

# Are the affluent prepared to pay for the planet? Explaining willingness to pay for public and quasi-private environmental goods in Switzerland

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**Abstract** A large number of ‘environmental justice’ studies show that wealthier people are less affected by environmental burdens and also consume more resources than poorer people. Given this double inequity, we ask, to what extent are affluent people prepared to pay to protect the environment? The analyses are couched within the compensation/affluence hypothesis, which states that wealthier persons are able to spend more for environmental protection than their poorer counterparts. Further, we take into account various competing economic, psychological and sociological determinants of individuals’ willingness to pay (WTP) for both public environmental goods (e.g., general environmental protection) and quasi-private environmental goods (e.g., CO<sub>2</sub>-neutral cars). Such a comprehensive approach contrasts with most other studies in this field that focus on a limited number of determinants and goods. Multivariate analyses are based on a general population survey in Switzerland ( $N = 3,369$ ). Although income has a positive and significant effect on WTP supporting the compensation hypothesis, determinants such as generalized interpersonal trust that is assumed to be positively associated with civic engagement and environmental concern prove to be equally important. Moreover, we demonstrate for the first time that time preferences can considerably influence survey-based WTP for environmental goods; since investments in the environment typically pay off in the distant future, persons with a high subjective discount rate are less likely to commit.

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## Introduction

A large number of empirical studies within environmental justice research show that wealthier people suffer less from environmental burdens and yet leave behind a greater ecological footprint (Wackernagel et al. 1999; York et al. 2003) than poorer people (Diekmann and Jann 2000; Lenzen and Murray 2001; Evans and Kantrowitz 2002; Muniz and Galindo 2005, among others). This socially unequal distribution<sup>1</sup>—of environmental burdens and consumption of resources—represents two sides of the same coin, resulting in a double advantage to wealthier individuals. To what extent are the affluent thus prepared to pay more for the protection of the environment? A greater willingness to pay (WTP) could be viewed as compensation for this double advantage. We do not presume that this trade-off is always subject to intention; in some circumstances, the compensation behavior may have the character of a byproduct of individual environment-related behavior. Alongside the compensatory view, with its argument for the retributive effect of varying degrees of WTP, within public debate and academic literature, some argue that environmental protection is a good that is reserved for those who are better off (the affluence hypothesis) and can afford it (e.g., Baumol and Oates 1979; Barry and Field 2009).

These two complementary hypotheses—the compensation hypothesis and the affluence hypothesis<sup>2</sup>—both prompt the central question: is income really the most important factor determining WTP for public and for (quasi-)private environmental goods?<sup>3</sup> Can a social distribution of WTP, dominated by those with higher incomes, be identified at all? Or are there other factors of equal significance affecting WTP independent of income? In order to answer such questions conclusively, various competing determinants affecting WTP must be taken into consideration. Previous studies have not always done so, and our paper takes this gap as its starting point. Many economic studies in the field of WTP analysis (or more specifically in the field of economic valuation) place the emphasis, along with attitudes relating to environmental goods, solely and fundamentally on income as the main explanatory variable (e.g., Bateman et al. 2002: 195). On the other hand, in sociological and psychological studies, income is given far less attention (e.g., Ajzen and Driver 1992; Kahneman and Ritov 1994). These studies place the emphasis largely on attitudes and norms as the determinants (using, e.g., the theory of planned behavior, as in Pouta and Rekola 2001 or the norm activating model, as in Guagnano 2001).

<sup>1</sup> Different definitions and theories of justice and equity (e.g. egalitarianism) have been excluded from this paper. See the overview in Liu (2001) for more information on this subject.

<sup>2</sup> Because the compensation hypothesis and affluence hypothesis are complementary and correspond to the same theoretical mechanism, in the remainder of the text, we refer only to the compensation hypothesis.

<sup>3</sup> We use the term “quasi-private environmental good” to describe goods which have characteristics of a private good and, in addition, positive external effects on the environment, see explanation below.

Although some studies support individual theories and confirm the effect of particular characteristics, it is uncertain if these theories and effects hold up in a direct comparison. In general, often the acknowledgement of competing explanatory factors shows that the effects of individual characteristics are overestimated or lose their significance entirely.

To assess the validity of the compensation hypothesis while controlling for alternative explanations, we examine the competing theoretical determinants of individuals' WTP for environmental goods discussed in various economic, psychological, and sociological theories. Besides income, we also take into account altruism, generalized trust, conditional cooperation (strategies), environmental concern, and post-materialistic values. In addition, and to our knowledge for the first time, we examine the influence of time preferences, or subjective discount rates, on survey-based WTP for environmental goods. By systematically incorporating competing determinants, our study also contributes to the literature that argues in favor of comparing and combining theories to explain environmental attitudes (Franzen and Meyer 2010), WTP (Liebe et al. 2010), and other forms of pro-environmental intentions or behavior (see, e.g., Stern 2000; Wall et al. 2007). To date, most studies have focused on a single theory or a limited number of theoretical determinants.

Using data from the 2007 Swiss Environment Survey ( $N = 3,369$ ), a general population study, we empirically test the effects of several theoretically proposed determinants of WTP for increased general environmental protection, CO<sub>2</sub>-neutralizing devices for cars as well as CO<sub>2</sub>-neutral fuel. This variety of dependent variables allows us to draw more general conclusions about the determinants of WTP for environmental goods. From a theoretical perspective, the focus is on the distinction between pure public environmental goods such as measures toward general environmental protection and quasi-private environmental goods such as CO<sub>2</sub>-neutral fuel. All the environmental goods examined have one commonality: they involve the payment of a 'surcharge' on top of the cost of less environmentally friendly alternatives. These payments thus constitute the characteristic differentiating them from traditional forms of pro-environmental behavior, which are not dependent on individual wealth per se and may even bring financial benefits (saving energy, for example).

### **Theoretical determinants of willingness to pay**

According to the compensation hypothesis, we begin our theoretical review of the determinants of WTP for environmental goods with the standard economic theory (i.e. income). Then, we discuss the importance of time preferences (i.e. subjective discount rates), altruism, and aspects of social dilemmas (i.e. generalized trust and conditional cooperation). Finally, we examine determinants from research into attitudes and values (i.e. environmental concern and post-materialistic values).

