Oldenburg Discussion Papers in Economics

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V-322-10

April 2010

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Revised Version

Abstract

This paper studies whether pro-environmental consumption choices are consistent with utility maximization and what role the consumption behavior of reference persons and one's own past behavior play in this context. By combining data on individuals' pro-environmental consumption from a unique data set with data on subjective well-being, we find that people could attain higher well-being (utility) by unilaterally consuming more environmentally friendly while at the same time reducing the quantity consumed. The distortions identified are smaller when people's reference persons consume more environmentally friendly and when the individual has a longer environmental friendly consumption history. We therefore conclude that learning from the behavior of others and from one's own past experience may help alleviate decision error in environment-friendly consumption.

JEL classification: Q20; D12; I31; H41

Keywords: pro-environmental consumption; consumer choice; utility maximization; well-being; life satisfaction.

Acknowledgements: We are grateful to Klaus Eisenack, Andrew Oswald and two anonymous referees for insightful comments. Useful comments were also received from participants of the workshop "Well-Being, Happiness and the Environment", University of Stirling, April 8-9, 2010. We thank Jens Clausen (Borderstep Institute, Hanover, Germany) for providing the survey data used in this paper. This research was supported by the German Federal Ministry for Education and Research (BMBF) through grant 01UN0602C.

1. Introduction

While environmental economics has traditionally been concerned with market failure (caused by externalities, non-rivalry, non-excludability, non-convexities, and asymmetric information) recent years have seen an increase of attention for behavioral failures and their implications for environmental economics and policy (Shogren and Taylor 2008). 'Behavioral failure' in this context refers to systematic deviations from rational choice theory, as explored and categorized by what has come to be known as behavioral economics.

A fundamental element of rational choice theory is that individuals hold perfect information about the benefits and costs of their decisions and make optimal, utility maximizing choices. Behavioral economics, however, has produced evidence of systematic deviations from utility maximization. Such deviations may arise, in particular, because of failures in affective forecasting, that is, in figuring out the utility consequences of one's choices.[1] A major source of such forecasting errors is unforeseen hedonic adaptation, that is, the circumstance that people become habituated to outcomes but do not anticipate habituation when making decisions.[2] Non utility-maximizing decisions due to unforeseen habituation arise, e.g., in work-leisure choice (Layard 2006).

Systematic misprediction of utility, obviously, presupposes that people are not sufficiently able to learn from experience. Utility misprediction is therefore less likely to occur in repetitive choice situations than in the case of unfamiliar choices. While it has been argued that there may be little learning even in some of the former cases (Frey and Stutzer 2004), it is nevertheless plausible that experience should reduce forecasting errors and the associated decision errors. Moreover, in addition to learning from their own experience, people may learn to some extent from the experience of others.

This paper studies whether pro-environmental consumption choices are consistent with utility maximization and what role the consumption behavior of reference persons and one's own past behavior play in this context. Conceptually, a simple test of whether a choice is utility-maximizing involves checking whether people could raise their utility by choosing differently, within the boundaries of their budget constraint. Empirically, such a test requires

[1] See Loewenstein and Adler (1995), Loewenstein and Schkade (1999), Loewenstein et al. (2003), Wilson and Gilbert (2003).

[2] See Frederick and Loewenstein (1999) for a review.

having an appropriate proxy for utility. This paper uses data on self-reported subjective well-being (happiness, life satisfaction) as an empirical approximation to experienced utility.[3]

By combining subjective well-being data with data on individuals' pro-environmental consumption, we find that people could attain higher utility by unilaterally consuming more environmentally friendly while reducing the *quantity* consumed. The distortions identified are smaller when people's reference persons (friends, neighbors, relatives) consume more environmentally friendly. Sub-optimal choices of environmental friendliness may thus decrease as environment-friendly consumption becomes more widespread in society. We also find evidence that distortions may decrease when individuals have a longer environmental friendly consumption history.

Our analysis benefits from a unique data set which contains information on five types of environmentally friendly consumer goods: organic food, low-energy light bulbs, low-energy household appliances, solar thermal heating systems, and 'green' electricity. This data base allows us to study whether people's intensities of buying organic food, low-energy light bulbs and household appliances as well as their overall level of pro-environmental consumption, including solar heating and green electricity, are utility maximizing.

Our qualitative results are robust to using several measures of environmental friendliness, several estimation methods, and several sets of controls. In particular, we control not only for individual socio-demographic characteristics but also for attitudes towards consumption and the environment. In this way we address the possibility that people with different environment-related and consumption-related attitudes may be inherently more (or less) satisfied, independent of the corresponding behaviors. As we find our qualitative results to be robust with respect to these controls, we are confident that the effects we are measuring should not be attributed to differences in attitudes but, in fact, refer to behaviors. We acknowledge, however, that unobserved heterogeneity cannot be ruled out entirely.

Rather than being mere empirical peculiarities, our findings are consistent with literature which suggests that hedonic adaptation applies more to the quantity consumed than to the environmental friendliness of consumption. Following Scitovsky (1976), people quickly get bored by 'more of the same' consumption (bigger houses, bigger cars) which ultimately will not add a lot of satisfaction. Moreover, the two dimensions of consumption affect our self-

[3] Following much of the literature, we use the terms 'subjective well-being', 'happiness', and 'life satisfaction' interchangeably. Using data on subjective well-being permits to separate consumption decisions from the utility thereby produced, that is, 'experienced utility'. Using subjective well-being data follows a recent line of research in economics (see Frey and Stutzer 2002, Layard 2005, Di Tella and MacCulloch 2006, Bruni and Porta 2007). Thorough discussions of the relationship between 'utility' and 'happiness' and of methodological issues in using happiness data are provided by Frey and Stutzer (2002) and Clark et al. (2008).

image differently (Laaksonen 1994). The satisfaction from consuming 'more of the same' (quantity) derives from upholding our self-image as people of higher status and is constantly undermined by other people matching or overtaking us. By contrast, the 'warm glow' (Andreoni 1990) from consuming altruistically in accordance with our self-image as people who 'do the right thing' (quality) may be less affected by such an erosion.

