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Environmental Impact and Pro-Environmental Behavior: Correlations to Income and Environmental Concern

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Abstract: Switzerland, like many other countries, has set targets to reduce greenhouse gas emissions. Private households play a significant part in achieving these aims. Therefore, it is important to know which factors are related to emissions. So far, most studies have focused on income, household size and other structural factors while neglecting the potential relevance of attitudinal variables such as environmental concern. Those studies that did examine environmental attitudes were mostly based on "intent-oriented" measures of pro-environmental behavior instead of actual environmental impacts.

The present study brings these lines of research together by analyzing the relationship between emissions, income and environmental attitudes within a framework of multivariate analysis. Furthermore, three specific emissions domains – mobility, housing and food – are analyzed separately and the results are compared to those based on a scale of pro-environmental behavior. All analyses are based on data from a large representative general population survey, the Swiss Environmental Survey 2007 (*n* = 3,369), and a subsequent life cycle analysis.

The results indicate that higher income and lower levels of environmental concern are both associated with higher emissions. Furthermore, overall emissions are higher for younger, male respondents with higher education, living in smaller households with cars. For emissions by mobility, being economically active is a further predictor of higher emissions. For housing, the pattern is slightly different, in that females and older respondents are attributed higher emissions. In the case of food, however, there is no clear-cut association between emissions and income. In conclusion, this study clearly indicates that next to income, environmental concern is an important predictor of GHG emissions, even when controlling for the effects of income. A very similar pattern of correlations was found for intent-oriented pro-environmental behavior.

Keywords: Environmental impact, greenhouse gas emissions, pro-environmental behavior, income, environmental concern

Introduction

Climate change and its mitigation has been a central topic in political debate and subsequently many countries have set emissions targets. For example, Switzerland currently aims to reduce its domestic greenhouse gas emissions (GHG) by 50% in comparison to their level in 1990 by 2030 (Swiss Federal Office for the Environment FOEN, 2015) and, at the time of writing, the parliament is discussing further reductions. Private households contribute a large share of the current GHG emissions (for the US, Bin & Dowlatabadi, 2005, report a share of 80% of GHG emissions was due to consumer demand; Hertwich & Peters, 2009, attribute 72% to household consumption globally). Thus it is important to know which structural, socio-economic or attitudinal factors are related to environmental burdens and whether the correlations are the same for all areas of consumption, including mobility, housing, or food.

Previous research on this topic differs regarding how a person's environmental impact or behavior is assessed and what factors are taken into account when analyzing it. These differences are of great theoretical and practical importance since they may lead to different research results and hence different suggestions for environmental politics and other practical interventions.

In the social sciences, environmental impacts are generally not studied directly. Instead, the focus is on "pro-environmental behavior" (PEB) which is usually assessed in terms of self-reported frequencies of various environmentally relevant behaviors (e.g. Bratt, Stern, Matthies, & Nenseth, 2014; Kaiser, 1998; Kaiser & Wilson, 2000; Olli, Grendstad, & Wollebaek, 2001; Schultz, Zelezny, & Dalrymple, 2000). Most of the time, this covers a wide range of behaviors from different domains; typical examples are recycling, switching off lights, purchasing organic groceries or refraining from using a car. In addition, these behaviors entail very different ecological impacts. Usually, care is taken that most respondents have a choice on whether to perform the behaviors in question. For example, this means that questions aimed specifically at home owners are omitted in a typical general population survey. Subsequently, these very different behaviors are merged into one general or several thematic indexes or latent variables – e.g. recycling, energy conservation or commuting – without weighting the behaviors according to their environmental impacts. Moreover, the selection procedure of behaviors has frequently been criticized for being insufficiently if at all theoretically grounded.

Stern (2000, p. 408) has labeled this type of measure as "intent-oriented" since the emphasis generally rests on behavior that people often associate with being "ecologically sound" while it may have comparatively little impact on actual resource consumption – examples are recycling, or refusing plastic bags in stores. Impact-oriented measures of environmental behavior, in contrast, attempt to assess actual resource consumption. A few studies in social sciences (to our knowledge these are: Abrahamse & Steg, 2009; Diekmann & Jann, 2000; Gatersleben, Steg, & Vlek, 2002; Kennedy, Krahn, & Krogman, 2015; Poortinga, Steg, & Vlek, 2004) and a long-standing tradition in environmental sciences (e.g. Kerkhof, Nonhebel, & Moll, 2009; Moll et al., 2005; Weber & Matthews, 2008) have done so. Typically, these studies focus on assessing absolute per capita or household impacts in terms of GHG emissions (in kg CO_2 equivalents), energy requirements (in Joule or kWh) or some other unit of ecological impact. Frequently, "direct" and "indirect" impacts are reported separately. Direct impacts result directly from the consumption of energy carriers such as electricity, gas, heating oil, petrol, etc. (Wiedenhofer, Lenzen, & Steinberger, 2013). Thus, this primarily captures energy use in the home (mainly space heating and electricity use) as well as by transport (i.e. by motorized travel). Indirect impacts are also called "embodied" or "embedded" impacts; they are "embedded" in goods and services in that they originate from the production, transportation and disposal of goods (cf. Druckman & Jackson, 2009; Vringer & Blok, 1995). This includes a broad range of categories such as food, consumables or services. For the year 2005, Jungbluth, Nathani, Stucki, and Leuenberger (2011) estimate that 74% of all GHG emissions due to Swiss consumption were indirect. A few studies further distinguish different categories of consumption, such as transport, food or consumables (e.g. Ala-Mantila et al., 2014; Büchs & Schnepf, 2013; Diekmann & Jann, 2000; Gough et al., 2011; Poortinga et al., 2004; Wiedenhofer et al., 2013).

So far, research on intent-oriented environmental behavior and research on actual environmental impacts have progressed rather independently from one another and typically used different analytical methods and explanatory variables. Generally, studies on environmental impacts do not consider attitudinal variables such as environmental concern or values. Instead, they focus mostly on bivariate relationships between environmental burden and structural variables (such as urbanity) and/or socio-demographic variables (such as income or number of people living in the household). Studies that do account for psychological variables and do so by means of multivariate statistical methods, in turn, are typically carried out by social scientists and (therefore) do not analyze actual environmental impacts but rely on intent-oriented measures. Very few studies have combined and compared the results obtained based on the two types of outcome measures (to our knowledge these are: Diekmann & Jann, 2000; Gatersleben et al., 2002; Kennedy et al., 2015).

Previous research based on intent-oriented measures points to the influence of environmental attitudes and values for at least some areas of behavior (for meta-analyses see: Bamberg & Möser, 2007; Hines, Hungerford, & Tomera, 1987) and thus suggests there is a "moral basis" for PEB (Whitmarsh, 2009, p. 14). In contrast, analyses of actual resource consumption typically conclude that primarily socio-demographic factors were important (such as income or household size; e.g. Lenzen et al., 2006; Moll et al., 2005). The latter result emphasizes the importance of the households' (financial) room for maneuver and thus advocates an incentive based approach, while the former result suggests that raising awareness of the issue at hand may help solve the problem.

The aim of the present study is to bring these lines of research together by analyzing the relationship between GHG emissions and environmental attitudes within a framework of multivariate analysis. As there are not many studies distinguishing between different domains of environmental impacts by private consumption, this is a second focus of this study: In addition to analyzing total GHG emissions, three specific domains – mobility, housing and food – are analyzed separately. This allows for the comparing of whether these emissions domains are differentially related to socio-economic and attitudinal variables. Furthermore, similar analyses are carried out for an intent-oriented measure of PEB to allow for a brief comparison. The subsequent discussion is centered on income and environmental concern, as the former has been central to previous research on environmental impacts, whereas the latter has been the focal point of studies on PEB. Thus, this study contributes to current research, not only by analyzing different areas of consumption separately, but also by mainly combining "psychological" explanatory variables with measures of environmental impacts.

All analyses are based on data from a large representative general population survey, the Swiss Environmental Survey 2007 (Diekmann & Meyer, 2008), and a subsequent life cycle assessment calculated with support from the Swiss Federal Laboratories for Materials Science and Technology (see Notter, Meyer, & Althaus, 2013).

Previous Research on Environmental Impact

This section provides an overview of previous results regarding correlates of environmental impact. As mentioned above, many studies present bivariate results only. For the following overview, the emphasis is on studies that control for the influence of at least some factors simultaneously.

Income is presumably the best-researched factor related to environmental impact. Previous studies generally conclude that there is a robust positive correlation of the two: the higher the income, the higher the environmental impact, irrespective of the specifics of the two variables (the unit of measurement, emission domain in question, and whether households or individuals are analyzed), the statistical method applied and the population researched (e.g. Ala-Mantila, Heinonen, & Junnila, 2014; Baiocchi, Minx, & Hubacek, 2010; Büchs & Schnepf, 2013; Diekmann & Jann, 2000; Druckman & Jackson, 2008; Gatersleben et al., 2002; Girod & de Haan, 2010b; Gough, Abdallah, Johnson, Ryan-Collins, & Smith, 2011; Hertwich & Peters, 2009; Kerkhof et al., 2009; Lenzen et al., 2006; Minx et al., 2013; Moll et al., 2005; Nässén, 2014; Vringer & Blok, 1995; Weber & Matthews, 2008; Wilson, Tyedmers, & Spinney, 2013). Based on the same survey data as the present study and on an only slightly different life cycle analysis, Notter et al. (2013) report a very close relationship between income and environmental impact (their bivariate regression analysis explains 91% of the variance in GHG emissions, p. 4018). However, a closer look reveals that prior to running regression analyses, their data was collapsed into eight income groups (resulting in $n = 8$). This inherently reduces variance and thus their extremely good model fit should be considered a methodological artifact.

Studies distinguishing between direct and indirect environmental impacts generally report higher income elasticities for the latter (e.g. Abrahamse & Steg, 2009; Shammin, Herendeen, Hanson, & Wilson, 2010; Wiedenhofer et al., 2013). However, when the (direct) environmental impacts of transport are compared to other areas, there is mostly a comparatively high elasticity (e.g. Büchs & Schnepf, 2013; Gough et al., 2011; Poortinga et al., 2004). Furthermore, high elasticities have been reported for services and consumables, whereas for food and home energy use less close relationships between income and impacts have been found (e.g. Ala-Mantila et al., 2014; Büchs & Schnepf, 2013; Diekmann & Jann, 2000; Gough et al., 2011; Hertwich & Peters, 2009; Poortinga et al., 2004; Wiedenhofer et al., 2013). Gough et al. (2011) argue that these different elasticities might be due to the necessity of expenditures for food and home energy, whereas most other areas allow for more individual variation.