As discussed in the introduction, we differentiate our explanatory objects and distinguish between WTP for pure public environmental goods (e.g., measures toward general environmental protection) and quasi-private environmental goods

(e.g., CO<sub>2</sub>-neutral fuel). Pure public environmental goods are characterized by a non-excludability and non-rivalry of consumption (Samuelson 1954; Cornes and Sandler 1986). Quasi-private environmental goods, however, show all the characteristics of private goods (excludability and rivalry) and thus produce individual private utility (e.g., the benefits of driving). But at the same time they do also have positive external effects on the environment (e.g., the improvement of environmental quality by using CO<sub>2</sub>-neutral fuel). Thus, some of the theoretical determinants may vary in the strength of their effect depending on the environmental good considered.

**Income**

According to the compensation hypothesis (or the affluence hypothesis), income is the most important determinant of WTP for public and quasi-private environmental goods (Baumol and Oates 1979; Carson et al. 2001; Barry and Field 2009). In the context of a restricted budget—given identical preferences—individuals with a higher income will be able to spend more for environmental goods than individuals with a lower income. Thus, we expect a positive effect of income on WTP for both pure public environmental goods and quasi-private environmental goods (see Table 1). From this standard economic view, behavioral differences do not arise from varying preferences, which are assumed to be the same for all but are the result of unequal constraints (i.e. incomes).

**Subjective discount rate**

Thwarting the expectations of standard economic theory, individuals do not always behave rationally when purchasing environmentally friendly goods. For example, when buying durable household goods such as a refrigerator, people often do not choose the model likely to be the most economical in the long run and which is ecologically preferable. When consumers have a stronger preference for the present over the future, they choose models with higher energy consumption but lower

**Table 1** Theoretical determinants of and effects on willingness to pay for environmental goods

Determinants	Expected effects on willingness to pay for...	
	Pure public environmental goods	Quasi-private environmental goods
Income	++	++
Subjective discount rate	--	--
Altruism	++	+
Generalized trust	++	+
Conditional cooperation	--	-
Environmental concern	++	++
Post-materialistic values	++	++

++ strong positive effects, + positive effects; -- strong negative effects, - negative effects

initial costs over models with low energy consumption but greater initial costs (Hausman 1979; Gately 1980; Ruderman et al. 1987).

Time preferences can be expressed in the subjective discount rate as an element of the discounting function (Samuelson 1937), which corresponds to the relative value that a person ascribes to her well-being at the point  $t$  in time compared to the point  $t + x$  (see Frederick et al. 2002 for a theoretical overview). The higher the subjective discount rate, the less important the future well-being. Investments in public and quasi-private environmental goods such as political measures toward environmental protection and the consumption of CO<sub>2</sub>-neutral fuel are exactly the kind of investments which only pay off in the distant future, and their utility for the environment is not directly noticeable. Thus, people with a higher subjective discount rate or a lower orientation toward the future should be less likely to pay for such goods.<sup>4</sup>

### Altruism

As the use-value of environmental goods is often not immediately apparent and is not restricted to those who pay, altruism must also be taken into consideration as a determinant. In the literature on economic valuation of public environmental goods, this idea has already been taken up with the concept of ‘non-use values’ (e.g., Freeman III 2003). According to this notion, expenditure on environmental goods leads to a bequest value in that the natural environment (diversity of species, water quality, etc.) is preserved for future generations: individuals’ own children and grandchildren. Altruism is not, however, necessarily directed solely at other people as beneficiaries; it can also be aimed at animals and plants, whole landscapes or the biosphere itself (Stern et al. 1993; Guagnano et al. 1994). Altruists are interested in improving the welfare of third parties, whether people or elements of the natural environment. In contrast to this ‘pure’ altruism, some studies have shown that altruistic behavior can itself generate use-value (‘participatory altruism’ is examined in Margolis 1982, and ‘impure altruism’ in Andreoni 1989, 1990), the feeling of ‘doing something good’. Expenditure on environmental goods is one way of purchasing this ‘feel-good factor’ or ‘moral satisfaction’ (see Kahneman and Knetsch 1992). Empirically, it is difficult to separate ‘pure’ altruism from ‘impure’ altruism (the ‘feel-good factor’). In the context of an additional use-value component, altruists, whether acting from ‘pure’ or ‘impure’ altruism, should show a greater WTP for environmental goods.

The influence of altruism is certainly not restricted to pure public environmental goods. In the case of WTP for quasi-private environmental goods, too, a positive relationship can be expected (Guagnano 2001, among others). This relationship is likely to be weaker because the private utility component is added to the public one.

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<sup>4</sup> Alongside this income-independent effect of time preferences, an indirect affluence or income effect can also be inferred. Studies in environmental research have demonstrated that higher income households show lower discount rates, sometimes close to the market interest rate (see, for example, Hausman 1979).

## Generalized trust and conditional cooperation

So far, we have viewed WTP (within the literature on economic valuation) as the purchase of environmental goods influenced by income as a budget constraint as well as time preferences and explicit altruistic preferences. This view changes fundamentally when WTP is taken as a contribution to a public (environmental) good for which non-excludability from the benefit applies (Samuelson 1954). This means that even people who have contributed nothing profit from the provision of the good, in the sense that their preferences are also met. The individual incentive to use the good as a ‘free rider’ leads to a social dilemma: “Social dilemmas are situations in which individual rationality leads to public irrationality. [...] As individuals we are each better off when we make use of a public resource, such as public television, without making any contribution, but if everyone acted on this conclusion, the public resource would not be provided and we would all be hurt” (Kollock 1998, p. 183).

In contrast to these incentive structures, individuals do nevertheless make substantial (albeit often suboptimal) contributions to public (environmental) goods (see Ledyard 1995; Camerer 2003 for overviews). They are willing to make expenditures although they could benefit from the others’ expenditure without doing anything themselves. Are people not aware of the structure of the social dilemma situation, or do they rely on the simultaneous financial contributions of others? Various theoretical approaches have attempted to place these and other questions in relation to voluntary contributions to public goods. Two determinants are consistently addressed: conditional cooperation and generalized trust (e.g., Ostrom 2000; Putnam 2000; Fischbacher et al. 2001; Gächter 2007). Central to both concepts (which are somewhat related) is the dependence of individuals’ behavior on expectations regarding the behavior of others. Conditionally cooperating individuals only make a contribution to a specific public good such as environmental protection when they are convinced that others are also doing so. Conversely, unconditionally cooperating individuals make decisions concerning WTP for a specific good entirely independent of their expectations of third parties’ actions. One might argue that generalized (or social) trust turns people into unconditional cooperators or that it makes conditional cooperators confident that the others also contribute to public goods. In either case, those who have a high level of generalized trust are more likely to initiate cooperation and, hence, to contribute more to the provision of public goods than those with lower levels of generalized trust.