In more general terms, hedonic adaptation has been found to be less important with respect to intrinsically rather than extrinsically motivated choices.[4] It is consistent with this logic that we find clear evidence of decision error with respect to low energy light bulbs, low energy household appliances, 'green' electricity, and solar heating systems, but less so with respect to organic food: While the former types of pro-environmental consumption are largely motivated by social (altruistic) concerns, purchasing organic food mainly reflects private benefits in terms of health and taste (Wier et al. 2008). Buying organic food can thus be said to be less intrinsically motivated than the other forms of environmental friendly consumption and, hence, be more subject to habituation effects. The asymmetry, in terms of (unforeseen) habituation, between quantity and quality may thus be smaller in the case of organic food than in the case of other pro-environmental behaviors.[5]

There are some theoretical models dealing with habitual consumption and the environment. Ono (2002) investigates the implications of consumption habits on environmental quality in an overlapping-generations framework. Wendner (2005) shows that habits exacerbate the environmental consequences of social comparison (status consumption).[6] In contrast to the present study, these papers focus on the environmental externalities created by the level of consumption, and they disregard the environmentally relevant characteristics of consumption and the choices pertaining to those characteristics. Moreover, these papers assume that people perfectly foresee habituation effects in making consumption choices.

Focusing on the trade-off between the level of consumption and its environmental friendliness, our study shows in a simple theoretical framework that consumption habits may

[4] In the case of intrinsic motivation, utility derives from an internal reward as a direct result of a particular activity or choice. In the case of extrinsic motivation, choice is purely instrumental. On concepts and evidence see Frey and Stutzer (2004).

[5] We acknowledge that the adoption of solar thermal energy systems may be motivated to some extent by prestige motives (Welsch and Kühling 2009a). Also, adoption of low-energy light bulbs and appliances may make sense even from an economic point of view, in addition to social concerns.

[6] Environmental effects of status consumption were studied by Howarth (1996) and Brekke and Howarth (2002). Status consumption means that people evaluate their consumption level relative to that of others. This way, consumption levels create negative externalities that lead to distortions in the choice between consumption and environmental quality. Due to such consumption externalities, environmentally relevant choices fail to be *socially* optimal (even disregarding environmental externalities). The present paper disregards status comparisons (which create 'external habits') and instead focuses on 'internal habits'. Importantly, internal habits imply that consumption choices may not only fail to be socially optimal, but may fail to be *individually* optimal.

imply a decision error. The notion of decision error relies on the distinction between *experienced utility* (the ex post hedonic quality associated with an act of choice) and *decision utility*, which describes the ex ante expectation of experienced utility (Kahneman et al. 1997). Decision errors are understood as consumption choices that yield a utility maximum ex ante, but fail to yield a utility maximum ex post (at unchanged exogenous conditions) when the utility consequences are actually experienced.

Under habitual consumption, a source of such deviation is that habituation may not be correctly anticipated when the decision is made. As we show in a stylized model, if consumption habituation is disregarded ex ante, the chosen degree of environmental friendliness may be too small relative to the ex post utility maximum if quality (environmental friendliness) and quantity are good enough substitutes for each other.

Assuming that we are sufficiently able to control for heterogeneity among individuals, our empirical findings constitute evidence that people consume too environmentally unfriendly according to their own utility evaluation. Our stylized model of decision making provides a possible rationale for these findings; yet we acknowledge that we cannot ultimately discriminate between the potential sources of this bias, that is, unforeseen habituation or simply a lack of information on the relevant characteristics of consumption goods.

While the implications of behavioral failure for environmental economics and policy have attracted some attention in recent years, similar issues as those studied in this paper have rarely been addressed in the empirical literature so far. Ferreira and Moro (2010) use happiness data to study whether the utility equalization condition of the hedonic pricing model is satisfied. Frey and Stutzer (2004) and Stutzer and Frey (2010) apply well-being regressions to investigate whether commuting choices are utility-maximizing. Similarly, Welsch and Kühling (2010) study whether some forms of pro-environmental consumption are utility maximizing. Given data limitations, however, they are unable to address the issue of learning from past behavior and the behavior of reference persons.[7]

The paper is structured as follows. Sections 2 and 3, respectively, present the theoretical and empirical frameworks. Section 4 presents the empirical results. Section 5 concludes.

[7] The literature discussed by Shogren and Taylor (2008) in their review article on 'behavioral-environmental economics' is concerned with implications of behavioral failure for contingent valuation, choice under risk, environmental conflict and cooperation, and the design of incentive mechanisms. That literature is typically based on experimental evidence, not on evidence using well-being data. Using subjective well-being data in environmental economics mainly refers to environmental valuation (see Welsch and Kühling 2009b and Ferreira and Moro 2010).

2. Theoretical Framework

2.1 The Model

We set up a simple illustrative model which shows how unforeseen habituation may lead to decision error in the choice between the quantity and the quality (environmental friendliness) of consumption.

We denote by x the quantity of a composite consumption good, whose environmental friendliness is indexed by q. The consumer's experienced utility function is specified as

$$U(z,q) = U(x - \alpha h, q) . \quad (1)$$

According to this specification, the level (quantity) of consumption is evaluated relative to a habit stock h; that is, $z = x - \alpha h$ denotes 'effective consumption' and $\alpha \in [0,1)$ indexes the importance of habits.[8]

Since we are dealing with a composite good (without any substitute), it is natural to postulate a strictly positive minimum level of effective consumption. Hence, the utility function is defined for $z \geq \underline{z} > 0$ and $q \geq 0$. It has the usual properties of monotonicity and strict concavity; that is, $U_z > 0,\ U_q > 0,\ U_{zz} < 0,\ U_{qq} < 0,\ U_{zq} = U_{qz} > 0$.[9] Moreover, we shall assume $U_z(\underline{z}, q) = U_q(z,0) = \infty$.