Household size and composition are a second frequently researched correlate of environmental impact. Generally, previous studies indicate that while environmental impact increases with household size (e.g. Abrahamse & Steg, 2009; Baiocchi et al., 2010; Gatersleben et al., 2002; Kennedy et al., 2015; Nässén, 2014), there are economies of scale: the larger a household is, the lower is the per capita impact of its members (eg. Ala-Mantila et al., 2014; Diekmann & Jann, 2000; Druckman & Jackson, 2008; Lenzen et al., 2006; Minx et al., 2013; Weber & Matthews, 2008; Wilson et al., 2013). This has mainly been attributed to "increased sharing of commodities, living space and utilities, rather than a significantly different consumption pattern" (Wiedenhofer et al., 2013:697-698).

Such economies of scale have not only been reported for overall per capita impacts, but also for both direct and indirect overall impacts, as well as for residential impacts in particular (e.g. Ala-Mantila et al., 2014; Diekmann & Jann, 2000; Druckman & Jackson, 2008; Gough et al., 2011; Wilson et al., 2013). However, there seems to be no relationship between household size and per capita impacts regarding mobility (Diekmann & Jann, 2000; Gough et al., 2011) and, so far, the results regarding food, services and consumables do not indicate any clear-cut pattern (cf. Ala-Mantila et al., 2014; Diekmann & Jann, 2000; Gough et al., 2011). Ala-Mantila et al. (2014) even report the opposite of economies of scale for per capita emissions by services and by tangible goods (i.e. persons in larger households are attributed higher per capita emissions).

Most studies do not allow for a comparison of impacts of adults and children but handle the topic of children in the household by distinguishing household types. Nonetheless, the studies by Baiocchi et al. (2010), Gough et al. (2011) and Thumim and White (2008) seem to support the notion that children have significantly lower impacts than adults.

The results for other socio-demographic variables like gender, age, education, or employment status remain inconclusive.[1] Regarding gender, Wilson et al. (2013) and Abrahamse and Steg (2009) did not find a correlation with direct per capita carbon emissions or household energy use, respectively, whereas Büchs and Schnepf (2013) and Thumim and White (2008) report higher overall emissions and higher direct per capita emissions, respectively, for female-headed households. Similarly, Diekmann and Jann (2000) report higher per capita energy requirements for housing by female respondents. However, females (or female-headed households) seem to cause lower environmental impacts when it comes to transport (Brand, Goodman, Rutter, Song, & Ogilvie, 2013; Büchs & Schnepf, 2013; Diekmann & Jann, 2000) as well as food (Diekmann & Jann, 2000).

A few studies report higher environmental impacts (by households or per capita) with increasing age (e.g. Lenzen et al., 2006; Nässén, 2014; Thumim & White, 2008; Wilson et al., 2013), while Kennedy et al. (2015) have not found any relationship at all and Büchs and Schnepf (2013) conclude there is a turning point where impacts decrease: they estimate

[1] As most methods to estimate environmental impacts are primarily based on household behavior, individual characteristics are in most cases (if at all) either operationalized for a random household member (i.e. the respondent, for example in the study by Poortinga et al., 2004) or for a household reference person, such as the person earning the highest income (e.g. Thumim & White, 2008) or the person financially responsible for accommodation (e.g. Büchs & Schnepf, 2013).

that direct home emissions fall beyond the age of 74 years and indirect emissions in general as well as direct transport emissions already decrease beyond the age of roughly 50 years. A study by Brand et al. (2013) supports this notion of a turning point for transport emissions. Diekmann and Jann (2000) report lower energy use for mobility with increasing age, while energy use for housing seems to increase with age. For food, they did not find a significant correlation. Three Dutch studies on household energy use either do not find any correlation or they report a negative correlation between age and energy use (Abrahamse & Steg, 2009; Gatersleben et al., 2002; Poortinga et al., 2004).

With regard to education, several studies report a positive correlation with GHG emissions (e.g. Büchs & Schnepf, 2013; Kennedy et al., 2015; Minx et al., 2013; Nässén, 2014). In the case of Büchs and Schnepf's (2013) study, this relationship is closest for direct transport emissions, somewhat less so for indirect and overall emissions and hardly existent for direct home emissions. Two more studies suggest that education may be linked to higher environmental impacts by transportation (Brand et al., 2013, regarding emissions; Poortinga et al., 2004, regarding energy use). However, regarding residential energy use Poortinga et al. (2004) report lower values with increasing education. Baiocchi et al. (2010) also found there to be a negative relationship for overall emissions, whereas the results presented by Lenzen et al. (2006) are mixed. Both Diekmann and Jann (2000) and Gatersleben et al. (2002) did not find any correlation.

The findings regarding employment are not conclusive either: while there is some evidence that employment is related to higher environmental impacts by transport (Brand et al., 2013; Büchs & Schnepf, 2013; Diekmann & Jann, 2000), the results for the remaining areas of consumption are rather often mixed and/or not significant at all (Büchs & Schnepf, 2013; Diekmann & Jann, 2000; Gough et al., 2011; Lenzen et al., 2006; Wilson et al., 2013).

To account for location, previous studies have for example included population density (e.g. Lenzen et al., 2006; Minx et al., 2013; Wiedenhofer et al., 2013), communal population figures (e.g. Diekmann & Jann; 2000), categories of urbanity (e.g. Ala-Mantila et al., 2014; Lenzen et al., 2006; Minx et al., 2013; Nässén, 2014) or of travel distances to "downtown" (e.g. Wilson et al., 2013). These studies generally agree that living in more urban locations is associated with (slightly) lower environmental impacts. This might be due to reduced private transport needs and lower residential energy requirements in urban areas for reasons such as shared walls, larger-scale central heating systems or smaller living spaces (cf. Wiedenhofer et al., 2013).

The studies by Ala-Mantila et al. (2014), Wiedenhofer et al. (2013) and Diekmann and Jann (2000) all use a rather fine-grained set of categories of energy use and emissions and thus report results regarding specific domains of environmental impact: the three studies agree that urbanity is correlated to lower environmental impacts by both transport and residential energy use. Regarding food, Ala-Mantila et al. (2014) report that residents of urban locations cause lower impacts, whereas both other studies do not find a link. In addition, Ala-Mantila et al. (2014) conclude that respondents living in more urban locations cause higher emissions by services. This is intuitively understandable if urbanity is understood as an indicator for the ease of access to many types of services such as cultural events, restaurants, or health care. Furthermore, Wiedenhofer et al. (2013) included the heating degree days to account for geographic variability. They conclude that higher heating degree days are linked to higher direct, residential energy requirements but unrelated to transport or food.

To our knowledge, only one of the studies looking into GHG emissions considers environmentally relevant attitudes or values as predictors: in their multivariate analysis of household emissions, Kennedy et al. (2015) report that concern with various environmental problems is negatively correlated to emissions. Furthermore, a few other studies on emissions use measures that do not strictly assess environmental attitudes: Baiocchi et al. (2010) use membership in an environmentally active organization as a proxy and find that membership is related to higher emissions. They suggest this might be the case as mainly wealthier households were members of the organization in question. Wilson et al. (2013) use a five-item index for "energy efficiency engagement" which turns out to be unrelated to direct emissions. However, this index may not strictly capture environmental concern and thus the results should be interpreted with caution. A study by Csutora (2012) and a related study by Tabi (2013) both discuss the (missing) correlation of GHG emissions and pro-environmental attitudes. However, they do not assess attitudes directly but use a categorization of their respondents as "browns", "greens" etc. based on behavior instead.

There are a few studies analyzing household energy requirements and environmenttally relevant values or attitudes. The results so far remain inconclusive: for example, Vringer, Aalbers, and Blok (2007) do not find a clear-cut connection between value patterns and household energy requirements; controlling for socio-demographic household characteristics, there is one exception: materialists require a little more energy for dwelling than their other value groups. Abrahamse and Steg (2009) report that none of the psychological constructs in their model – attitudes toward energy conservation, perceived behavioral control, personal norms, awareness of responsibility and ascription of responsibility – remain significant when controlling for socio-demographic variables. Similarly, in a study by Poortinga et al. (2004) neither environmental concern (as measured by the New Environmental Paradigm), nor concern about global warming (p. 78), nor a high valuation of environmental quality are related to home or transport energy use. In contrast, the studies by Gatersleben et al. (2002) indicate that higher environmental awareness (Study 1) and a belief that "We should be careful with our natural environment because we depend on it" (Study 2, p. 350) are linked to lower energy use. Diekmann and Jann (2000) report diverging results for different areas of consumption: neither overall energy use nor energy use by mobility is related to environmental concern. Yet respondents with higher environmental concern use less energy with regards to food, clothing and recycling. Interestingly, higher environmental concern is related to *higher* residential energy use.

As this review of previous research shows, the results are ambiguous for most of the potential correlates. In particular, there are not many multivariate studies and only few of them take into account environmental concern or other attitudinal variables. Furthermore, there are hardly any studies comparing different areas of consumption. In the present study, we will use a broad range of predictors of GHG emissions, among them income and environmental concern, and run separate analyses for different areas of consumption.

Hypotheses

We expect that respondents with higher incomes cause higher GHG emissions, in particular in the areas of mobility and housing. Almost all purchases of goods and services have an impact on the environment. Production and processing of goods and services are energy consuming and, if from fossil resources, contribute to GHG emissions. Although, in theory, the proportion of consumption decreases with income, the absolute value increases. Hence, we assume that income has a strong effect on emissions.