Independent of other determinants, WTP should be lower when people base their pro-environmental behavior on the contributions of third parties and higher when they have generalized trust in others. These expected correlations should apply to both public and quasi-private environmental goods, as both improve the general quality of the environment. With quasi-private environmental goods such as CO<sub>2</sub>-neutral fuel, however, the private utility component comes into play; therefore, aspects of a (perceived) social dilemma should be less significant for these goods. Thus, we expect a lower correlation for general trust and conditional cooperation in the case of a quasi-private environmental good.

## Environmental concern

In contrast to economic theories, in the (social-)psychological approach, attitudes constitute a key determinant—possibly the most important determinant—of behavior and behavioral intentions. In (social-)psychological environmental research, general environmental concern is used to explain individual pro-environmental behavior. However, attitudes and behavior are shown to be only moderately related when, contrary to the correspondence rule, they are not measured on the same level of specificity (see Hines et al. 1986/1987). Several empirical studies still, however, infer significant effects of general environmental concern on specific pro-environmental behaviors such as WTP for environmental goods (e.g., Cooper et al. 2004; Kotchen and Reiling 2000). Despite a stimulating discussion of newer models postulating indirect effects of environmental concern (e.g., the ABC model in Guagnano et al. 1995 or the low-cost hypothesis in Diekmann and Preisendörfer 2003), in this paper, we are only examining direct effects, according to which individuals with a higher environmental concern should show a higher WTP for public and quasi-private environmental goods.

## Post-materialistic values

The final rival determinant comes from values research. According to Inglehart's post-materialism hypothesis (Inglehart 1990, 1995, 1997), people with post-materialistic values can be assumed to show a greater WTP for environmental goods. These ideals are the result of a fundamental shift from materialistic to post-materialistic values experienced by people who grow up in secure conditions. With increasing prosperity, people are freed of pressing economic problems and can follow other—post-materialistic—goals such as self-fulfillment, 'freedom' or environmental protection (the 'scarcity hypothesis'). In contrast to the income effect, the post-materialism hypothesis concerns a long-term change in preferences and/or values and not in constraints. These values are formed during socialization and often remain intact throughout individuals' entire lives (the 'socialization hypothesis'). Thus, those who show greater WTP for environmental goods do not necessarily have high incomes. They must, however, have been socialized under conditions of physical and economic security in order to develop post-materialistic values.

Table 1 offers a summary of the theoretical determinants to be tested and their expected effects (direction and strength) on WTP, by type of environmental good.

## Data basis, variables, and descriptive findings

The following sections provide information about our dataset, the methods and the measurements of determinants. In addition, we present descriptive findings on the dependent and explanatory variables.

## Database and methods

The empirical analyses are based on data gathered in a nationwide, general population study, the Swiss Environmental Survey 2007.<sup>5</sup> Data collection is based on a two-stage random sample taken from members of the adult population of Switzerland with a registered telephone.<sup>6</sup> The selected households were notified by mail before the survey was carried out. The study was described as an investigation into ‘living conditions in Switzerland’ and not as an ‘environmental study’ in order to avoid a disproportionate number of people with an above-average interest in the environment taking part. The households were then contacted by telephone. The respondent in each household was selected at random from all members of the household over eighteen and interviewed in German, French, or Italian. Foreigners who belonged to the resident population were also included as long as they could answer questions in one of these three languages. The response rate was 52% (RR2, according to standards laid down by the American Association for Public Opinion Research, AAPOR). The telephone interview, with an average length of 37 min, was followed by a written follow-up questionnaire. A total of 83% of those interviewed by telephone also took part in the written, postal questionnaire (Diekmann and Meyer 2008).<sup>7</sup>

## Variables and descriptive findings

The dependent variables constitute three questions on WTP for environmental goods (for the exact wording, see Table 5 in the Appendix). The first question is about WTP higher taxes to improve general environmental protection. The second question is about the acquisition of an additional car device that prevents the emission of CO<sub>2</sub> while driving. The third question concerns WTP a surcharge for CO<sub>2</sub>-neutral fuel. The technology to produce both these CO<sub>2</sub>-neutral goods does not (yet) exist, and so these are hypothetical scenarios. For both scenarios, respondents were told to assume no other changes in the vehicle. The question relating to fuel was answered only by motorists.

<sup>5</sup> The Swiss Environmental Survey 2007 (Schweizer Umweltsurvey 2007) was funded by the Schweizerischer National funds (Swiss national funding body: project number 100012-107835). The project was supported by the Swiss Federal Office for the Environment, the cantons of Basel city (environment and energy office) and Zürich (waste, water, energy and air office), the central Swiss cantons (environment offices) and the environment and health protection offices of the city of Zürich. The Swiss Federal Statistical Office provided financial and methodological support but had no influence over the methods chosen and the results produced.

<sup>6</sup> In the first step of the sampling procedures, households were selected randomly from regional strata. At the second step, one person per household was drawn at random. To account for this design, we use weights in our estimates of the descriptive statistics (Diekmann and Meyer 2008). In the case of estimates using multivariate regression (in the following section), we do not apply any weighting procedure: Comparing the weighted and unweighted regression estimates, the results remain essentially unchanged.

<sup>7</sup> To check for an environment-related selection bias due to the change from the telephone interview to the postal questionnaire, we compared the means of the index for environmental concern (see Table 3) between the participants and non-participants of the written interview: no significant difference could be observed.



With these three questions, willingness or unwillingness to pay in principle was first established and, in the case of a positive response, a follow-up question asked for the amount the respondent would be willing to pay. The general environmental protection question requested a monthly sum additional to all current taxes and expenditures. With the CO<sub>2</sub> device, the follow-up question asked how much the respondents would be willing to pay for such a product, including the cost of installing it in their vehicle. To determine the size of the surcharge for CO<sub>2</sub>-neutral fuel, 1.6 Swiss francs were assumed to be the normal price of a liter of gas (the market price at the time of the survey).

A shared characteristic of these three dependent variables is the voluntary financial contribution to public environmental protection. The first question asks about a pure public good, improved general environmental protection (see Table 1, left-hand column). The second and third questions ask about quasi-private goods, a CO<sub>2</sub>-neutral device, and CO<sub>2</sub>-neutral fuel (see Table 1, right-hand column): alongside their benefits to the environment, they also provide the benefits of driving. In addition, if the vehicle is understood as a status symbol (see ‘conspicuous consumption’, in Veblen 1899; Frank 1985), an increase in prestige constituting a private utility could also be seen to apply for these two CO<sub>2</sub>-related goods (particularly as the questions stipulated that the other characteristics of the vehicles remain the same). The CO<sub>2</sub>-neutral fuel and the additional device are in any case tied to a durable consumer good: the vehicle.