The level of consumption and its environmental friendliness are connected through a budget constraint. We assume that the unit price of the composite good is a function of environmental friendliness:

$$p = P(q) .$$

$P(q)$ is strictly positive, increasing and strictly convex on the domain $[0, \bar{q}]$, where $\bar{q}$ will be defined later: $0 < P(q) < \infty,\ 0 < P_q(q) < \infty,\ 0 < P_{qq}(q) < \infty$.

The consumer has a constant exogenous and non-storable income $y > 0$, such that the budget constraint is stated as

[8] Since we are not dealing with environmental externalities and their correction by public policy, we do not consider preferences over the public good of environmental quality (which might be viewed as depending on an aggregate of the individual q variables).

[9] Throughout, we use lower case letters to denote variables and upper case letters to denote functions. Subscripts like U_z (U_{zz}) are used to denote first (second) partial derivatives of a function with respect to a variable, unless this simplified notation gives rise to ambiguity.

$$P(q)x = y.$$ [10]

Rearranging will allow us to express the quantity as a function of income and quality:

$$x = \frac{y}{P(q)} =: X(y,q) > 0. \tag{2}$$

Given the properties of $P(q)$ stated above, this function has the property $-\infty < X_q(y,q) < 0$. For considerations of feasibility and optimality of quantity-quality configurations, we assume that income and the price function are such that $(1-\alpha)X(y,0) >$ $\underline{z}$. Then there is a value $\overline{q} > 0$, defined by the condition $(1-\alpha)X(y,\overline{q}) =$ $\underline{z}$, which represents the quality attainable at given income if effective consumption is at its minimum.

It will prove useful to substitute *x* in (1) according to (2). This gives utility as a function of environmental friendliness:

$$U(z,q) = U(X(y,q) - \alpha h, q),$$

with $dU(X(y,q) - \alpha h, q)/dq = U_z(X(y,q) - \alpha h, q) \cdot X_q(y,q) + U_q(X(y,q) - \alpha h, q)$ as the total derivative. We make the additional assumption of strict concavity in *q*, that is $d^2U(X(y,q) - \alpha h, q)/dq^2 < 0$.

Finally, we specify the habituation process which, by necessity, is of a dynamic nature. We assume that the habit stock in the current period, *t*, is equal to the previous period's level of consumption: $h_t = x_{t-1}$. Effective consumption is then given by $z_t = x_t - \alpha x_{t-1}$.[11] The model can then, ultimately, be written as

$$U(z_t, q_t) = U(X(y,q_t) - \alpha X(y, q_{t-1}), q_t). \tag{3}$$

Having specified the model, we now address the consumer's behavior. Two behavioral scenarios will be considered: forward-looking optimization and myopic optimization.

[10] Monotonicity of the utility function implies that the budget constraint is binding.

[11] This specification of habit formation is used by, among others, Wendner (2005). Carroll (2000) studies more general adaptive processes in a multiplicative (instead of 'subtractive') habits framework. Alternative specifications of habit formation are discussed by Wendner (2003).

Forward-looking optimization means that the consumer maximizes

$$W(q_o,...,q_T) = \sum_{t=0}^{T} \delta^t \, U(X(y,q_t) - \alpha X(y,q_{t-1}), q_t)$$

with respect to the sequence of q_t, where $\delta \in (0,1)$ is the discount factor. The important point of forward-looking behavior is that the choice of every q_t (and resulting $X(y,q_t)$) takes the implications for the next periods' habit stock into account.

The first-order conditions, $\partial W(q_0,...,q_T)/\partial q_t = 0$ (t = 0,1…,T), of the maximization problem can be (re)stated as follows:

$$\frac{\partial U(z_t,q_t)}{\partial z_t}\frac{\partial X(y,q_t)}{\partial q_t} + \frac{\partial U(z_t,q_t)}{\partial q_t} - \alpha\delta \frac{\partial U(z_{t+1},q_{t+1})}{\partial z_{t+1}}\frac{\partial X(y,q_t)}{\partial q_t} = 0 \text{ for } t \neq T, \tag{4a}$$

$$\frac{\partial U(z_t,q_t)}{\partial z_t}\frac{\partial X(y,q_t)}{\partial q_t} + \frac{\partial U(z_t,q_t)}{\partial q_t} = 0 \text{ for } t = T. \tag{4b}$$

In (4a), the first term (which is negative) refers to the marginal disutility from quantity foregone when quality is increased, whereas the second term is the marginal utility from increasing quality. The third term reflects the circumstance that an increase in current quality, by reducing the current quantity attainable, reduces next period's habit stock. The presence of the third term implies that the sum of the first two terms is negative: The marginal utility from increasing quality has to be smaller than the marginal disutility from quantity foregone because a higher current value of quality has a beneficial effect in terms of next period's habit stock. The latter effect is lacking in the last period (equation (4b)).

In the case of myopic behavior, the effect of current decisions on the future habit stock is disregarded. In this case, current utility, as stated in equation (3), is maximized with respect to current quality, taking the 'inherited' habit stock as given. The first-order condition $dU(z_t,q_t)/dq_t = 0$ in every period then takes the following form:

$$\frac{\partial U(z_t,q_t)}{\partial z_t}\frac{\partial X(y,q_t)}{\partial q_t} + \frac{\partial U(z_t,q_t)}{\partial q_t} = 0 \text{ for } t = 0,1...,T. \tag{5}$$

This means that the marginal utility from increasing quality equals the marginal disutility from quantity foregone. In other words, the *net* marginal utility from quality is zero. The value q_t that solves this condition depends, of course, on q_{t-1}.

It is obvious that condition (5) is a special case of condition (4a), which (formally) arises when the discount factor, δ, is zero. Appendix A shows that, no matter whether the discount factor is zero or positive, there exists a unique steady-state solution to (4a), $q*$, and associated $z* = (1-\alpha)X(y, q*)$.

2.2 *Habituation and Decision Error*

In the case of myopic behavior, it is possible to study the effect of habituation on the quantity-quality choice, and the effect of taking habituation incorrectly into account. We focus on the steady-state solution to condition (5).