Given a "moral basis" for environmental behavior, we would expect that persons with higher environmental concern cause lower emissions. However, many people may fall into a trap to self-deception and may overestimate their contribution to environmental conservation. Also, it has been supposed that persons choose less uncomfortable, more symbolic forms of eco-friendly behavior such as recycling of glass and paper. It has also been argued that persons prefer to satisfy their environmental conscience with low-cost activities that have only a small impact on the environment (Diekmann & Preisendörfer, 1998, 2003). Moreover, rebound and moral licensing effects often lower the gains of environmentally responsible behavior (e.g. Chitnis, Sorrell, Druckman, Firth, & Jackson, 2014; Merritt, Effron, & Monin, 2010). All in all, we do not expect a strong effect of environmental concern on the actual environmental impact measured in terms of GHG emissions.

In contrast, income should have a much smaller weight for explaining intent-oriented, personal pro-environmental behavior. PEB scales mostly consist of items measuring symbolic forms of environmentally responsible behavior and even people with high incomes and large amounts of consumption may score high on PEB scales. By the same reasoning, environmental concern should be more strongly related to PEB than to GHG emissions. Thus, we expect a very different pattern in the effects of income and environmental concern on GHG emissions versus PEB.

Data and Methods

Participants and Procedure

All analyses are based on data from the Swiss Environmental Survey 2007, a representative general population study (n = 3369). The data collection was based on a two-stage random sample taken from the adult population of Switzerland with a registered telephone extension. In a first step, households were selected randomly from regional strata and notified by mail. The study was described as an investigation into living conditions in Switzerland and not as an environmental study in order to avoid including a disproportionate number of people with an above-average interest in the environment taking part. The households were then contacted by telephone. In the second step of the sampling procedure, one respondent within each household was selected at random from all its members aged 18 or older and being able to respond in German, French or Italian. Foreigners belonging to the resident population were included provided they could complete the survey in one of the three languages mentioned. The telephone interviews were conducted between November 2006 and March 2007. On average they lasted 37 minutes. The resulting response rate was 52% (RR2, Research, AAPOR). A written follow-up questionnaire was completed by a total of 83% of those already interviewed (2789 persons). Up to two reminders were issued.

The resulting sample consists of 56% females and the average age was 49.9 years (ranging from 18 to 94 years). The median level of education is 12 years. Further information on the sample as well as on procedures and materials can be found in the project documentation (Diekmann & Meyer, 2008).[2]

[2] To test for an environment-related self-selection bias, for the written survey, the index's measures of environmental concern during the oral interview were compared between the participants and non-participants. No significant differences were observed (t = .268, df = 3132, p = .789).

Multiple Imputation of Missing Data

Missing data was handled by multiple imputation using chained equations (MICE). Multiple imputation is currently considered a state-of-the-art technique to handle missing data (Van Buuren, 2012). It assumes missingness is at random while – unlike the common practice of listwise deletion – not requiring the data to be missing *completely* at random (e.g. White, Royston, & Wood, 2011).

The MICE procedure is regression-based and creates multiple complete copies of the dataset. Each of these copies contains different estimates for the missing values. In this study, 120 imputed datasets were created using 75 variables. Further information can be found in the Appendix.

All analyses that follow are based on the 120 imputed datasets. The results were pooled following Rubin's rules (cf. StataCorp., 2011). To allow for comparison, all multivariate analyses were also carried out with complete cases only (i.e. listwise deletion, see Tables A5 and A6 in the Appendix). The results are comparable to the results using the imputed data. However, the analyses on imputed data are more efficient, as was indicated by lower standard errors (cf. van Buuren, 2012, p. 254).

Estimation of GHG Emissions

While compiling the questionnaire items regarding behavior for the "Swiss Environmental Survey 2007", Diekmann and Meyer closely collaborated with life cycle experts at the Swiss Federal Laboratories for Materials Science and Technology (Empa) in order to allow for a later life cycle analysis (LCA). Empa subsequently carried out an LCA for every individual respondent, as is reported in Notter et al. (2013). The results are expressed in annual kg CO_2 equivalents per person.

In the present study, we do not distinguish between direct and indirect emissions. Instead, emissions are split into different areas of consumption. Thus, each category includes both direct and indirect emissions. These are: housing (covering space heating, building infrastructure, electricity), mobility (covering travel by air, public transport, car and motorbike), food and non-durable consumer goods. Previous studies have identified food, shelter and mobility as the most important consumption categories (Hertwich & Peters, 2009, in general; Jungbluth et al., 2011, for Switzerland).

Depending on the data available, the original computations by Empa followed different paths for different respondents (e.g. computation of impacts by housing may only be based on monthly rental costs in the case of households renting their home). Overall, there were two alternative paths for emissions by car travel and five for housing. As we strongly suspect the different paths result in different biases, one path was chosen for all respondents and instead of replacing missing values by mean or modal values, we opted for multiple imputations as described above. Furthermore, after consultation with the LCA experts at Empa, a few corrections to individual cases and the procedure in general were applied. A few steps required for estimating GHG emissions were carried out prior to imputation (but missing values remained missing), but most were carried out afterwards.

Emissions by mobility include air travel, public transport and motorized private transport. The resulting emissions are estimated based on the distance traveled by each means of transport. For air travel, short-haul and long-haul flights are treated separately. [3] The distance covered by short-haul flights is based on the number of flights with small aircrafts and "regular" short-haul flights. For the former a travel distance of 200 km per trip is assumed, for the latter we use a distance of 2,000 km for a return trip. The distance traveled in long-haul flights is calculated based on frequency and origins and destinations indicated. This is done by means of spherical trigonometry, assuming flight routes describe an orthodrome, while adding 10% for ascent, descent and deviation from the orthodrome (see Table S1 in Notter et al., 2013, for a list of how vague destination details were interpreted). Travel distances by public transport were estimated based on the amount of time the respondents indicated having spent on trains and on buses or tramways during the previous week. These travel times were translated into distances by assuming an average speed for these means of transport. For motorized private transport, travel by motorbikes, travel by cars available to the household and travel in other cars (such as rental cars, taxis) were accounted for. For both cars and motorbikes, the distances traveled were used to infer emissions by fuel consumption as well as emissions due to infrastructure use and maintenance of vehicles and roads.

GHG emissions by housing cover emissions by electricity consumption, building infrastructure and space heating. As suggested by Notter et al. (2013), electricity consumption is set to roughly 4558 MJ per year for all respondents living in low-energy buildings and

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[3] For air travel, we refrain from employing multiple imputation as this allows for a simpler imputation model and for using all available data. Missing values were replaced by mean and modal values, respectively: for short-haul flights, only one value for the number of flights in small aircrafts was missing and replaced by the modal value (0) as only 9 out of the remaining 3368 respondents used a small aircraft at all. For long-haul flights, all respondents indicated the number of flights they took and trip details for up to three flights. After data cleansing, 98 out of 863 long-haul flights lacked details on origin and destination. Nine of these trips are unaccounted for even though the respondents were asked for details, whereas the remaining 89 flights lack details because the respondents indicated they took more than three flights. For all incomplete long-haul flights, the average distance of all long-haul flights is used.

roughly 9772 MJ per year for the remaining persons (since electricity consumption was not measured). GHG emissions by construction of the building and its end-of-life treatment were estimated as a function of the living area. Emissions by heating were estimated based on the construction period of the building (prior to 1971, between 1971 and 1989, 1990 or later), the type of building (detached house, semi-detached and row houses, apartment buildings with up to four units and larger than four units), type of heat energy carrier, living area, thermal insulation (from the beginning, since a later retrofit or not at all) and the period the windows were last renewed. Low-energy buildings are interpreted as following the standards of 38 and 60 kWh per square meter, respectively, depending on whether they were built in 1990 or later versus prior to that.

GHG emissions by food were estimated based on age, gender, share of organic food products consumed and number of days a week with meat consumption. In order to account for emissions by non-durable consumer goods, the impacts of six different materials were taken into account: paper, glass, organic waste, polyethylene terephthalate (PET), aluminum and tin. Every respondent is assumed to have an average consumption of these materials. The emissions of each type of material are computed depending on whether the person indicates they recycle the material in question or not.

Intent-Oriented Pro-Environmental Behavior

Thirteen items were used to assess PEB from an intent-oriented perspective: recycling of (1) organic waste, (2) PET, (3) aluminum and (4) tin, (5) frequent or very frequent consumption of organic produce, (6) use of recycled toilet paper and (7) of recycled paper in general, (8) avoidance of standby on the television set, (9) use of energy-saving light bulbs, (10) switching off lights upon leaving a room, (11) environmentally friendly reaction when feeling cold at home in winter (not turning up heating), (12) no air travel for private purposes during the past year and (13) no car in household. All of these items were recoded into binary variables and summed up. This results in a scale ranging from 0 to 13 with high values indicating environmentally friendly behavior (M = 8.23, 95% CI [8.16, 8.30]). The reliability of the scale turned out rather low (mean of Cronbach's alpha across M = 120, α = .456, n = 3369). However, due to the heterogeneous content of the items this is not surprising.

Income and Environmental Concern

Income is assessed as the net household equivalence income, i.e. the household's disposable income was divided by the square root of the number of individuals living in the household. If possible, income is based on an open question; otherwise it is based on categories. The median equivalence income amounts to CHF 4571 per month[4] (95% CI [4468, 4674]; M = 5256, 95% CI [5110, 5401]; n = 3369). Due to its right-skewed distribution, income is logarithmized for all regression analyses to follow.

Environmental concern was measured by the nine five-point items suggested by Diekmann and Preisendörfer (2001; for an English translation see Table A1 in the Appendix). While the items cover three theoretical dimensions – affective, cognitive and conative – a factor analysis on the complete cases produced a one-dimensional solution (principal components: $\chi^2(36) = 4657.95$, $p = .000$; KMO = .851; 34.5% of variance explained, n = 3134) as put forth by Diekmann and Preisendörfer (2001). The corresponding reliability was $\alpha = .760$ (mean of Cronbach's alpha across M = 120, n = 3369). The items were reverse-scored if applicable and an average score was computed. While the resulting scale theoretically ranges from 1 to 5, its mean is 3.68 (95% CI [3.66, 3.70]; n = 3369). High values indicate high environmental concern.