Table 2 gives descriptive statistics of the dependent variables. For WTP in principle (Yes–No), the share of individuals willing to pay is shown firstly for all valid responses to this question and then only for observations included in multivariate analyses.<sup>8</sup> Despite different numbers of observations, the shares remain largely identical and show that the Swiss population’s WTP can be rated highly when compared internationally, particularly as far as taxes for environmental protection are concerned (see, for example, Franzen and Meyer 2010 on reference values in 2000 for Germany, Japan and the United States). About 70% of the respondents are prepared to pay higher taxes or expenditures for improved general environmental protection. For the reduction of CO<sub>2</sub> specifically, the acceptance rate is even 10 percentage points higher (CO<sub>2</sub>-neutralizing device and fuel around 80%). On the one hand, the high agreement rates are hardly due to a selection bias (cf. “Database and methods”); on the other hand, we cannot completely rule out the influence of social desirability. However, it should be kept in mind that we are not primarily interested in absolute rates but in explaining WTP by competing determinants and, hence, their relative effects.

The amounts people say they are willing to pay (assuming WTP in principle) are listed at the bottom of the table. On average, participants are prepared to pay additional taxes amounting to around CHF 100 (\$88, calculated according to the exchange rate in June 2009) per month for improved environmental protection. The

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<sup>8</sup> The question about general environmental protection was asked in a telephone interview and the questions on CO<sub>2</sub> (device and fuel) in the written follow-up questionnaire administered to fewer respondents. The decrease in the number of observations in the regression models is due to missing values for the explanatory variables, for example, for income. Cf. Table 3.

**Table 2** Variables and descriptive results for willingness to pay

Dependent variables	<i>N</i>	Mean	Sd	Min	Max	Description of the variable
<i>Willingness to pay in principle : Yes–No</i>						
Environmental protection	3,338	0.68		0	1	Willingness to pay higher taxes in order to protect the environment
Environmental protection (regression)	1,522	0.71		0	1	As with environmental protection, but only observations included in the multivariate analyses
CO <sub>2</sub> : Device	1,696	0.80		0	1	Willingness to pay for a CO <sub>2</sub> -neutralizing device.
CO <sub>2</sub> : Device (regression)	858	0.82		0	1	As with CO <sub>2</sub> -neutralizing device, but only observations included in the multivariate analyses
CO <sub>2</sub> : Fuel	2,207	0.83		0	1	Willingness to pay for CO <sub>2</sub> -neutral fuel (yes, certain and yes possibly).
CO <sub>2</sub> : Fuel (regression)	1,102	0.82		0	1	As with CO <sub>2</sub> fuel, but only observations included in the multivariate analyses
<i>Willingness to pay: amount in CHF</i>						
Environmental protection	2,008	99.3	100.6	1	600	Additional amount to taxes for environmental protection in general, per month, upper centile excluded.
Environmental protection (regression)	1,015	100.0	98.1	1	600	As with environmental protection, but only observations included in the multivariate analyses
CO <sub>2</sub> : Device	1,360	1,680	1,391	3	7,000	Amount participants are willing to pay for CO <sub>2</sub> -neutralizing device, upper centile excluded.
CO <sub>2</sub> : Device (regression)	702	1,637	1,312	3	7,000	As with CO <sub>2</sub> -neutralizing device, but only observations included in the multivariate analyses
CO <sub>2</sub> : Fuel	1,606	27.5	24.1	0.1	154	Amount participants are willing to pay for CO <sub>2</sub> -neutral fuel in addition to the price for normal fuel, only values below CHF 1.60 (indicated reference price for one liter of normal fuel)
CO <sub>2</sub> : Fuel (regression)	821	26.9	23.5	0.1	150	As with CO <sub>2</sub> fuel, but only observations included in the multivariate analyses

For exact wording, see Table 5 in the Appendix

standard deviation is relatively high, however. In order to avoid biases through extreme outliers, the top centile is excluded from the multivariate analyses. This procedure was also used for the CO<sub>2</sub>-neutralizing device.<sup>9</sup> The mean WTP for this is

<sup>9</sup> In economic valuation using stated preference methods, certain zero bids and outliers are discussed as protest responses, that is respondents state a WTP that is lower or higher than their true WTP because they protest against some aspect of the survey such as the valuation scenario (e.g., Lindsey 1994). Although protest responses are mostly censored, to date there are no common standards with regard to the determination and treatment of protest bids (e.g., Jorgensen et al. 1999 for a critical discussion). In the present study, we opted for the exclusion of very high WTP values, since we are not primarily interested in welfare estimates or cost-benefit analysis (where exclusion may heavily affect results) but in effects of

CHF 1,680 (\$1,500) and, even with the above-mentioned boundary, reaches a maximum of CHF 7,000 (\$6,250).<sup>10</sup> For CO<sub>2</sub>-neutral fuel, the upper boundary was set at CHF 1.60, the amount indicated in the survey as the reference price for a liter of fuel. For amounts above CHF 1.60, despite unambiguous wording of the question, it is still unclear whether or not these values refer to the total price (1.60 plus surcharge). Around 6% of the responses were thus excluded. In relation to the reference price, the mean surcharge of 0.27 CHF corresponds to a price increase of around 17 percentage points.

Table 3 contains descriptions of the variables and descriptive results for the theoretical determinants and other control variables included in the multivariate analyses as independent variables (for exact wording, see Table 6 in the appendix). *Income* as the central explanatory variable is operationalized by what is known as the net household equivalence income. This is calculated by dividing the disposable household income by the square root of the number of individuals living in the household. Due to its right-skewed distribution, the logarithm is taken before it is entered in regression analysis in Table 4.

In order to determine the *subjective discount rate*, respondents participated in a hypothetical game at the end of the telephone interview. In this game, they chose between two amounts of money: CHF 1,000 (\$880) immediately or a larger amount of money in a year's time. If the respondent opted for the larger sum, this amount was reduced and the person was asked again to choose between the sum of CHF 1,000 paid out immediately and the larger sum after a year. This was continued until the respondent either opted for the sum of CHF 1,000 immediately or until the amount closest to CHF 1,000 was reached.<sup>11</sup> In order to make this game as realistic as possible, three respondents were randomly selected to receive an amount between CHF 1,000 and CHF 2,000 in accordance with their responses. From the results of these games, we calculated each respondent's discount rate. The average discount rate was 65%. This result is in line with other studies (Frederick et al. 2002), which also found the average subjective discount rate to be well above the objective market interest on monetary loans.