We start by examining how the size of the habituation parameter, if correctly taken into account, affects the steady-state optimum $q*$. Appendix B establishes

Proposition 1. The steady-state solution to condition (5), $q*$, is increasing (decreasing) in the strength of habituation α if the elasticity of substitution between quantity and quality is greater (less) than unity. The reverse applies to the optimal $x* = X(y, q*)$ and $z* = (1-\alpha)X(y, q*)$.

This result is intuitive: An increase in α reduces the marginal capacity of *x* to generate *effective* consumption *z*. If quality is a good enough substitute for quantity, the consumer will thus choose a larger *q*/*x* ratio at larger α. Conversely, if quality is a poor substitute for quantity, more *x* and less *q* will be chosen at larger α.

If, instead of taking habituation correctly into account, the consumer uses a smaller value $\hat{\alpha} < \alpha$, there will be a decision error, whose sign depends on the elasticity of substitution. The result on the influence of α on the optimal (x, q) configuration immediately implies that under $\hat{\alpha} < \alpha$ the chosen environmental friendliness *q* will be less (greater) than optimal if the elasticity of substitution between quantity and quality is greater (less) than unity. This applies, in particular, if habituation is completely disregarded, i.e., $\hat{\alpha} = 0$ while $\alpha > 0$.

In the empirical part of this paper, we consider whether decision error with respect to pro-environmental consumption is affected by the corresponding consumption behavior of the consumer's reference persons or her own past behavior. What could be the nature of such an influence? One idea is that people's forecasting error concerning habituation is correlated with these reference behaviors. More specifically, people whose reference persons consume more environmentally friendly or who have consumed environmentally friendly for a longer period of time might be those who better anticipate the habituation to consumption levels. Likewise, those people may simply be better informed about the benefits of environmentally friendly consumption goods. Through any of these avenues, more environmentally friendly consumption of reference persons or a longer pro-environmental consumption history may go along with smaller distortions in pro-environmental consumption choices.

2.3 A Test of Utility Maximization

The aim of our empirical analysis will be to gain evidence on whether or not pro-environmental consumption is utility-maximizing. Our empirical approach is to estimate a life satisfaction function which includes indicators of environmental friendliness q among the arguments. Since we have data on income y but not on the quantity x, we will use a reduced-form utility function $V(y,q)$.

According to equation (4a), a steady-state optimum, q^*, is characterized by $V_q(y,q^*)=0$. If at some observed value q^o, this condition fails to be satisfied, observed choice is not utility maximizing: people could increase their utility by choosing differently. Specifically, $V_q(y,q^o)>0\ (<0)$ implies $q^o < q^*$ ($q^o > q^*$), as illustrated in Figure 1. The sign of the derivative $V_q(y,q^o)$ will thus allow us to determine the direction of decision error, that is, whether the choice of pro-environmental consumption is distorted downwards or upwards (if at all). The magnitude of the derivative $V_q(y,q^o)$ measures the size of the decision error.

A possible source of such error is unforeseen (or incorrectly foreseen) habituation. In particular, Proposition 1 suggests that $V_q(y,q^o)>0$ -- which we will find empirically -- arises if $\hat{\alpha}<\alpha$, provided that the elasticity of substitution between quantity and quality is sufficiently large.

It should be emphasized that decision error, as indicated by $V_q(y,q^o)>0$ can be, but need not be caused by unforeseen habituation: On the one hand, we were able to unambiguously demonstrate the choice implications of unforeseen habituation only in a special case, the myopic steady-state optimum. On the other hand, sub-optimal choices may have other reasons, such as insufficient information about the benefits of environmentally friendly consumption goods.

3. Empirical Framework

3.1 The Data

Our empirical analysis is based on a survey on several types of pro-environmental behavior which was conducted from July to September 2007 in the region of Hanover, Germany (Clausen 2008).[12] In order to capture a sufficient number of subscribers to green electricity and users of solar thermal units, the survey was conducted in several stages. Initialy, 520 subscribers to green electricity were sent an invitation to participate; 150 requested and 122 completed the questionnaire. Similarly, 963 owners of solar thermal energy systems were sent an invitation to participate in the survey. Of these, 190 requested the questionnaire, and 139 completed it. In addition 233 face-to-face interviews with randomly sampled persons were conducted, using the same questionnaire. Overall, we have 494 valid questionnaires.[13] The survey instrument is documented in Appendix C.[14]

One set of items in the survey refers to respondents' socio-demographic characteristics (age, sex, marital status, household size, employment status, housing situation, educational attainment, health status, household income) and their environment-related and consumption-related attitudes. Household income is measured on a scale from 1 to 10, which refers to 10 income brackets (from less than 1.000 to more than 5.000 Euros per month). Environmental attitudes are captured by respondents' opinions on the severity of environmental problems, the necessity of a change to renewable energy sources, and the danger from nuclear power. General attitudes towards consumption are captured by a question on how much respondents enjoy consumption.

[12] The region of Hanover has about 1.1 million inhabitants, of which about 500.000 live in the city proper.

[13] Since our sample is composed of three sub-samples (subscribers to green electricity: postal survey; users of solar heating systems: postal survey; general population: face-to-face interview) we checked whether this affects our results by including dummy variables for the sub-samples. The dummy variables turned out insignificant and the results unaffected by their inclusion.

[14] As to green electricity, the share in the Hanover region (9.4 percent of households) is similar as in Germany overall (12 percent). As to solar heating systems, the share in the Hanover region (4.8 percent of households) is larger than the country average (2.5 percent). The reason for the latter discrepancy may be that solar heating is actively promoted by several semi-public organizations in the region (Clausen 2008).

With respect to pro-environmental consumption, the survey includes questions on the intensity of buying organic food (variable *food*), low-energy light bulbs (*lighting*), and low-energy household appliances (*appliances*).[15] Response options and their coding are as follows: never = 1, sometimes = 2, often = 3, always = 4. In addition, respondents were asked whether they possess a solar thermal system (*solar*) and whether they are subscribers to 'green' electricity (*electricity*), with response options no = 0, yes = 1 in both cases.