Analyses

The results section below first presents descriptive results before turning to multivariate regression analyses. The latter generally use only those predictors that have not been used to estimate emissions (except for gender and age in the case of food). Otherwise, correlations should be overestimated by design – as presumably is the case in many studies that rely on expenditures both to estimate and predict emissions in the subsequent analyses (this is for example pointed out by Ala-Mantila et al., 2014). This in turn entails that our regression analyses do not include certain variables, such as living area or type of building, which would – by definition – be correlated to environmental impact.

[4] 1,000 CHF amounted to roughly 810 USD at the time the survey was started (Swiss National Bank, 2014).

Results

Descriptive Results

Estimated average annual GHG emissions per capita amount to 6028 kg CO_2 equivalents (95% CI [5904, 6151]). This total is composed of emission in several categories as described in the method section. Figure 1 illustrates the relative shares of the different consumption categories. As expected, mobility and housing represent large shares with 46% (2754 kg, 95% CI [2650, 2859]) and 33% (1972 kg, 95% CI [1907, 2037]), respectively.

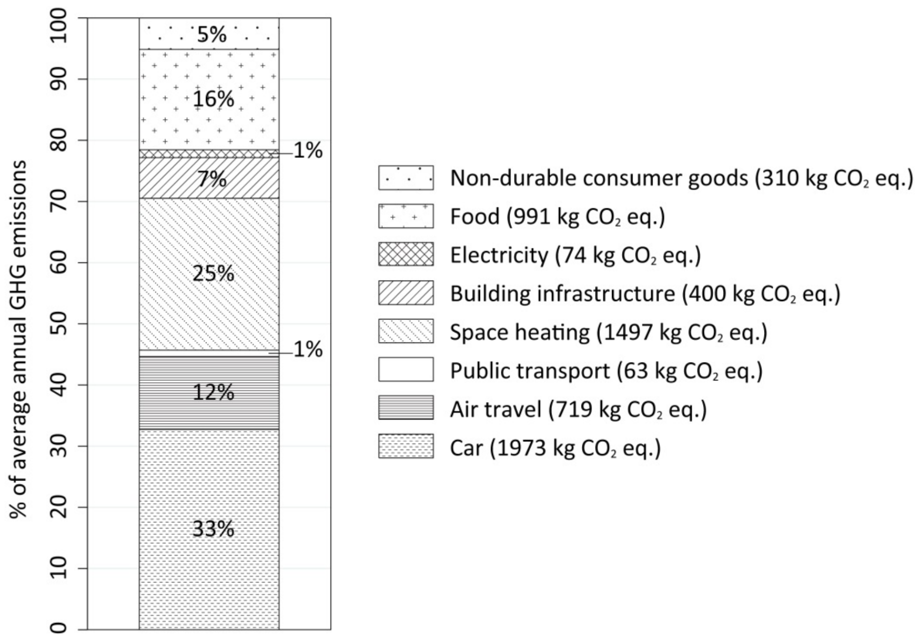

Figure 1. Annual average GHG emissions per capita, divided into subcategories (average emissions in brackets)

When these numbers are compared to other studies in Switzerland, they seem rather low as Jungbluth et al. (2011) conclude that most studies on Switzerland report CO_2 equivalents per capita at in between 8.6 and 13 tons. The low estimate of the present study can be explained by the fact that our survey did not assess all categories of consumption. In particular, most services (including health services, or education) and many long-lived goods (such as furniture, electronic equipment, household equipment, or clothing) are not covered.

A comparison of the 10% of the sample with the lowest per capita emissions (2342 kg, 95% CI [2301, 2383] per person) and the 10% with the highest emissions (13984 kg, 95%

CI [13475, 14493]) reveals a factor of 6 between the emissions of these two groups. The 10% highest emitters cause roughly 23% of the total emissions of our sample, whereas, for the lowest emission decile, it is only 4%. Table 1 gives an overview of the differences between the lowest and the highest emission deciles.

Table 1. Descriptive statistics for the lowest and the highest emission deciles

	Lowest emission decile		Highest emission decile	
	Mean	95% CI	Mean	95% CI
GHG total [kg CO_2 eq.]	2342	2301, 2383	13984	13475, 14493
GHG housing [kg CO_2 eq.]	802	756, 847	3769	3358, 4180
GHG mobility [kg CO_2 eq.]	391	354, 429	8846	8268, 9425
GHG food [kg CO_2 eq.]	838	810, 866	1058	1021, 1095
PEB (0-13)	9.3	9.1, 9.5	7.2	7.0, 7.5
Equivalence income (per month, in thsd CHF)	4.1	3.6, 4.5	7.7	6.9, 8.5
Environmental concern (1-5)	3.9	3.9, 4.0	3.4	3.4, 3.5
Number of persons in household	2.7	2.5, 2.8	2.0	1.9, 2.2
Children in household (0/1)	.23	.18, .28	.13	.09, .16
Female (0/1)	.77	.72, .82	.37	.32, .43
Age (divided by 10)	5.1	4.9, 5.3	4.8	4.6, 4.9
Years of education	12.2	11.8, 12.5	14.0	13.7, 14.4
Economically active (0/1)	.50	.44, .56	.77	.73, .82
Car in household (0/1)	.53	.47, .59	.94	.92, .97
City (0/1)	.31	.26, .37	.19	.15, .24
Small or medium-sized town (0/1)	.11	.07, .14	.15	.11, .19
Agglomeration (0/1)	.38	.32, .44	.44	.38, .49
Rural community (0/1)	.21	.16, .25	.22	.17, .27
Frequency of consumption of organic products (1-5)	3.5	3.3, 3.6	3.1	3.0, 3.2
Number of days a week with meat consumption	2.4	2.2, 2.6	3.6	3.4, 3.8
Square footage of apartment or house per person (m^2)	41.9	39.4, 44.4	88.7	81.9, 95.6
Air travel for private purposes (0/1)	.14	.10, .18	.71	.66, .76
Low-energy building (0/1)	.29	.22, .38	.15	.10, .21
Home owner (0/1)	.38	.33, .44	.49	.44, .55

Note: *n* varies between imputations (*n* = 312-358 for lowest emission decile, *n* = 323-353 for highest emission decile).

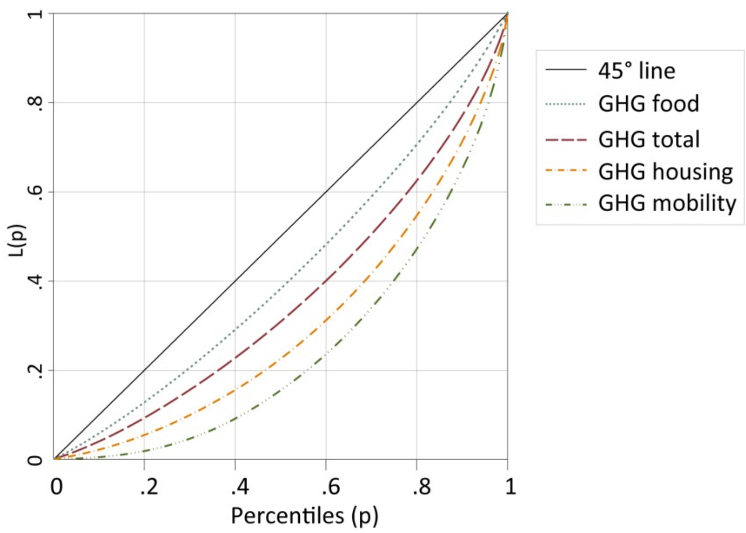

Figure 2. Lorenz curves for total GHG emissions per capita and for those by housing, mobility and food (based on one imputation only)

This unequal distribution is particularly true for mobility and housing, and less so for food (see Lorenz curves in Figure 2). Figure 3 visualizes average annual per capita emissions by income deciles, split up into the different categories. A comparison of the emissions of the highest and lowest income deciles reveals a factor of about 1.8 between the emissions by these two groups (roughly 8762 kg per person (95% CI [8184, 9340]) and 4792 kg per person (95% CI [4420, 5164]), respectively). The top income percentile causes approximately 15 % of the total emissions of our sample, whereas, for the lowest decile, it is about 8 %.

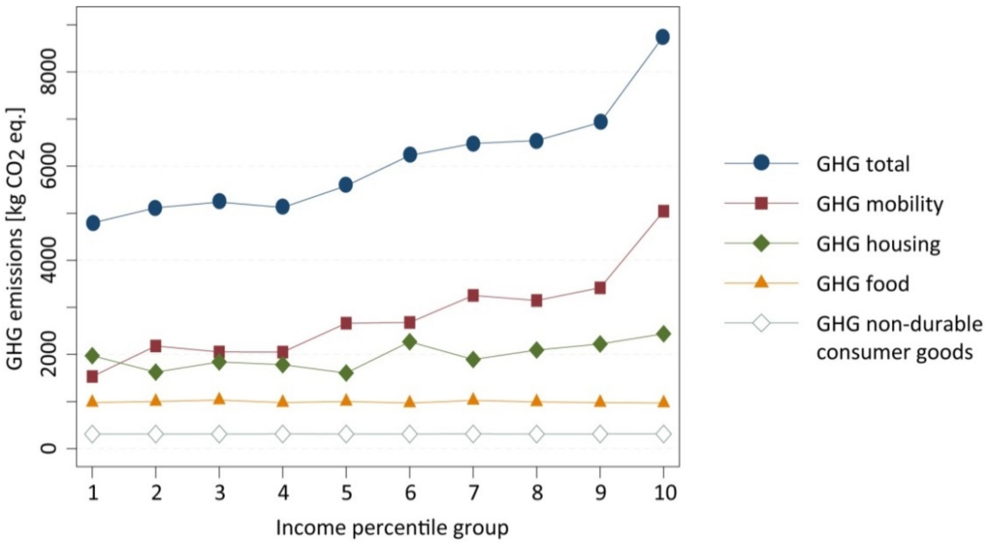

Figure 3. Mean annual GHG emissions by deciles of equivalence income, split for areas of consumption

Particularly for mobility, there seems to be a relationship between income and emissions (Figure 3). This is also reflected by the bivariate correlation between equivalence income and GHG emissions (see Table 2). The correlation analysis reveals that higher total GHG emissions as well as emission from mobility and housing are all related to both higher income and lower environmental concern whereas emissions by food are only related to lower environmental concern but not to income (see Table 2). Furthermore, lower environmental concern and higher income are both related to lower values on the intent-oriented scale (PEB).