*Altruism* was measured using a behaviorist approach. A '2' on the index for altruism is given to people who have an organ donor card and have voluntarily given blood at least once in their life. Anyone who fulfills one of the two criteria is given a '1' and everyone else a '0'. On average, participants answer fewer than one of the questions in the affirmative (see Table 3).

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Footnote 9 continued

competing determinants on WTP. The exclusion of outliers is also a common practice in social research in general. It has to be noted that the present survey did not contain any questions concerning protest responses in the group of zero bids. Thus, if there are any, we are not able to detect protest responses among those respondents who stated that they are not willing to pay.

<sup>10</sup> For comparison, the best-selling vehicle in Switzerland in 2007 was the VW Golf ([http://www.auto-schweiz.ch/cms/Personenwagen\\_nach\\_Modellen.html](http://www.auto-schweiz.ch/cms/Personenwagen_nach_Modellen.html): 11.06.09). The price for the basic model in 2007 was CHF 25,310 (\$22,600).

<sup>11</sup> For the higher amount, there was a choice between the following sums: CHF 2,000 (\$1,760), CHF 1,500 (\$1,320), CHF 1,300 (\$1,144), CHF 1,200 (\$1,056), 1150 CHF (\$1,012), CHF 1,100 (\$968), CHF 1,050 (\$924), CHF 1,030 (\$906), CHF 1,020 (\$898), CHF 1,010 (889\$). See Diekmann and Meyer (2008).

**Table 3** Variables and descriptive findings of the dependent variables

Independent variables	<i>N</i>	Mean	Sd	Min	Max	Description of the variable
<i>Theoretical determinants</i>						
Income (equivalized disposable income)	2,908	5,276	3,808	700	83,417	Equivalized disposable income in CHF, monthly disposable household income divided by the square root of the number of persons living in the household.
Subjective discount rate	3,159	0.65	0.41	0.005	1	Subjective discount rate measured using a multi-stage decision procedure
Altruism	2,255	0.68	0.65	0	2	Additive index consisting of two binary coded variables concerning blood donating behavior and possession of an organ donor card
Generalized trust	2,588	9.89	2.37	3	15	Additive index consisting of three 5-point variables concerning perceived trustworthiness, opportunism, and helpfulness of other people
Conditional cooperation	2,753	2.01	0.84	1	5	A 5-point variable concerning the dependence of one's own pro-environmental behavior on other people's behavior
Environmental concern	3,134	33.01	5.77	10	45	Additive index consisting of nine 5-point variables to measure environmental concern according to Diekmann and Preisendörfer (2001)
Post-materialistic values	2,444	0.76	0.60	0	2	Mean number of post-materialistic items reported as a priority for the country, based on the 4-item set of questions proposed by Inglehart (1990).
<i>Control variables</i>						
Sex (1 = female)	3,369	0.54		0	1	Sex: 1 = female, 0 = male
Years of education	3,363	12.8	2.8	9	19	Conversion of highest degree completed into years of education according to recommendations by the Swiss Federal Statistical Office.
Age in years	3,369	47.9	16.7	18	94	Age in years
Kilometer by car per year	2,578	13,710	14,014	800	195,800	Kilometer by car per year as driver or passenger with cars of the household.
Car ownership	2,752	0.77		0	1	Car ownership in household

For exact wording, see Table 6 in the Appendix

**Table 4** Full multivariate models to explain willingness to pay for environmental goods

	Willingness to pay in principle (1 = Yes)			Amount participants were willing to pay		
	Environmental protection	CO <sub>2</sub> -neutral device	CO <sub>2</sub> -neutral fuel	Environmental protection	CO <sub>2</sub> -neutral device	CO <sub>2</sub> -neutral fuel
Income (log)	0.23 <sup>+</sup> (1.80)	0.41* (2.06)	0.43* (2.55)	32.54** (4.95)	538.05** (4.68)	4.01* (2.43)
Subjective discount rate	-0.13 (-0.83)	-0.46 <sup>+</sup> (-1.92)	0.17 (0.81)	1.52 (0.19)	-272.28* (-2.27)	-2.62 (-1.16)
Altruism	0.14 (1.39)	0.22 (1.33)	0.33* (2.45)	5.93 (1.32)	168.65* (2.11)	3.24** (2.74)
Generalized trust	0.09** (3.24)	0.13** (3.10)	0.14** (3.79)	3.03* (2.37)	-8.19 (-0.39)	0.09 (0.23)
Conditional cooperation	-0.02 (-0.20)	-0.06 (-0.45)	-0.35** (-3.24)	4.84 (1.20)	7.06 (0.10)	-0.59 (-0.52)
Environmental concern	0.13** (11.48)	0.08** (4.63)	0.09** (5.88)	3.37** (5.40)	16.63 <sup>+</sup> (1.84)	0.60** (3.89)
Post-materialistic values	0.40** (3.86)	0.22 (1.31)	0.34* (2.30)	8.33 (1.60)	256.88** (3.05)	3.36* (2.31)
Sex (1 = female)	0.10 (0.74)	-0.22 (-1.03)	0.19 (1.02)	-25.38** (-3.90)	-64.13 (-0.60)	0.61 (0.33)
Age in years	-0.01 (-1.60)	-0.02* (-2.18)	0.01 (1.26)	-0.16 (-0.86)	0.76 (0.22)	-0.05 (-0.80)
Education in years	0.11** (4.02)	0.13** (2.85)	0.07 <sup>+</sup> (1.77)	5.40** (4.07)	87.25** (4.08)	0.55 (1.60)
Constant	-6.03** (-8.74)	-3.49** (-2.83)	-4.33** (-4.41)	-169.95** (-4.74)	-1143.25* (-1.99)	-6.65 (-0.62)
Pseudo R <sup>2</sup>	0.131	0.099	0.108			
Adjusted R <sup>2</sup>				0.107	0.124	0.048
Number of observations	1522	858	1102	1015	702	821

Logit models for willingness to pay in principle, OLS estimation for the amount participants were willing to pay; robust standard errors were used for estimation; models concerning CO<sub>2</sub> additionally controlled for car ownership and kilometers by car per year; z and t values in parentheses; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; +  $p < 0.10$

The *generalized trust* of the participants, on the other hand, is more pronounced. It is measured with an additive index of three 5-point questions on perceived trustworthiness, opportunism, and helpfulness. Ranging from 3 to 15, the index has a mean of almost 10, and the reliability is 0.61 (Cronbach's alpha). On a 5-point response scale (1 = cooperation irrespective of others, 5 = cooperation only if others also make a contribution), the average for the extent of *conditional cooperation* is 2. In other words, for at least some of the respondents, the contribution of others does not appear to be a prerequisite for taking environmental action themselves.