In order to provide a more aggregate picture of pro-environmental consumption, our empirical analysis employs several composite indicators of environmental friendliness, in addition to using the variables *food*, *lighting*, and *appliances* separately. One indicator is defined as the sum of those three variables (*consumption3* = *food* + *lighting* + *appliances*); it takes the values 3, 4, …, 12. Another indicator involves all five types of pro-environmental behavior available in our data base. It is built by recoding the responses concerning food, lighting, and appliances into binary variables (never/sometimes = 0, often/always = 1) and adding the five binary variables plus unity.[16] The resulting variable (*consumption5*) takes the values 1, 2, …, 6. Finally, as we shall see, results concerning the consumption of organic food will be different from those concerning the other four behaviors. We will therefore consider an additional indicator constructed similarly to *consumption5* but disregarding organic food (*consumption4*, taking values 1, 2, …,5). [17]

With regard to organic food, solar systems, and green electricity, people were also asked about the behaviors of their friends, neighbors and relatives, where the response options and their coding are the same as those with respect to the respective own behaviors. We thus have the variable *peers_food* = 1, 2, 3, 4. In addition, we construct an indicator of the overall environmental friendliness of a respondent's friends, neighbors and relatives. This indicator is built by recoding the responses concerning organic food consumption of peers into a binary variable (never/sometimes = 0, often/always = 1) and adding the three binary peer-behavior variables plus unity. The resulting variable *peers* takes the values 1, 2, …, 4.

[15] With respect to our theoretical framework, it is clear that organic food is more expensive than conventional food. Energy efficient appliances, arguably, may be cheaper in the long run. It is unclear to what extent consumers' choice is affected by such considerations.

[16] We experimented with alternative binary variables concerning food, lighting and appliances, coded never = 0, sometimes, often, always = 1, and found our qualitative results unaffected.

[17] Though environmental friendliness has, rhetorically, been dubbed as 'quality', both the theoretical and the empirical analysis require a quantitative measure of the degree of environmental friendliness of a person's consumption. Our empirical indicators represent our best efforts to get as close to a continuous measure (assumed in the theoretical model) as permitted by data availability.

Finally, people who buy organic food ‘often’ or ‘always’ were asked to state for how long they have been buying organic food (variable *history*: less than one year = 1; more than one year = 2; more than two years = 3=; more than five years = 4; more than ten years = 5).

In addition to the consumption-related items, the survey includes a 10-point life satisfaction question of the following form: “All things considered, how satisfied are you with your life as a whole these days?” Respondents were presented a scale from 1 to 10, where 1 is labeled “not at all satisfied” and 10 is labeled “very satisfied” and were asked to indicate their level of satisfaction using that scale.

The summary statistics of the variables are presented in Table A in Appendix D.

3.2 The Empirical Model and Strategy

We assume that reported life satisfaction of individual *i*, LS_i, is an ordered categorical variable, that is, we can observe the range in which true (latent) experienced utility, u_i , lies, but not its exact level. Reported life satisfaction is then related to *income*, various forms of pro-environmental consumption (*pec*) and *controls* according to the following model:

$$u_i = \alpha \cdot income_i + \beta \cdot pec_i + \gamma \cdot controls_i + \varepsilon_i \qquad \text{(6a)}$$

$$LS_i = n \quad \Leftrightarrow \quad \mu_n \le u_i < \mu_{n+1}, \qquad \text{(6b)}$$

where *n* represents the 10 discrete life satisfaction categories (1 to 10) and μ_n are nine estimated threshold values that differentiate the categories from each other. Equation (6a) gives the empirical analog to the reduced-form utility function $V(y,q)$, linearized at the point of observation, while (6b) specifies how reported life satisfaction (*LS*) is associated with unobserved experienced utility.

The vector of *controls* comprises socio-demographic characteristics (age, sex, marital status, household size, educational attainment, health) on the one hand and indicators of attitudes (environment-related attitudes, consumption-related attitude) on the other hand. Attitude indicators are included because attitudes may be correlated with both life satisfaction and pro-environmental behaviors, such that their omission leads to biased estimates. In this sense, controlling for attitudes is an approximation to using individual fixed effects (which would be the preferred strategy in a sample with panel structure).[18]

The crucial parameter in the above specification is the coefficient on *pec*. This coefficient measures the derivative of the reduced-form experienced utility function, that is, the marginal utility from pro-environmental consumption *net* of the marginal disutility from quantity foregone. As explained in section 2, an ex post utility maximum would imply that this net marginal utility be zero. In the event that pro-environmental consumption choices are utility maximizing, the coefficient on *pec* should thus be insignificant.

The basic model stated above will be augmented to include interactions of pro-environmental consumption with the pro-environmental consumption of friends, neighbors and relatives, and the history of the respondents' pro-environmental consumption behaviors. Such interactions permit to check whether, if at all, distorted choice is linked to the behavior of others and of oneself in the past.

The model from equation (6) will be estimated by means of an ordered probit maximum likelihood estimator, which determines the parameters in (6a) and the life satisfaction thresholds in (6b) simultaneously. To account for possible biases when estimating interaction effects in probit models (Ai and Norton 2003), we will estimate the interaction models alternatively as ordered probits and by using least squares.[19] Standard errors will be corrected for heteroskedasticity.

3.3 Some Methodological Issues

At the theoretical level, it is clear that a non-zero derivative of the reduced-form experienced utility function with respect to environmental-friendliness indicates a decision error. At the empirical level, a significant (non-zero) coefficient of *pec* may reflect uncontrolled heterogeneity with respect to the benefits and costs of pro-environmental behavior. In this case, optimality still requires zero net marginal utility for all individuals, but the level of pro-environmental consumption and total utility may differ. Therefore, with individual heterogeneity, not all of the differences in environmental-friendly consumption and life

[18] We believe that omission of common determinants of life satisfaction and pro-environmental behaviors is the main source of potential estimation bias. Important common determinants may be personality traits. Since these traits are unobserved, we try to proxy them by indicators of attitudes which may be thought to affect both life satisfaction and pro-environmental behaviors. By controlling for these determinants of life satisfaction, we account for endogeneity in the sense that people who are more satisfied due to these factors may be more inclined towards pro-environmental behavior.