Table 2. Bivariate correlations (estimated using Stata's "mibeta" with the option "fisherz", n = 3369)

	1	2	3	4	5	6	7	8
1 GHG total (log.) [a]	-							
2 GHG housing (log.) [a]	.474***	-						
3 GHG mobility (log.) [a]	.687***	-.076***	-					
4 GHG food (log.) [a]	.200***	-.125***	.173***	-				
5 GHG consumer goods	.003	.003	.006	.018	-			
6 PEB [b]	-.264***	.042*	-.290***	-.353***	-.266***	-		
7 Equivalence income (log.) [a]	.328***	.135***	.325***	-.004	.045*	-.159***	-	
8 Environmental concern	-.211***	-.029	-.178***	-.269***	-.061***	.266***	-.104***	-
9 Number of persons in household	-.147***	-.521***	.168***	.165***	-.033	-.011	-.065***	-.029

Notes:
*** $p < .001$, ** $p < .01$, * $p < .05$.
[a] An equivalent table where none of the variables is logarithmized can be found in the Appendix (Table A2).
[b] "PEB" abbreviates "pro-environmental behavior" and refers to the intent-oriented measure of behavior. High values indicate environmentally friendly behavior.

Regression Analyses

To analyze the effects of income and environmental concern on GHG emissions and on PEB, ordinary least squares (OLS) regression models were estimated. For these analyses, all measures of GHG emissions were logarithmized due to their skewed distributions. Information on the control variables can be found in Table A3 in the Appendix. Table 3 shows the results of these analyses. Standardized regression coefficients as well as models with complete cases only (listwise deletion) can be found in the Appendix (Tables A4-A6).

The overall explanatory power of the models ranges from 0.18 to 0.46 (as the values of adjusted R^2 in Table 4 indicate). As expected, income has a significant and strong impact on GHG emissions. A one percent increase in income is related to a 0.18 percent increase in overall GHG emissions. Exploring the three dimensions of emissions separately, the increase for emissions by housing is 0.14 percent, for emissions by mobility it is 0.34 percent, while there is no significant coefficient for food consumption. Poorer and richer households alike generate the same level of emissions by food consumption. The opposite is true for the mobility dimension. Here, we find the largest income effect of all three dimensions. Despite a very high degree of overall motorization in Switzerland, richer households spend much more income on fossil fuel consuming transportation than households that are less well off.

Now, let us turn to environmental concern. We did not expect a strong effect of environmental concern on emissions. Surprisingly, we have found a clear pattern of positive coefficients across all three dimensions of emissions. The coefficient is smallest for housing and larger for mobility and food but all coefficients are significant with $p < 0.05$ (housing) or $p < 0.01$ (mobility, food). Housing is a long-term investment and apartment size and respective heating costs are more or less fixed from the beginning. On the other hand, there is more room for decision-making in the area of mobility and food consumption, and for both dimensions we observe a considerable impact of respondents' environmental concern.

Table 3. OLS regression models for intent-oriented PEB and GHG emissions per capita (total and categories)

	PEB[a]	GHG Total (log.)	GHG Housing (log.)[b]	GHG Mobility (log.)[b]	GHG Food (log.)[b]
Equivalence income (per month, in thsd, log.)	-0.42**	0.18**	0.14**	0.34**	-0.02
	(-5.62)	(10.20)	(5.10)	(8.14)	(-1.57)
Environmental concern (1-5)	0.71**	-0.09**	-0.05*	-0.11**	-0.10**
	(13.74)	(-7.85)	(-2.55)	(-3.97)	(-13.45)
Number of persons in household	0.20**	-0.11**	-0.26**	-0.08**	0.02**
	(6.02)	(-13.78)	(-21.95)	(-4.24)	(3.53)
Children in household (0/1)	-0.13	0.04	0.04	0.01	-0.02
	(-1.19)	(1.50)	(0.88)	(0.15)	(-1.33)
Female	0.21**	-0.15**	0.05	-0.36**	-0.17**
	(3.02)	(-9.39)	(1.90)	(-9.68)	(-18.12)
Age (divided by 10)	0.27**	-0.02**	0.07**	-0.15**	-0.02**
	(10.89)	(-2.64)	(6.78)	(-10.47)	(-7.09)
Years of education	0.08**	0.01**	0.02**	0.05**	-0.01**
	(6.23)	(4.82)	(3.45)	(6.61)	(-7.79)
Economically active (0/1)	0.12	0.03	-0.05	0.19**	0.01
	(1.38)	(1.47)	(-1.38)	(3.98)	(0.86)
Car in household (0/1)	-0.96**	0.31**		1.65**	
	(-10.13)	(13.17)		(26.90)	
German-speaking area	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
French-speaking area	-0.52**	0.04	-0.18**	0.20**	0.03*
	(-5.76)	(1.79)	(-4.90)	(3.87)	(2.18)
Italian-speaking area	-0.54**	0.04	-0.10	0.16*	-0.11**
	(-3.94)	(1.08)	(-1.71)	(1.96)	(-5.68)
City	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
Small or medium-sized town	0.54**	0.07**	0.18**	-0.14*	0.06**
	(4.72)	(2.78)	(4.39)	(-2.23)	(3.59)
Agglomeration	0.41**	0.05*	0.07*	-0.10	0.06**
	(4.44)	(2.20)	(2.04)	(-1.81)	(4.79)
Rural community	0.62**	0.08**	0.05	-0.06	0.12**
	(5.63)	(3.14)	(1.26)	(-0.96)	(8.13)
Aggregate distance to local facilities (km, log.)	0.06	0.01		0.01	
	(1.12)	(0.55)		(0.26)	
Constant	3.69**	8.54**	7.29**	6.33**	7.54**
	(11.01)	(107.28)	(56.16)	(34.30)	(164.51)
Number of observations	3369	3369	3369	3369	3369
Adjusted R^2	0.178	0.267	0.316	0.459	0.229

** $p < .01$, * $p < .05$. *t* values in brackets.

Notes:

[a] "PEB" abbreviates "pro-environmental behavior" and refers to the intent-oriented measure of behavior. High values indicate environmentally friendly behavior.

[b] GHG emissions by housing were estimated at the household level and then divided by the number of persons living in the household. Emissions by mobility and by food, on the other hand, solely relate to the respondents' personal travel and eating habits, respectively.

Turning to personal behavior, we assumed large effects of environmental concern on intent-oriented PEB and small or no effects of income. The former hypothesis is corroborated by our analyses while the latter hypothesis is refuted. Both income and environmental concern are significantly related to PEB. Interestingly, for our two key independent variables, income and environmental concern, we find a similar pattern of relationships, whether analyzing the "subjective" PEB measure or the "objective" GHG emissions.

Let us briefly comment on the further covariates. For household size, economies of scale are visible on the PEB scale, for overall emissions as well as emissions by housing and mobility, but not for food. There is no difference between respondents living in households with and without children. There are higher PEB scores and lower overall and mobility-related emissions for both women and older persons. The same is true for emissions by food but this is hardly surprising given this is inherent in the computation of emissions (as outlined in the chapter on the estimation of emissions). For housing, emissions are higher for older persons but there is no gender difference.

There is no significant correlation between being economically active and PEB scores or emissions, respectively, except for emissions by mobility – economically active persons cause significantly higher transport emissions. As car travel is the key contributor to emissions by mobility, the presence of a car in the household is related to significantly higher emissions. For two variables – education and residence – the pattern of associations with PEB and emissions is inconsistent. Education is weakly but positively related to overall, home and transport emissions, whereas the correlation is negative in the domain of food. In contrast, higher education is associated with more environmentally friendly behavior on the PEB scale. A reason might be that persons with higher education may overrate their pro-environmental behavior.

For location, i.e. living in more urban and more central locations, there is no easily interpretable pattern of location. For mobility, this is not surprising, as previous research has often indicated possible rebound effects, in the sense that urban dwellers are more prone to air travel which compensates for possible emission savings by lower car use (e.g. Brand & Preston, 2010; Heinonen, Jalas, Juntunen, Ala-Mantila, & Junnila, 2013; Ottelin, Heinonen, & Junnila, 2014).

Conclusion

Our research focused on the question of how both income and environmental concern are related to greenhouse gas (GHG) emissions. Moreover, we also explored the effects of these variables on intent-oriented pro-environmental behavior (PEB).

Based on data from a nation-wide environmental survey in Switzerland, we observe a large variance of per capita GHG emissions. While the decile with the lowest emissions generates about 2.3 tons per capita, the uppermost decile is responsible for six times as many emissions or 14 tons of CO_2 equivalents per capita. The variance is much larger for mobility (a factor of 23) than for food (factor 1.3), with the sector of housing in between (factor 4.7).

Income and environmental concern, as well as further socio-demographic variables, only account for part of the variance. The bivariate correlation between income and GHG emissions is 0.33, i.e. income explains about one tenth of the variance. The correlation with environmental concern is lower (-0.21), and this variable explains 4.4 percent of the variance. Multivariate analyses yield similar results. Income is strongly related to emissions but there is also a significant coefficient for environmental concern. Moreover, we find the same pattern of relationships for intent-oriented PEB, that is, the more symbolic forms of environmentally responsible behavior.

Closer inspection of the three dimensions of emissions reveals significant regression weights of income for mobility and housing but not for food consumption. For the latter, affluence may instead be related to a qualitative shift toward more expensive products, including organic food (see for example Girod & de Haan, 2010a). In contrast, environmental concern is significantly related to all three dimensions of emissions.

By economies of scale, larger households save on per capita emissions in the area of housing. During the past few decades, average household size has declined and the number of single households has increased. Given this process will continue in individualized societies, and other things being equal, GHG emissions of private households will increase.

The positive message is that there is plenty of room for emission reductions. The impact of income on GHG emissions is far from perfect. Even in high-income groups there is a large variation of GHG-related consumption patterns. Environmental concern may contribute to spending income in more environmentally friendly ways, for example, by shifting consumption to less carbon intensive alternatives, such as vegetarian meals as opposed to eating meat, or wind surfing instead of jet skiing. For policy and practical interventions, this implies that not only monetary but also soft incentives may prove useful.