*Environmental concern* is measured using nine 5-point questions proposed by Diekmann and Preisendörfer (2001). In line with socio-psychological research on attitudes, the questions can be classified according to three components: 'affective', 'cognitive', and 'conative'. A factor analysis with subsequent varimax rotation gives a one-dimensional solution, and the reliability of the scale is 0.76 (Cronbach's alpha). Ranging from 10 to 45, the environmental concern scale has a mean of 33.

*Post-materialism* is measured with the set of questions proposed by Inglehart (1990) where participants have to select the two most important policies for the country from four specified policies (two materialistic and two post-materialistic). The index of post-materialism can have the values 0, 1 or 2, depending on how many post-materialist goals are preferred. Only 9% of respondents may be described as pure post-materialists, that is these persons reported both of the two post-materialistic items to be a priority for the country.

In addition to the theoretical determinants, we also tested a number of socio-demographic variables that might influence WTP for environmental goods. Compared to the official statistics (BFS Bundesamt für Statistik, Sektion Demografie und Migration 2007), there are slightly more women in our dataset (54%) than in the population (52%), and the middle-age group is somewhat overrepresented (18–39 years: 33 vs. 36%, 40–59 years: 41 vs. 36%, 60–95 years: 26 vs. 27%). In a large number of studies (e.g., Greenbaum 1995; Dietz et al. 1998; Zelezny et al. 2000), women, younger people, and those with a higher education<sup>12</sup> display greater tendency toward environmentally friendly action. As we control for these variables in our models, we rule out a potential bias of the effects of interest from a theoretical perspective. Education in years was calculated from the highest degree of education completed according to recommendations of the Swiss Federal Statistical Office. In the models on WTP for a reduction of CO<sub>2</sub> emissions (CO<sub>2</sub>-neutralizing device for the vehicle and fuel), the number of kilometers driven per year and car ownership were also included as control variables.

## Multivariate analyses

For all dependent variables, the WTP was measured in two steps, firstly willingness in principle and secondly the amount. In our analysis, we interpret these two steps as two independent decisions and analyze them separately, using a logistic model for WTP in principle and an OLS regression for the amount. We believe separating

<sup>12</sup> The official annual statistics about the state of the population do not provide any information about education (BFS Bundesamt für Statistik, Sektion Demografie und Migration 2007).

these analyses is justified both statistically and substantively. WTP involves two qualitatively different decisions (intention to buy versus no intention to buy; amount willing to pay given an intention to buy), which might be determined differently. For example, the decision to buy a vehicle is likely distinct from the decision about the price that a person is prepared to pay: income may not influence the decision to buy at all, but clearly has an effect on the price paid. The same mechanism likely plays a role regarding environmental goods.

These arguments can also be supported statistically. We have tested to what extent a separate analysis of both decisions is statistically acceptable and whether explanatory determinants display the same effect on both decisions. We compared a Tobit model against a Cragg model (see Cragg 1971; Jones 1989; Liebe 2007). The Tobit model is based on censored data and is a ‘hybrid’ of a binary and a continuous regression, while the Cragg model is a ‘two-part model’ that assumes independence of both decisions and comprises a separate estimate of a binary model and a truncated regression. Over and above that, a further simplification (complete dominance) can be made if in addition to the superiority of the Cragg model, a dominance of the WTP in principle over decisions on the WTP amount (first hurdle dominance) can be observed. This can be tested with a Heckman selection model (see specifically Jones 1989). Our data fulfills the assumptions of the Cragg model as well as the dominance assumption on the basis of a Heckman model, supporting the separate estimate of a logistic model for WTP in principle and an OLS regression for the WTP amounts on statistical grounds.

The results of the multivariate models with all variables are shown in Table 4.<sup>13</sup> The first three columns give the results of the binary logistic regressions for WTP in principle and the last three columns the results of the OLS regressions explaining the amount participants were willing to pay (among those who said they were willing to pay in principle).

Income—the central variable from the perspective of the compensation hypothesis (or affluence hypothesis)—has a consistent positive and significant effect. While the effect on general environmental protection in principle is rather weak (significant at the 10% level), the effect on the amount of WTP is quite strong. This trend can also be detected in a basic model in which only income and the control variables are included as predictors (see Appendix, Table 7; no significant effect in the logistic model for general environmental protection). The income effects from these basic models also remain stable or even gain in importance under control of all other theoretical determinants (Table 4). The *compensation hypothesis* is therefore generally confirmed.<sup>14</sup>

The stronger the time preference or the higher the subjective discount rate, the lower the WTP, as shown by the result for a CO<sub>2</sub>-neutralizing device for the car. This negative effect applies both to WTP in principle and to the WTP amount. For the other two environmental goods, time preference does not play any role. The

<sup>13</sup> We also conducted an outlier analysis by excluding some seemingly influential observations and by re-estimating the models. Since the results remained unchanged, outliers are not a problem in the present study.

<sup>14</sup> If the amount people are willing to pay and income are both included in the OLS regressions as logarithmic quantities, the income effects in Table 4 can be interpreted as elasticities and assume values of 0.40 for environmental protection, 0.30 for the CO<sub>2</sub>-neutralizing device, and 0.15 for the CO<sub>2</sub>-neutral fuel. Accordingly, for example, an increase in income of 10% leads to an increase in demand for a CO<sub>2</sub>-neutralizing device of 3%.

influence of the *subjective discount rate* therefore seems not to depend on the type of decision but rather on the characteristics of the environmental good. One differentiating criterion implied here is the time schedule of the financial investment made and the resulting pay-off. Of the environmental goods considered, the CO<sub>2</sub>-neutralizing device is the one that most closely encapsulates the basic problem of time preferences in the environmental sector, that is, a large initial investment in a consumer durable with subsequent (private) pay-offs in the long term (Hausman 1979, among others). With the other two environmental goods considered, in each case the investment is a matter of repeated decisions (monthly contribution for the environment in general and filling up with fuel).

The pattern for the influence of *altruism* is also quite clear. Persons behaving altruistically in other ways show a significant higher WTP for CO<sub>2</sub>-neutral fuel (in principle and also concerning the amount they are willing to pay) and they are willing to pay a higher amount for a CO<sub>2</sub>-neutral device for their vehicle. In the other models, the coefficient on altruism has the expected positive sign but does not exceed the significance threshold. Our measure of altruism by means of willingness to donate blood or organs only captures the altruism described by Stern et al. (1993) as ‘anthropocentric’. In fact, CO<sub>2</sub> is an issue connected to medium and long-term consequences for humanity. Regarding general environmental protection, however, concern about the welfare of all creatures and plants (‘biospheric’ altruism) might also be of significance (Stern et al. 1993). If ‘biospheric’ altruism is really more important than ‘anthropocentric’ altruism, this would explain the lack of an altruism effect in connection with general environmental protection. Unfortunately, this idea cannot be tested here; in future work, these two types of altruism (‘anthropocentric’ and ‘biospheric’) should be measured separately in order to shed more light on this question.