[19] Given the ordinal character of the dependent variable, life satisfaction equations are preferably estimated using an ordered probit model. As found by Ferrer-i-Carbonell and Frijters (2004) and many others, however, least squares estimation of life satisfaction equations usually produces very similar results.

satisfaction (conditional on the observables) may be attributable to decision errors. Given our efforts to control for heterogeneity in both observable characteristics and in attitudes, however, a major portion of the coefficient on *pec*, if significant, may be taken to capture such errors.

Another issue is that our theoretical framework refers to a continuous variable of environmental friendliness, whereas the empirical analysis employs intensity indicators on a discrete scale. While a truly continuous measure of a person's environmental friendliness is difficult to create from our data, the indicators we use include four to ten points and are the best ones available in view of data limitations.[20] In addition, by employing several indicators alternatively we are able to check the robustness of our results with respect to the choice of indicator.

A final issue concerns the information on environmental friendly behaviors. Instead of self-reports on pro-environmental behavior, it would in principle be desirable to have information revealed in a more objective way. If, in fact, there *is* a deviation between self-report and actual behavior, the discrepancy will probably be an over-statement rather than an under-statement of one's environmental friendliness. Such an upward bias in the relevant variable, however, will imply that the associated coefficient in the reduced-form utility function is too small, rather than too large. Thus, there is likely no risk of finding a positive slope coefficient if in fact it is zero: if we err, we err on the 'right' side. Moreover, the circumstance that the information on the behavior of a respondent's reference persons relies on assessments by the respective respondent may be not very problematic, because what is relevant is not the behavior of the reference persons per se, but the behavior of the reference persons as perceived by the respondent.

4. Empirical Results

4.1 Main Results

Table 1 presents the results of several versions of our life satisfaction regressions formulated in equation (6). The results concerning the control variables present no surprises: life satisfaction is positively and significantly related to health, being female, and being employed or retired. It is negatively and significantly related to being divorced, and there is a U-shaped relationship of life satisfaction to age. These findings are unaffected by which pro-

[20] The data base we are using does not contain information on expenditures on environment-friendly consumption.

environmental behavior is considered. They are consistent with other data sets for industrialized countries (see Frey and Stutzer 2002), which enhances confidence in the quality of our data.

Concerning our main variables of interest, the regressions in Table 1 contain positive, significant coefficients for income, which differ little across the various regressions. The coefficients on the indicators of pro-environmental consumption are also positive and significant except in the case of *food*. In the latter case, the coefficient is close to zero and insignificant. The coefficient on the composite indicator *consumption3* is significant at the 10 percent level, whereas the coefficient on *consumption5* is significant at the five percent level. This difference reflects the circumstance that organic food consumption is included in *consumption3* as one of three constituents (along with low energy light bulbs and low energy appliances), whereas it enters *consumption5* only as one out of five constituents (along with lighting, appliances, solar heating, and green electricity). When we exclude organic food from this composite indicator of pro-environmental consumption (*consumption4*), the associated coefficient is positive and significant at the five percent level.

The significantly positive coefficients on most of the indicators of pro-environmental consumption are consistent with the idea that people could raise their satisfaction by consuming more environmental friendly. The insignificant coefficient on *food* suggests that there is no such decision error in the case of organic food consumption.

In addition to the sign and statistical significance of the coefficients, their magnitude is of some interest. As an example, consider the indicator *consumption4*, whose coefficient is 0.122. This indicator takes the value 1 if a person uses neither low-energy light bulbs and appliances nor solar systems and green electricity; it takes the value 5 if a person uses all of them. The difference in life satisfaction would then be 4 * 0.122 = 0.488. This magnitude is similar to the effect of a severe life event, like divorce (-0.508). This suggests that the utility loss from consuming environmentally unfriendly may be quite substantial.

Table 2 presents estimation results when we include interactions of respondents' pro-environmental behaviors with the corresponding behaviors of reference persons (friends, neighbors and relatives). To avoid biased estimates we include not only the interactions of the behaviors with this variable, but also the variable itself (Brambor et al. 2006).[21] Recall that we have data on the behavior of reference persons (peers) for organic food, solar systems and green electricity, but the latter two behaviors are available only as yes/no variables. Therefore,

[21] The results with respect to the controls are not shown in the following tables since they are qualitatively the same as in Table 1.

consumption of organic food is the only category for which the intensity of one's own consumption and the consumption of peers are jointly available.[22] Behavior interactions concerning lighting, appliances, solar heating and green electricity can thus not be considered individually. They are however, considered collectively as constituents of the composite indicators of pro-environmental behavior. As a robustness check of the regressions with interactions, we show results for both ordered probit (OPM) and linear (OLS) models.

The results for income are not appreciably different from those in Table 1. The coefficient on the un-interacted *food* variable is now positive, but continues to be insignificant. The interaction of *food* with organic food consumption of peers is negative and insignificant in the case of OPM and negative and significant in the case of OLS. The (un-interacted) consumption of organic food by peers has a weakly significant positive coefficient regardless of the estimation method.

The sign pattern for the various composite indicators of pro-environmental consumption is the same as in the case of organic food: positive with respect to the respondents' own behavior, negative with respect to the interaction variable, and positive with respect to the behavior of peers. However, in contrast to the case of food, all those coefficients are significant. Moreover, the coefficients on the un-interacted variables *consumption3*, *consumption5*, and *consumption4* are now larger than their counterparts in Table 1. Together with the result that the coefficients on the interaction terms are negative, this suggests that people whose peers display little pro-environmental consumption behavior make larger decision errors, whereas the error is smaller in people whose peers consume more environmentally friendly.[23]

Besides peer influence, the second main focus of this paper is on people's own consumption history. As described in the data section, we have data on how long people who buy organic food 'often' or 'always' have been consuming organic food. Table 3 presents regression results on organic food for this subset of respondents, where the intensity of organic food consumption is measured on a two-point scale (often = 1, always = 2). It can be seen that the coefficient on this indicator of the intensity of organic food consumption (*food2*) is negative and insignificant when we omit peer behavior and the consumption history (as is the coefficient on the four-point indicator in Table 1). When we extend this model to include organic food consumption of peers and the corresponding interaction, we get the same sign pattern as in the corresponding regressions in Table 2: positive coefficients on one's own

[22] For appliances and lighting we have data on intensities, but not on peer behavior.