However, note that there are limitations to the present study. In principle, the life cycle analysis carried out for this study could be further improved for example by covering additional fields of consumption (such as electronic equipment or furniture) or by capturing relevant behavior in more detail – for example, by incorporating information on car fuel efficiency or actual heating energy use. However, there is a tradeoff between costs and benefits, feasibility and precision. Much of the desired, more detailed information is not reliably accessible by means of questionnaires. Despite the obvious allure of life cycle analyses, one should – as with scales of PEB – always keep the related blind spots in mind, such as the imprecision associated with conversion factors, for example, from distances to impacts. Furthermore, despite multivariate regression analyses one should be cautious inferring causality between the variables of interest. For this purpose, future research may consider experimental or longitudinal designs. In addition, the present study relies on self-reported behavior. Observational data or – for example – data from registers of buildings and dwellings may prove helpful.

References

Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households’ direct and indirect energy use and savings? *Journal of Economic Psychology, 30*(5), 711-720.

Ala-Mantila, S., Heinonen, J., & Junnila, S. (2014). Relationship between urbanization, direct and indirect greenhouse gas emissions, and expenditures: A multivariate analysis. *Ecological Economics, 104*(0), 129-139.

Baiocchi, G., Minx, J., & Hubacek, K. (2010). The Impact of Social Factors and Consumer Behavior on Carbon Dioxide Emissions in the United Kingdom. *Journal of Industrial Ecology, 14*(1), 50-72.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14-25.

Bin, S., & Dowlatabadi, H. (2005). Consumer lifestyle approach to US energy use and the related CO2 emissions. *Energy Policy, 33*(2), 197-208.

Brand, C., Goodman, A., Rutter, H., Song, Y., & Ogilvie, D. (2013). Associations of individual, household and environmental characteristics with carbon dioxide emissions from motorised passenger travel. *Applied Energy, 104*(0), 158-169.

Brand, C., & Preston, J. M. (2010). '60-20 emission' - The unequal distribution of greenhouse gas emissions from personal, non-business travel in the UK. *Transport Policy, 17*, 9-19.

Bratt, C., Stern, P. C., Matthies, E., & Nenseth, V. (2014). Home, Car Use, and Vacation: The Structure of Environmentally Significant Individual Behavior. *Environment and Behavior*.

Büchs, M., & Schnepf, S. V. (2013). Who emits most? Associations between socio-economic factors and UK households' home energy, transport, indirect and total CO2 emissions. *Ecological Economics, 90*, 114-123.

Chitnis, M., Sorrell, S., Druckman, A., Firth, S. K., & Jackson, T. (2014). Who rebounds most? Estimating direct and indirect rebound effects for different UK socioeconomic groups. *Ecological Economics, 106*(0), 12-32.

Csutora, M. (2012). One More Awareness Gap? The Behaviour–Impact Gap Problem. *Journal of Consumer Psychology, 35*, 145–163.

Diekmann, A., & Jann, B. (2000). Sind die empirischen Ergebnisse zum Umweltverhalten Artefakt? Ein Beitrag zum Problem der Messung von Umweltverhalten [Are the empirical results regarding environmental behavior artefacts? A contribution to the problem of measuring environmental behavior]. *Umweltpsychologie, 4*(1), 64-75.

Diekmann, A., & Meyer, R. (2008). Schweizer Umweltsurvey 2007. Dokumentation und Codebuch [Swiss Environmental Survey 2007. Documentation and Codebook]. Zurich: Chair of Sociology, ETH Zurich.

Diekmann, A., & Preisendörfer, P. (1998). Environmental Behavior - Discrepancies between Aspirations and Reality. *Rationality and Society, 10*(1), 79-102.

Diekmann, A., & Preisendörfer, P. (2001). *Umweltsoziologie. Eine Einführung [Environmental Sociology. An Introduction]*. Reinbek bei Hamburg: Rowohlt.

Diekmann, A., & Preisendörfer, P. (2003). Green and Greenback. The Behavioral Effects of Environmental Attitudes in Low-Cost and High-Cost Situations. *Rationality and Society, 15*.

Druckman, A., & Jackson, T. (2008). Household energy consumption in the UK: A highly geographically and socio-economically disaggregated model. *Energy Policy, 36*(8), 3177-3192.

Druckman, A., & Jackson, T. (2009). The carbon footprint of UK households 1990–2004: A socio-economically disaggregated, quasi-multi-regional input–output model. *Ecological Economics, 68*(7), 2066-2077.

Gatersleben, B., Steg, L., & Vlek, C. (2002). Measurement and determinants of environmentally significant consumer behavior. *Environment and Behavior, 34*(3), 335-362.

Girod, B., & de Haan, P. (2010a). GHG reduction potential of changes in consumption patterns and higher quality levels: Evidence from Swiss household consumption survey. *Energy Policy, 37*(12), 5650-5661.

Girod, B., & de Haan, P. (2010b). More or Better? A Model for Changes in Household Greenhouse Gas Emissions due to Higher Income. *Journal of Industrial Ecology, 14*(1), 31-49.

Gough, I., Abdallah, S., Johnson, V., Ryan-Collins, J., & Smith, C. (2011). The distribution of total greenhouse gas emissions by households in the UK, and some implications for social policy. *CASE Paper* (Vol. 152). London: Centre for Analysis of Social Exclusion, London School of Economics.

Heinonen, J., Jalas, M., Juntunen, J. K., Ala-Mantila, S., & Junnila, S. (2013). Situated lifestyles: I. How lifestyles change along with the level of urbanization and what the greenhouse gas implications are - a study of Finland. *Environmental Research Letters, 8*(2), 025003.

Hertwich, E. G., & Peters, G. P. (2009). Carbon Footprint of Nations: A Global, Trade-Linked Analysis. *Environmental Science & Technology, 43*(16), 6414-6420.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and Synthesis of Research on Responsible Behavior: A Meta-Analysis. *Journal of Environmental Education, 18*(2), 1-8.

Jungbluth, N., Nathani, C., Stucki, M., & Leuenberger, M. (2011). Environmental Impacts of Swiss Consumption and Production. A combination of input-output analysis with life cycle assessment. *Environmental studies* (Vol. 1111). Bern: Federal Office for the Environment FOEN.

Kaiser, F. (1998). General measure of ecological behavior. *Journal of Applied Social Psychology, 28*(5), 395-422.

Kaiser, F., & Wilson, M. (2000). Assessing people's general ecological behavior: A cross-cultural measure. *Journal of Applied Social Psychology, 30*(5), 952-978.

Kennedy, E. H., Krahn, H., & Krogman, N. T. (2015). Are we counting what counts? A closer examination of environmental concern, pro-environmental behaviour, and carbon footprint. *Local Environment, 20*(2), 220-236.

Kerkhof, A. C., Nonhebel, S., & Moll, H. C. (2009). Relating the environmental impact of consumption to household expenditures: An input-output analysis. *Ecological Economics, 68*(4), 1160-1170.

Lenzen, M., Wier, M., Cohen, C., Hayami, H., Pachauri, S., & Schaeffer, R. (2006). A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan. *Energy, 31*(2–3), 181-207.

Merritt, A. C., Effron, D. A., & Monin, B. (2010). Moral Self-Licensing: When Being Good Frees Us to Be Bad. *Social and Personality Psychology Compass, 4/5*, 344-357.

Meyer, R., & Bruderer Enzler, H. (2013). Geographische Informationssysteme (GIS) und ihre Anwendung in den Sozialwissenschaften am Beispiel des Schweizer Umweltsurveys [Geographic Information Systems (GIS) and their Application in the Social Sciences using the Example of the Swiss Environmental Survey]. *Methoden, Daten, Analysen (mda), 7*(3), 317-346.

Minx, J., Baiocchi, G., Wiedmann, T., Barrett, J., Creutzig, F., Feng, K., . . . Hubacek, K. (2013). Carbon footprints of cities and other human settlements in the UK. *Environmental Research Letters, 8*(3), 035039.

Moll, H. C., Noorman, K. J., Kok, R., Engström, R., Throne-Holst, H., & Clark, C. (2005). Pursuing More Sustainable Consumption by Analyzing Household Metabolism in European Countries and Cities. *Journal of Industrial Ecology, 9*(1-2), 259-275.

Nässén, J. (2014). Determinants of greenhouse gas emissions from Swedish private consumption: Time-series and cross-sectional analyses. *Energy, 66*, 98-106.

Notter, D. A., Meyer, R., & Althaus, H.-J. (2013). The Western Lifestyle and Its Long Way to Sustainability. *Environmental Science & Technology, 47*(9), 4014-4021.

Olli, E., Grendstad, G., & Wollebaek, D. (2001). Correlates of environmental behaviors - Bringing back social context. *Environment and Behavior, 33*(2), 181-208.

Ottelin, J., Heinonen, J., & Junnila, S. (2014). Greenhouse gas emissions from flying can offset the gain from reduced driving in dense urban areas. *Journal of Transport Geography, 41*, 1-9.

Poortinga, W., Steg, L., & Vlek, C. (2004). Values, environmental concern, and environmental behavior - A study into household energy use. *Environment and Behavior, 36*(1), 70-93.

Schultz, P. W., Zelezny, L., & Dalrymple, N. J. (2000). A multinational perspective on the relation between Judeo-Christian religious beliefs and attitudes of environmental concern. *Environment and Behavior, 32*(4), 576-591.

Shammin, M. R., Herendeen, R. A., Hanson, M. J., & Wilson, E. J. H. (2010). A multivariate analysis of the energy intensity of sprawl versus compact living in the U.S. for 2003. *Ecological Economics, 69*(12), 2363-2373.

StataCorp. (2011). *Stata Multiple-Imputation Reference Manual. Release 12*. College Station, Texas: Stata Press.

Stern, P. C. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues, 56*(3), 407-424.

Swiss Federal Office for the Environment FOEN. (2015). Switzerland targets 50% reduction in greenhouse gas emissions by 2030. Retrieved from http://www.bafu.admin.ch/klima/03449/12696/index.html?lang=en&msg-id=56394. Retrieved 2015.03.25.