*Generalized trust* has the expected positive and significant effect on WTP in principle in all three models. Trust in other people encourages the decision to make a contribution toward environmental protection through buying public and quasi-private environmental goods. As for the amount people are willing to pay, a significant positive effect can be observed for taxes to support general environmental protection, which confirms our hypothesis that the effect of trust in a social dilemma situation is more pronounced for pure public goods than for quasi-private ones. The results for *conditional cooperation*, however, do not show the expected pattern. Here, the effect is stronger for quasi-private environmental goods: the more people make their own environment-related behavior dependent on the behavior of others, the lower the willingness to pay in principle for CO<sub>2</sub>-neutral fuel. Apart from this effect, no other significant effects of conditional cooperation can be observed. Overall, a pattern emerges where trust in others and strategies of conditional cooperation have a greater influence on WTP in principle than on the amount people are willing to spend. This is in line with the intuitive expectation that in the context of a social dilemma, the expected behavior of others has a stronger effect on the decision to cooperate per se than on the amount of the contribution (given a willingness to cooperate).

*Environmental concern* as a general attitude is the most influential determinant across all models in Table 4. It has the expected positive and significant effect. Those with environmentally friendly attitudes are more willing to pay in principle for public and quasi-private environmental goods and are also willing to make



higher payments. Some authors (e.g., Kahneman et al. 1993, 1999) put the direct measure of WTP on the same level as specific attitudes toward the environmental good and, therefore, would assign it to the conative component of environmental concern. From this perspective, the effects of environmental concern reported here should not be interpreted causally. However, we understand and operationalize environmental concern as a general attitude toward the environment, the basis for specific behavioral intentions and actual behavior.

The effects of the intensity of *post-materialist values* do not give such a coherent picture. Nevertheless, except for the CO<sub>2</sub>-neutralizing device (WTP in principle) and the additional environmental taxes (WTP amount), the expected positive significant effect can be observed. Overall—along with general environmental concern and income—post-materialism proved to be one of the key determinants in our study.

With regard to the control variables, relatively stable effects of education can be seen where the WTP in principle and the WTP amount mostly rise significantly with an increasing level of education.

The overall explanatory power of the models is rather low (see Pseudo- $R^2$  and Adj.  $R^2$ ). Compared to the basic models (see Appendix), containing only control variables and income as independent variables, the additional determinants in Table 4 show improvements in the model performance of between 6 percentage points (for the CO<sub>2</sub>-neutral device) and 11 percentage points (for general environmental protection) as far as WTP in principle is concerned and of about 3 percentage points for the amount people are willing to pay. This indicates that the *compensation hypothesis* is most convincing in explaining the additional amount people are willing to pay for the environment. However, with regard to WTP in principle, other competing explanatory variables such as environmental concern and aspects of social dilemmas are equally important.

## Conclusions and discussion

‘Environmental Justice’ research consistently finds unequally distributed environmental burdens and social differences in consumption—both weighted in favor of more affluent individuals. We asked to what extent affluent individuals were willing to pay more for environmental protection in return. The validity of the compensation hypothesis was tested empirically by accounting for the effect of income and controlling for competing theoretical determinants on WTP. For this, the classic economic theory, which explains behavior using assumptions about preferences and constraints, was supplemented by altruistic preferences and aspects of social dilemmas. Additionally and for the first time to our knowledge, we included survey-based time preferences (subjective discount rates) as a determinant of WTP for environmental goods. The selection of theory-based determinants was completed with environmental concern as general attitude, the central concept in (socio-) psychological research, and with post-materialistic values. In line with the results of other studies (e.g., Cragg 1971; Liebe et al. 2010), not all determinants in our analysis have the same effect on the WTP in principle as they have on the WTP amount. A separate analysis for these two decisions was, therefore, deemed important.

Two key findings emerge: first, the affluent are more willing to spend money to offset the environmental destruction of their spending habits. This holds true for the WTP in principle and the WTP amount. When all other competing theoretical determinants are simultaneously taken into account, the compensation hypothesis can be confirmed particularly regarding the amount of WTP. Second, the effect of income does not change with the environmental good under examination. Therefore, the compensation hypothesis is confirmed universally, irrespective of the environmental good in question. However, in convincing individuals to make a contribution to the environment at all (i.e. WTP in principle), general environmental concern, generalized interpersonal trust and, to a certain degree, strategies of conditional cooperation as well as post-materialistic values are all at least equally important.

While subjective discount rates were shown to have no universal effect on WTP for environmental goods, a significant influence could be identified in the case of the CO<sub>2</sub>-neutralizing device for motor vehicles. This quasi-private environmental good most closely resembles the consumer durables whose acquisition is discussed within environmental research under the heading of ‘time preferences’. Apart from this, the theoretically based assumption that certain determinants display varying effects depending on the characteristic of the environmental good (public vs. quasi-private goods, see Table 1) cannot be confirmed in the current analysis.

Further, our results indicate that, alongside income, environmental concern and aspects of social dilemmas should also be taken into consideration when (political) decision makers seek to encourage financial contributions toward environmental protection. Income has a strong positive influence on the amount that would be paid (assuming a WTP in principle), which implies that some form of compensation for the double advantage enjoyed by affluent individuals over poorer individuals can be found.

Future research into such environment-related inequalities should more precisely analyze the effects of income and their social distribution using other research objects as well (e.g., the sustainability of consumption patterns or the individuals’ adaptation to environmental innovations). It would also be desirable to compare the size of these compensation effects with the smaller degree of environmental burdens and the greater consumption of resources enjoyed by the affluent. Collecting data on actual purchasing behavior would be an additional useful step in this line of research.