[23] In addition to food and the various composite indicators, we experimented with the variables *solar* and *electricity*, for which the respective peer behaviors are available as yes/no variables. For both of these behaviors we obtained positive coefficients for the behaviors themselves and negative coefficients for the interaction with peer behavior, but the latter were insignificant (possibly due to small variance in the yes/no variables).

consumption of organic food and on organic food consumption of peers, and a negative interaction term between the two. In contrast to the OLS estimates, the OPM estimates of these coefficients are now significant. These results lend additional support to our main conclusion concerning the influence of peers.

The next set of regressions in Table 3 includes our indicator of how long people have been buying organic food (*history*) together with an interaction term. Regardless of the estimation method (OPM, OLS), the coefficient on one's own consumption is now negative, whereas the coefficient on the interaction with *history* is positive. The variable *history* has a negative coefficient. The coefficients are significant in the case of OPM and insignificant in the case of OLS. The signs of the coefficients may suggest that intensive buyers of organic food (often, always) learn over time that their initial expectations concerning the benefits of organic food were exaggerated (negative coefficient on *food*) and get closer to the optimum with increasing experience (positive coefficient on the interaction with *history*).

In the last set of regressions in Table 3 we include peer consumption and the length of the pro-environmental consumption history jointly. The signs of the coefficients are consistent with those obtained when peer consumption and the length of the consumption history are included separately. Except for the respondents' own un-interacted consumption behavior, the coefficients are significant in the case of OPM. In the case of OLS, significance is lacking for the interaction with *history*. These results support the evidence from the preceding regressions that peer influence alleviates any tendency for food consumption to be too environmentally unfriendly, whereas the length of the pro-environmental consumption history alleviates any tendency of intensive buyers of organic food to initially over-consume. We conclude from these results that intensive buyers of organic food seem to commit no decision errors on *average*. Those who have recently started to buy organic food and whose reference persons are intensive consumers of organic food may over-consume organic food, whereas under-consumption may arise with a lack of organic food consumers among one's reference persons.

4.2 Some Robustness Checks

We conducted a number of robustness checks with respect to additional control variables and with respect to the weighting of our data. The results are assembled in Tables B – F in Appendix D.

While the regressions presented so far control for environment-related attitudes, the quantity consumed and the environmental friendliness of consumption may be correlated, in addition, with attitudes towards consumption. Table B in Appendix D shows results for regressions which include an indicator of the degree to which people 'enjoy consumption' (measured on a five-point scale).[24] It can be seen that this variable is positively and significantly related to life satisfaction. The coefficients of the composite indicators of pro-environmental consumption – when included without peer interactions – are slightly smaller than their counterparts in Table 1, but remain positive. Except for *consumption3* (which weighs organic food more heavily than *consumption5* and *consumption4*) these coefficients are significant. When the consumption of peers and the associated interactions are included, we find very little difference to the corresponding results in Table 2. We thus conclude that our results are not driven by heterogeneity with respect to peoples' attitude towards consumption. The results refer to behavior and not to environment-related and consumption-related attitudes.

A second issue is that the option to purchase solar heating equipment is related to home ownership. To the extent that home ownership may enhance life satisfaction, omission of this variable may bias the coefficients of those indicators of pro-environmental behavior which include solar equipment (*consumption5, consumption4*). Table C in Appendix D shows the regression results when home ownership is included as an additional control. The coefficients on home ownership are positive but insignificant. The other results show little difference to their counterparts in Tables 1 and 2 which omit home ownership. Our previous conclusions thus remain intact with respect to this check.

Finally, we check whether and in what way our results are affected by the stratified nature of our sample. While our data set contains 36.6 percent of subscribers to green electricity and 34.0 percent of users of solar thermal systems, the shares in the general population are about 12 percent and 2.5 percent, respectively.[25] Since it is not clear whether using green electricity and using solar thermal systems are independent from each other, we apply weighting factors for the two behaviors separately as well as jointly. Table D presents weighted estimation results that account for the share of green electricity users and Table E presents weighted results that account for the share of users of solar thermal systems. Table F presents weighted results that apply both weightings jointly.

In all three cases, the regression results without interactions are the same in terms of signs and significance as in Table 1, and the magnitudes are very similar. When we consider the regressions with interaction terms, we always get the same signs and similar magnitudes as before, but the precision and, hence, significance levels are lower, especially in the cases with weighting for solar heating (Table E and Table F).

[24] The variable 'enjoy consumption' is coded 'nerved by consumption' = 1, …, 'enjoy consumption' = 5, that is, the ordering in the survey (Appendix C) was reversed.

[25] See footnote 15.

At a ‘technical’ level, the reduced significance arises because multi-collinearity among own behavior, peer behavior, and the interaction variable (as indicated by variance inflation factors) is much lower in the weighted sample than in the total sample. From a substantive point of view, this means that among solar energy users there is less similarity between own behavior and peer behavior than there is among other respondents. This reflects the circumstance that the milieu of solar energy users is less uniformly populated with environment-friendly consumers as is the case with buyers of organic food, low-energy light bulbs and appliances, and subscribers to green electricity (Welsch and Kühling 2009a). It is this potentially greater divergence between own pro-environmental behavior and that of peers which permits to sharply differentiate their effects. With decreasing weight of solar energy users these effects tend to get blurred.

We conclude from these checks that our qualitative results are robust to including additional controls and to different weightings of the data.

4.3 Discussion

Our results suggest that in deciding on pro-environmental consumption people fail to attain their utility maximum. More specifically, except for organic food, they could raise their utility by unilaterally consuming more environment-friendly than they do. Clearly, this proposition is more far-reaching than the usual proposition that utility would increase if *everybody* behaved more environment-friendly, thus raising the level of the public good of environmental quality. From the perspective of experienced utility, environmental friendliness of consumption is thus not only less than socially optimal, but less than individually rational.