Swiss National Bank. (2014). Interest rates and exchange rates November 2014. Retrieved from http://www.snb.ch/en/iabout/stat/statpub/akziwe/stats/akziwe/akziwe_S1_Wechsel. Retrieved 2014.11.20.

Tabi, A. (2013). Does pro-environmental behaviour affect carbon emissions? *Energy Policy, 63*, 972-981.

Thumim, J., & White, V. (2008). Distributional Impacts of Personal Carbon Trading: A report to the Department for Environment, Food and Rural Affairs. London: DEFRA.

Van Buuren, S. (2012). *Flexible Imputation of Missing Data*. Boca Raton: Chapman & Hall / CRC.

Vringer, K., Aalbers, T., & Blok, K. (2007). Household energy requirement and value patterns. *Energy Policy, 35*(1), 553-566.

Vringer, K., & Blok, K. (1995). The direct and indirect energy requirements of households in the Netherlands. *Energy Policy, 23*(10), 893-910.

Weber, C. L., & Matthews, H. S. (2008). Quantifying the global and distributional aspects of American household carbon footprint. *Ecological Economics, 66*(2-3), 379-391.

White, I. R., Royston, P., & Wood, A. M. (2011). Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine, 30*(4), 377-399.

Whitmarsh, L. (2009). Behavioural responses to climate change: Asymmetry of intentions and impacts. *Journal of Environmental Psychology, 29*(1), 13-23.

Wiedenhofer, D., Lenzen, M., & Steinberger, J. K. (2013). Energy requirements of consumption: Urban form, climatic and socio-economic factors, rebounds and their policy implications. *Energy Policy, 63*, 696-707.

Wilson, J., Tyedmers, P., & Spinney, J. E. L. (2013). An Exploration of the Relationship between Socioeconomic and Well-Being Variables and Household Greenhouse Gas Emissions. [Article]. *Journal of Industrial Ecology, 17*(6), 880-891.

Appendix

Further Information Regarding Imputation

In Multiple Imputation using Chained Equations (MICE), missingness may be correlated to the observed variables in the imputation model. In order to make this assumption more plausible, current research suggests including possible covariates as well as the dependent variable in the imputation models (see for example Collins, Schafer, & Kam, 2001; Enders, 2010, p. 201f; Graham, 2009, p. 559f; Van Buuren, 2012, p. 250; White, Royston, & Wood, 2011, p. 384f). Thus, the imputation model of this study is based on 75 variables. Of these 75 variables, 40 are later combined into the five dependent variables and an additional 15 variables are needed as predictors in the regression analyses. The missing rates of these variables vary between 0% and 51% (52 variables with less than 10%, six with 10-19.9%, ten with 20-30% and seven with more than 30% missing values).

To create the 120 imputed data sets used in the present study, the "mi" command in Stata 12.1 was used (StataCorp., 2011). Depending on the properties of the variable to impute, ordinary least squares (OLS) or multinomial, ordinal or binary logistic regression models were specified unless predictive mean matching (PMM) was applied. PMM was used for semi-continuous variables (with a pile-up at zero) such as distance driven by car, hours on the bus or rent, and also for variables with a restricted range of plausible values, e.g. attitudinal Likert-scaled items or the number of days a week with meat consumption. One of the advantages of PMM is that it does not produces values outside the already observed range, as it samples from the observed values of the variable that is imputed (White et al., 2011, p. 383). PMM is computationally not as intensive as, for example, truncated regression or ordinal logistic regression, and it has been shown to perform well when variables are not normally distributed, for semi-continuous variables or when relationships are not linear (Van Buuren, 2012; White et al., 2011, p. 384f).

In some cases, missingness is determined by a filter question. For example, only persons indicating the presence of a car in the household were asked what annual distance they traveled in it. In this case, the imputation of distance was only carried out if a car was available. Prior to imputation, the variables were recoded into a suitable format. In some cases, original variables were combined into new variables to allow for a simpler imputation model, for example, in the case of hours on the train or distance traveled by car.

All regression models are estimated using Stata's "mi estimate" command while adjusted R^2 values were computed using Stata's command "mibeta" with the option "fisherz" – consequently the calculations are based on Fisher's *z* calculation as recommended by Harel (2009). Percentiles were estimated using simultaneous quantile regression ("mi estimate: sqreg") as suggested by Lachenbruch (2010). The Stata code used for this paper is available from the first author upon request.

Further Tables

Table A1. Translation of the environmental concern scale by Diekmann and Preisendörfer (2001)

	Item text
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.

Table A2. Bivariate correlations (variables not logarithmized, estimated using Stata's "mibeta" with the option "fisherz", n = 3369)

	1	2	3	4	5	6	7	8
1 GHG total	-							
2 GHG housing	.483***	-						
3 GHG mobility	.870***	-.002	-					
4 GHG food	.142***	-.091***	.118***	-				
5 GHG consumer goods	.004	-.007	.003	.015	-			
6 PEB[a]	-.229***	.035	-.250***	-.343***	-.266***	-		
7 Equivalence income	.250***	.098***	.238***	-.026	.029	-.135***	-	
8 Environmental concern	-.185***	-.037*	-.168***	-.261***	-.061***	.266***	-.087***	-
9 Number of persons in household	-.136***	-.397***	.054**	.160***	-.033	-.011	-.080***	-.029

Notes:
*** $p < .001$, ** $p < .01$, * $p < .05$.
[a] "PEB" abbreviates "pro-environmental behavior" and refers to the intent-oriented measure of behavior. High values indicate environmentally friendly behavior.

Table A3. Description of variables in regression analyses

Variable label [a]	Complete cases					Imputed data		
	N	Mean	95% Confidence interval		Missing rate	Mean	95% Confidence interval	
			Lower limit	Upper limit			Lower limit	Upper limit
Total GHG emissions [kg CO_2-eq.] [b]	763	6225	6007	6443	77.4%	6028	5904	6151
GHG emissions by housing [kg CO_2-eq.] [b]	1216	1984	1883	2085	63.9%	1972	1907	2037
GHG emissions by mobility [kg CO_2-eq.] [b]	1629	2973	2830	3116	51.6%	2754	2650	2859
GHG emissions by food [kg CO_2-eq.]	3348	990	979	1000	0.6%	991	981	1002
PEB [b]	1948	8.28	8.19	8.37	42.2%	8.23	8.16	8.30
Equivalence income (per month, in thsd)	2908	5.26	5.11	5.40	13.7%	5.26	5.11	5.40
Environmental concern (1-5)	3134	3.67	3.66	3.71	7.0%	3.68	3.66	3.70
Number of persons in household	3369	2.35	2.30	2.40	0.0%	2.35	2.30	2.40
Children in household (0/1)	3369	0.19	0.17	0.20	0.0%	0.19	0.17	0.20
Female (0/1)	3369	0.56	0.55	0.58	0.0%	0.56	0.55	0.58
Age in years (divided by 10)	3369	5.00	4.94	5.05	0.0%	5.00	4.94	5.05
Years of education [c]	3363	12.99	12.89	13.08	0.2%	12.98	12.89	13.08
Economically active (0/1)	3364	0.65	0.63	0.66	0.1%	0.65	0.63	0.66
Car in household (0/1)	3369	0.79	0.78	0.80	0.0%	0.79	0.78	0.80
French-speaking area (0/1) [d]	3369	0.16	0.15	0.18	0.0%	0.16	0.15	0.18
Italian-speaking area (0/1) [d]	3369	0.07	0.06	0.07	0.0%	0.07	0.06	0.07
Small or medium-sized town (0/1) [e]	3369	0.15	0.14	0.16	0.0%	0.15	0.14	0.16
Agglomeration (0/1) [e]	3369	0.40	0.38	0.42	0.0%	0.40	0.38	0.42
Rural community (0/1) [e]	3369	0.21	0.20	0.23	0.0%	0.21	0.20	0.23
Aggregate distance to facilities (km, log.) [f]	3360	1.65	1.61	1.69	0.3%	1.65	1.61	1.68

Notes:

[a] "0/1" indicates a variable is binary with "0" meaning "no" and "1" meaning "yes".

[b] The high number of missing values is due to the large number of variables that was combined to create these variables (between 13 and 40 variables).

[c] Highest degree completed (categories) converted into years of education according to recommendations by the Swiss Federal Statistical Office.

[d] Persons living in the French- or Italian-speaking areas, respectively, as opposed to the German-speaking area.

[e] Persons living in a small or medium-sized town, in an agglomeration community or a rural community, respectively, as opposed to living in a large city for Swiss standards (i.e. Geneva, Lausanne, Bern, Basel, Zurich).

[f] Sum of straight-line distances to the following facilities: closest post office, closest grocery store and closest public transport stop. For more details see Meyer and Bruderer Enzler (2013).

Table A4. OLS regression models for intent-oriented PEB and GHG emissions per capita (total and categories), displaying standardized regression coefficients

	PEB[a]	GHG Total (log.)	GHG Housing (log.)[b]	GHG Mobility (log.)[b]	GHG Food (log.)[b]
Equivalence income (per month, in thsd, log.)	-0.11**	0.20**	0.10**	0.14**	-0.03
	(-5.62)	(10.20)	(5.10)	(8.14)	(-1.57)
Environmental concern (1-5)	0.23**	-0.13**	-0.04*	-0.06**	-0.21**
	(13.74)	(-7.85)	(-2.55)	(-3.97)	(-13.45)
Number of persons in household	0.13**	-0.28**	-0.46**	-0.07**	0.07**
	(6.02)	(-13.78)	(-21.95)	(-4.24)	(3.53)
Children in household (0/1)	-0.02	0.03	0.02	0.00	-0.03
	(-1.19)	(1.50)	(0.88)	(0.15)	(-1.33)
Female	0.05**	-0.15**	0.03	-0.13**	-0.29**
	(3.02)	(-9.39)	(1.90)	(-9.68)	(-18.12)
Age (divided by 10)	0.23**	-0.05**	0.15**	-0.19**	-0.14**
	(10.89)	(-2.64)	(6.78)	(-10.47)	(-7.09)
Years of education	0.11**	0.09**	0.06**	0.10**	-0.13**
	(6.23)	(4.82)	(3.45)	(6.61)	(-7.79)
Economically active (0/1)	0.03	0.03	-0.03	0.07**	0.02
	(1.38)	(1.47)	(-1.38)	(3.98)	(0.86)
Car in household (0/1)	-0.19**	0.25**		0.50**	
	(-10.13)	(13.17)		(26.90)	
German-speaking area	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
French-speaking area	-0.09**	0.03	-0.09**	0.05**	0.03*
	(-5.76)	(1.79)	(-4.90)	(3.87)	(2.18)
Italian-speaking area	-0.07**	0.02	-0.03	0.03*	-0.09**
	(-3.94)	(1.08)	(-1.71)	(1.96)	(-5.68)
City	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
Small or medium-sized town	0.09**	0.05**	0.08**	-0.04*	0.07**
	(4.72)	(2.78)	(4.39)	(-2.23)	(3.59)
Agglomeration	0.10**	0.05*	0.04*	-0.04	0.10**
	(4.44)	(2.20)	(2.04)	(-1.81)	(4.79)
Rural community	0.12**	0.07**	0.03	-0.02	0.16**
	(5.63)	(3.14)	(1.26)	(-0.96)	(8.13)
Aggregate distance to local facilities (km, log.)	0.02	0.01		0.00	
	(1.12)	(0.55)		(0.26)	
Number of observations	3369	3369	3369	3369	3369
Adjusted R^2	0.178	0.267	0.316	0.459	0.229

