preferences regarding different mitigation measures, although these preferences might not coincide for some individuals. 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.

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# Appendix

Table 6: Latent class model (uncertain positive responses coded as negative responses)

Number of obs.: N = 8080; Number of resp.: n = 1010; Number of param.: p = 68
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 Frs) air travel | -0.022* | -0.005*** | -0.050*** | -0.020*** |
| | *(0.012)* | *(0.001)* | *(0.004)* | *(0.001)* |
| Cost (in Frs) heating | -0.045* | -0.003 | -0.091*** | -0.030*** |
| | *(0.024)* | *(0.002)* | *(0.005)* | *(0.002)* |
| Cost (in Frs) hotel | -0.269 | 0.086*** | -0.084*** | -0.125*** |
| | *(0.164)* | *(0.013)* | *(0.014)* | *(0.014)* |
| Cost (in Frs) rental car | -0.322 | 0.054*** | -0.083*** | -0.074*** |
| | *(0.224)* | *(0.013)* | *(0.015)* | *(0.013)* |
| Emissions reduced (in t$CO_2$) | 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 |

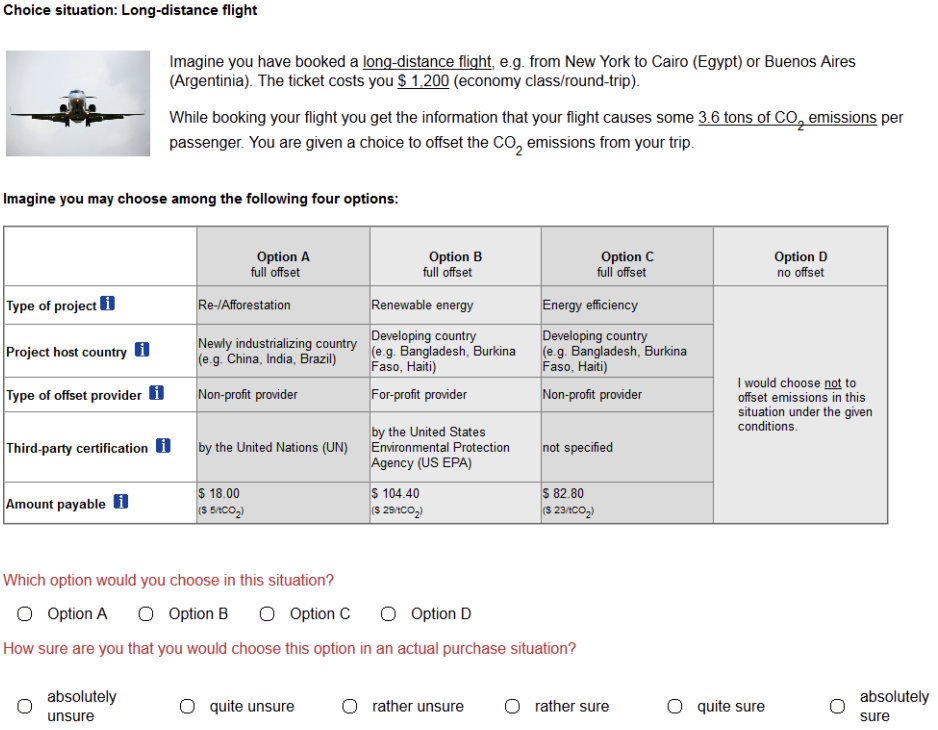
Table 7: Indices and scales used in the analysis

**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 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 New York to Cairo (Egypt) or Buenos Aires (Argentinia). The ticket costs you $ 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 United States Environmental Protection Agency (US EPA) | not specified | |
| Amount payable | $ 18.00 ($ 5/t$CO_2$) | $ 104.40 ($ 29/t$CO_2$) | $ 82.80 ($ 23/t$CO_2$) | |

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.