Our theoretical and empirical analysis strategy has several strengths compared to other studies—although they could also be viewed as weaknesses. All of the theoretical determinants we considered have a vague relationship to WTP in terms of a behavioral intention or behavior. Accordingly, these factors were measured on a general level (e.g., the subjective discount rates). The strength thus lies in the fact that these determinants comply with many different types of behavior, in this case WTP for diverse kinds of environmental goods. Our study does indeed show that factors such as general environmental concern and generalized trust play a significant role in explaining WTP for various environmental goods and ultimately complement the compensation hypothesis, putting it into perspective. The relationships between such general factors and specific behavioral intentions or behavior (such as the purchase of CO<sub>2</sub>-neutral fuel), however, lead to regression models of low explanatory power, which could be interpreted as a weakness of our analyses. Following the correspondence rule, more specific determinants might lead to stronger empirical

relationships—for example, attitudes toward CO<sub>2</sub> reduction in the field of transport (e.g., within the context of the theory of planned behavior, Ajzen 1991). But one should be aware that with such an approach, the number of research objects would be greatly reduced. Occasionally, it cannot be ruled out that general attitudes might even develop a stronger effect than specific attitudes (see, e.g., Liebe et al. 2010 for an example regarding WTP for the protection of biodiversity in forests).

Although no strong effects can be noted in our study, the inclusion of time preferences in explanations of WTP for environmental protection and for other forms of pro-environmental behavior can be regarded as important. But subjective discount rates are currently not assessed in standardized forms and, hence, measurement instruments should be improved.

Studies that systematically incorporate competing determinants for the explanation of pro-environmental behavior are rare (Kollmuss and Agyeman 2002). Future research should pursue this approach further. Decision makers need to know the real incentives for pro-environmental behavior. This study is an important step in that direction.

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## Appendix

**Table 5** : Wording of questions for willingness to pay

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### Environmental protection:

It is not normally possible to increase environmental protection for free. Would you be prepared to pay higher taxes or duties for improved environmental protection?

Could you please tell me the amount in Swiss francs that you would be prepared to pay per month in addition to your taxes for improved environmental protection in Switzerland?

### CO<sub>2</sub>-neutral device for your car

#### No car ownership

Let us assume you buy a car that costs 15,000 francs. There is the technology to have this car fitted with a device to stop CO<sub>2</sub> being emitted into the air when the car is driven. How much would you be prepared to pay for such a device, including installation?

#### Car ownership

Let us assume there was the technology to have this car fitted with a device to stop CO<sub>2</sub> being emitted into the air when the car is driven. How much would you have been prepared to pay for such a device, including installation?

### CO<sub>2</sub>-neutral fuel

Let us assume you could run the car you use most frequently on fuel such as, for instance, hydrogen, biogas or electricity that means no additional CO<sub>2</sub> is emitted into the air (CO<sub>2</sub>-neutral). Would you be prepared to pay more for this than you currently pay for gas or diesel?

A liter of gas costs about 1.60 francs nowadays. How much more would you pay for a liter of alternative fuel if you could drive the same distance with this fuel as with a liter of gas?

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For further details such as filters and presentation of the questions, see Diekmann and Meyer 2008

**Table 6** Wording of questions for determinants of willingness to pay**Subjective discount rate**

You have a choice between two amounts, a lower one now or a higher one in a year's time. The lower amount now is 1,000 francs. And the higher one in a year's time is 2,000 francs. Which of these two amounts would you choose? [1000CHF (880\$) remains constant; the higher amount can be any of the following sums: 2000CHF (1760\$), 1500 CHF (1320\$), 1300 CHF (1144\$), 1200 CHF (1056\$), 1150 CHF (1012\$), 1100 CHF (968\$), 1050 CHF (924\$), 1030 CHF (906\$), 1020 CHF (898\$), 1010 CHF (889\$)]

**Altruism**

How often have you given blood as a civilian (outside military service), not counting for members of your family?

Do you have an organ donor card?

**Generalized trust**

Generally speaking, would you say that most people can be trusted, or that you cannot be too careful in dealing with people?

Do you think that most people would try to take advantage of you if they had the chance, or would they try to be fair?

Would you say that most of the time people try to be helpful or that they are mostly looking out for themselves?

**Conditional cooperation**

Regardless of what other people do, I personally try to behave in a way that is environmentally aware as far as possible

**Environmental concerns****Affective component**

It bothers me when I think about the environmental conditions in which our children and grandchildren will probably have to live

If we continue down the same path, we are heading toward an environmental catastrophe.

If I read news or watch TV news reports about environmental problems, I often become outraged and angry

**Cognitive component**

There are limits on growth that our industrialized world has already exceeded or will soon reach

Most people in this country still do not act in an environmentally conscious way

In my opinion, many environmentalists exaggerate claims about environmental threats

**Conative Component**

Politicians still do not do enough to protect the environment

In order to protect the environment, we should all be willing to reduce our current standard of living

Actions to protect the environment should be implemented even if they cause job losses

**Post-materialism**

If you had to choose between the following policies, which should come first and second for Switzerland in your opinion?

Maintain law and order in Switzerland

Give people more say in government decisions

Fight rising prices

Protect freedom of speech

For more details, see Diekmann und Meyer 2008

**Table 7** Basic model to explain the willingness to pay for environmental goods

	Willingness to pay in principle (1 = Yes)			Amount participants were willing to pay		
	Environmental protection	CO <sub>2</sub> -neutral device	CO <sub>2</sub> -neutral fuel	Environmental protection	CO <sub>2</sub> -neutral device	CO <sub>2</sub> -neutral fuel
Income (log)	0.08 (0.64)	0.36 <sup>+</sup> (1.91)	0.34* (2.10)	28.71** (4.59)	555.74** (4.73)	3.30* (2.07)
Sex (1 = female)	0.38** (3.16)	-0.07 (-0.38)	0.40* (2.35)	-18.85** (-2.98)	-85.15 (-0.81)	1.21 (0.64)
Age in years	-0.00 (-0.68)	-0.01 <sup>+</sup> (-1.91)	0.02* (2.53)	-0.04 (-0.25)	1.26 (0.37)	-0.03 (-0.63)
Years of education	0.13** (4.94)	0.16** (3.50)	0.09* (2.54)	6.12** (4.67)	90.99** (4.16)	0.69* (2.06)
Kilometer by car per year		-0.01 (-0.74)	-0.01 (-1.55)		-0.96 (-0.24)	-0.24* (-2.49)
Car ownership		-0.25 (-0.62)	-0.08 (-0.22)		44.52 (0.22)	1.36 (0.35)
Constant	-0.88* (-2.09)	-0.10 (-0.12)	-0.94 (-1.37)	-14.69 (-0.68)	-517.40 (-1.37)	16.18* (2.39)
Pseudo <i>R</i> -square	0.022	0.041	0.028			
Adj. <i>R</i> -square				0.074	0.098	0.017
Number of observations	1522	858	1102	1015	702	821

Logit models for willingness to pay in principle, OLS estimation for the amount participants were willing to pay; *z* and *t* values in parentheses; robust standard errors were used for estimation; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; <sup>+</sup>  $p < 0.10$

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