** $p < .01$, * $p < .05$. *t* values in brackets. Regression coefficients are standardized.

Notes:

[a] "PEB" abbreviates "pro-environmental behavior" and refers to the intent-oriented measure of behavior. High values indicate environmentally friendly behavior.

[b] GHG emissions by housing were estimated at the household level and then divided by the number of persons living in the household. Emissions by mobility and by food, on the other hand, solely relate to the respondents' personal travel and eating habits, respectively.

Table A5. OLS regression models for intent-oriented PEB and GHG emissions per capita (total and categories) using complete cases only[a]

	PEB[b]	GHG Total (log.)	GHG Housing (log.)[c]	GHG Mobility (log.)[c]	GHG Food (log.)[c]
Equivalence income (per month, in thsd, log.)	-0.46**	0.21**	0.20**	0.39**	-0.04*
	(-4.64)	(6.10)	(3.47)	(5.59)	(-2.04)
Environmental concern (1-5)	0.67**	-0.13**	-0.07	-0.25**	-0.10**
	(9.27)	(-5.25)	(-1.77)	(-5.09)	(-6.58)
Number of persons in household	0.19**	-0.08**	-0.25**	-0.03	0.02*
	(4.15)	(-5.86)	(-10.87)	(-1.13)	(2.52)
Children in household (0/1)	-0.12	0.01	0.03	-0.04	-0.02
	(-0.81)	(0.17)	(0.46)	(-0.45)	(-0.57)
Female	0.18*	-0.14**	0.07	-0.32**	-0.17**
	(1.96)	(-4.50)	(1.26)	(-5.05)	(-8.39)
Age (divided by 10)	0.37**	-0.03*	0.07**	-0.14**	-0.02*
	(10.14)	(-1.98)	(3.09)	(-5.08)	(-2.38)
Years of education	0.08**	0.01	0.02	0.00	-0.02**
	(4.34)	(0.83)	(1.79)	(0.21)	(-3.87)
Economically active (0/1)	0.29*	-0.06	-0.21**	0.04	0.03
	(2.48)	(-1.36)	(-3.17)	(0.54)	(1.30)
Car in household (0/1)	-0.99**	0.31**		1.59**	
	(-7.26)	(5.93)		(15.04)	
German-speaking area	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
French-speaking area	-0.41**	0.05	-0.19*	0.24*	0.02
	(-3.31)	(0.93)	(-2.19)	(2.25)	(0.67)
Italian-speaking area	-0.46*	-0.11	-0.23	0.01	-0.14*
	(-2.42)	(-1.30)	(-1.65)	(0.05)	(-2.57)
City	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
Small or medium-sized town	0.54**	0.10	0.20*	0.09	0.04
	(3.50)	(1.87)	(2.27)	(0.80)	(1.20)
Agglomeration	0.25	0.11*	0.10	0.13	0.07*
	(1.96)	(2.36)	(1.35)	(1.40)	(2.40)
Rural community	0.57**	0.15**	0.14	0.12	0.12**
	(3.70)	(2.75)	(1.68)	(1.12)	(3.70)
Aggregate distance to local facilities (km, log.)	0.11	0.00		0.10*	
	(1.49)	(0.07)		(2.01)	
Constant	3.47**	8.76**	7.33**	7.14**	7.58**
	(7.26)	(50.29)	(26.91)	(20.44)	(71.56)
Number of observations	1651	687	687	687	687
Adjusted R^2	0.187	0.280	0.324	0.470	0.249

** $p < .01$, * $p < .05$, t values in brackets.

Notes:

[a] For the model of PEB, the set of complete cases was determined separately whereas for all models on GHG emissions, completeness was defined by the model on GHG Total.

[b] "PEB" abbreviates "pro-environmental behavior" and refers to the intent-oriented measure of behavior. High values indicate environmentally friendly behavior.

[c] GHG emissions by housing were estimated at the household level and then divided by the number of persons living in the household. Emissions by mobility and by food, on the other hand, solely relate to the respondents' personal travel and eating habits, respectively.

Table A6. OLS regression models for intent-oriented PEB and GHG emissions per capita (total and categories) using complete cases only[a], displaying standardized regression coefficients

	PEB[b]	GHG Total (log.)	GHG Housing (log.)[c]	GHG Mobility (log.)[c]	GHG Food (log.)[c]
Equivalence income (per month, in thsd, log.)	-0.12**	0.23**	0.12**	0.18**	-0.08*
	(-4.64)	(6.10)	(3.47)	(5.59)	(-2.04)
Environmental concern (1-5)	0.21**	-0.18**	-0.06	-0.15**	-0.23**
	(9.27)	(-5.25)	(-1.77)	(-5.09)	(-6.58)
Number of persons in household	0.12**	-0.25**	-0.44**	-0.04	0.11*
	(4.15)	(-5.86)	(-10.87)	(-1.13)	(2.52)
Children in household (0/1)	-0.02	0.01	0.02	-0.02	-0.02
	(-0.81)	(0.17)	(0.46)	(-0.45)	(-0.57)
Female	0.05*	-0.15**	0.04	-0.15**	-0.29**
	(1.96)	(-4.50)	(1.26)	(-5.05)	(-8.39)
Age (divided by 10)	0.29**	-0.08*	0.13**	-0.19**	-0.10*
	(10.14)	(-1.98)	(3.09)	(-5.08)	(-2.38)
Years of education	0.11**	0.03	0.06	0.01	-0.14**
	(4.34)	(0.83)	(1.79)	(0.21)	(-3.87)
Economically active (0/1)	0.07*	-0.05	-0.12**	0.02	0.05
	(2.48)	(-1.36)	(-3.17)	(0.54)	(1.30)
Car in household (0/1)	-0.19**	0.22**		0.48**	
	(-7.26)	(5.93)		(15.04)	
German-speaking area	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
French-speaking area	-0.08**	0.03	-0.07*	0.06*	0.02
	(-3.31)	(0.93)	(-2.19)	(2.25)	(0.67)
Italian-speaking area	-0.06*	-0.04	-0.05	0.00	-0.09*
	(-2.42)	(-1.30)	(-1.65)	(0.05)	(-2.57)
City	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
Small or medium-sized town	0.10**	0.08	0.09*	0.03	0.05
	(3.50)	(1.87)	(2.27)	(0.80)	(1.20)
Agglomeration	0.06	0.12*	0.06	0.06	0.12*
	(1.96)	(2.36)	(1.35)	(1.40)	(2.40)
Rural community	0.12**	0.14**	0.08	0.05	0.18**
	(3.70)	(2.75)	(1.68)	(1.12)	(3.70)
Aggregate distance to local facilities (km, log.)	0.04	0.00		0.06*	
	(1.49)	(0.07)		(2.01)	
Number of observations	1651	687	687	687	687
Adjusted R^2	0.187	0.280	0.324	0.470	0.249

** $p < .01$, * $p < .05$, t values in brackets. Regression coefficients are standardized.

Notes:

[a] For the model of PEB, the set of complete cases was determined separately whereas for all models on GHG emissions, completeness was defined by the model on GHG Total.

[b] "PEB" abbreviates "pro-environmental behavior" and refers to the intent-oriented measure of behavior. High values indicate environmentally friendly behavior.

[c] GHG emissions by housing were estimated at the household level and then divided by the number of persons living in the household. Emissions by mobility and by food, on the other hand, solely relate to the respondent's personal travel and eating habits, respectively.

References Appendix

Collins, L. M., Schafer, J. L., & Kam, C.-M. (2001). A Comparison of Inclusive and Restrictive Strategies in Modern Missing Data Procedures. *Psychological Methods, 6*(4), 330-351.

Enders, C. K. (2010). *Applied Missing Data Analysis*. New York: The Guildford Press.

Graham, J. W. (2009). Missing Data Analysis: Making It Work in the Real World. *Annual Review of Psychology, 60*, 549-576.

Harel, O. (2009). The estimation of R^2 and adjusted R^2 in incomplete data sets using multiple imputation. *Journal of Applied Statistics, 36*(10), 1109-1118.

Lachenbruch, P. A. (2010). Stata tip 89: Estimating means and percentiles following multiple imputation. *Stata Journal, 10*(3), 496-499.

Meyer, R., & Bruderer Enzler, H. (2013). Geographische Informationssysteme (GIS) und ihre Anwendung in den Sozialwissenschaften am Beispiel des Schweizer Umweltsurveys [Geographic Information Systems (GIS) and their Application in the Social Sciences using the Example of the Swiss Environmental Survey]. *Methoden, Daten, Analysen (mda), 7*(3), 317-346.

StataCorp. (2011). *Stata Multiple-Imputation Reference Manual. Release 12*. College Station, Texas: Stata Press.

Van Buuren, S. (2012). *Flexible Imputation of Missing Data*. Boca Raton: Chapman & Hall / CRC.

White, I. R., Royston, P., & Wood, A. M. (2011). Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine, 30*(4), 377-399.