Failure to attain the utility maximum reflects a decision error, that is, a divergence between decision utility and experienced utility. Evidence of such decision errors has been found previously with respect to commuting (Frey and Stutzer 2004, Stutzer and Frey 2010) and with respect to ‘environment-friendly goods’ (in an unspecific sense), recycling, and water saving (Welsch and Kühling 2010). In contrast to the latter study (which relies on data from the World Value Surveys), the present paper has benefited from a unique data set which allowed us to investigate the influence of peer behavior and one’s own consumption history on decision error. We found that decision error to the disadvantage of environmental friendly consumption is alleviated by reference persons consuming more environment-friendly. On the other hand, there is some evidence that expectations concerning the benefits of organic food may be exaggerated initially and get reduced with increasing length of the relevant consumption history.

While Welsch and Kühling (2010) did not address the influence of peer behavior and the consumption history, they found evidence that decision error to the disadvantage of pro-environmental consumption is a decreasing function of people's education level. Though we do not report the pertinent results in detail, we note that similar relationships can be found in our data set. This similarity further enhances the confidence in our data base.

An important finding of our study is that choice distortions clearly apply to environment-friendly lighting, appliances, electricity and heating, but less so with respect to organic food. This difference may be related to the fact that organic food consumption mainly reflects private benefits in terms of health and taste (Wier et al. 2008), which differ from the intrinsic (altruistic) motives of other pro-environmental behaviors. In terms of motivation, there may thus be less of an asymmetry between the quantity consumed and organic food than there is between the quantity consumed and more altruistic forms of environmental friendly consumption. Since a possible source of the identified choice distortions is an asymmetry in hedonic adaptation, and since this asymmetry is related to differences in motivations, this might explain the difference in the occurrence of choice distortions.

5. Conclusions

This paper has explored the hypothesis that decision error may bias consumer choice against pro-environmental consumption. We tested this proposition by combining data on pro-environmental consumption with data on subjective well-being elicited in the region of Hanover, Germany in 2007. We found that people could attain higher utility by consuming more environmentally friendly or, in other words, that the intensity of some forms of pro-environmental consumption is less than utility maximizing.

While this evidence is consistent with some earlier literature, a novel finding of this study is that the utility bias is smaller the more environmental friendly is the consumption of people's reference persons. Sub-optimal choices of environmental friendliness may thus decrease as environmental-friendly consumption becomes more widespread in society. The bias against pro-environmental consumption is clearly evident with respect to lighting, appliances, heating, and electricity, but less so with respect to organic food. In the latter case, there may even be an initial 'excess consumption', which we found to be decreasing with experience. Overall, we conclude that learning from the consumption behavior of others and from one's own consumption history may help alleviate utility misprediction and the resulting decision errors in environment-friendly consumption.

While our results are robust to using several measures of environmental friendliness, several estimation methods, and several sets of controls, some limitations of our study should be kept in mind. One issue is that our indicators of the intensity of pro-environmental behavior are not continuous variables. This problem is inherent in our data base. The indicators we use comprise up to ten intensity levels and reflect our best efforts given the data available. A second issue is that the information on pro-environmental behavior relies on self-reports. It would be desirable to have information that is revealed in a more objective way. Third, the results concerning the 'history' of environmentally friendly consumption refer only to intensive buyers of organic food and cannot readily be generalized to environmentally friendly consumption in general. Finally, being a cross-section, our data does not permit to completely control for unobserved heterogeneity (as would be possible by using individual fixed effects in a panel data framework). Future work may strive to overcome these limitations such as to check the results of this paper.

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Appendix A: Steady State

A steady-state solution $q*$ to condition (4a) must satisfy

$$(1-(1+\delta)\alpha)\cdot U_z((1-\alpha)X(y,q),q)\cdot X_q(y,q)+U_q((1-\alpha)X(y,q),q)=0 \qquad \text{(A1)}$$

It follows from $U_q(z,0)=\infty$ and $-\infty < X_q(y,q) < 0$ that $dU((1-\alpha)X(y,0),0)/dq =$ $U_z((1-\alpha)X(y,0),0)\cdot(1-\alpha)\cdot X_q(y,0)+U_q((1-\alpha)X(y,0),0)=\infty$. Also, because $U_z(\underline{z}, q) = \infty$, we have $dU((1-\alpha)X(y,\overline{q}),\overline{q})/dq$ = $U_z((1-\alpha)X(y,\overline{q}),\overline{q})\cdot(1-\alpha)\cdot X_q(y,\overline{q})+$ $U_q((1-\alpha)X(y,\overline{q}),\overline{q})=-\infty$, where $\overline{q}>0$ is the solution to the condition $(1-\alpha)X(y,\overline{q})=\underline{z}$. We observe that, because $d^2U((1-\alpha)X(y,q),q)/dq^2<0$, the left-hand side of (A1) is strictly decreasing in q. The Intermediate Value Theorem then implies that there exists a unique $q^*\in(0,\overline{q})$ which solves condition (A1).

Appendix B: Proof of Proposition 1

This appendix shows that in the myopic optimum a greater value of the habituation parameter implies a greater (smaller) steady-state value of *q* if and only if the elasticity of substitution between *z* and *q* is greater than (less than) unity.

We start from the first-order condition (5) evaluated at the steady state, which can be written explicitly in terms of α as follows (suppressing the dependence on *y* as well as time indices and the asterisk symbol):

$$U_z((1-\alpha)X(q),q)\cdot(1-\alpha)\cdot X_q(q)+U_q((1-\alpha)X(q),q)=:V_q(q,\alpha)=0 \qquad \text{(B1)}$$

Differentiating (B1) yields $dq/d\alpha=-V_{q\alpha}/V_{qq}$. Since $V_{qq}=d^2U/dq^2<0$, we get $\text{sgn}\ dq/d\alpha=\text{sgn}\ V_{q\alpha}=-\text{sgn}\ V_{q\beta}$, where $\beta:=1-\alpha$.

Simple computation yields the following equivalence:

$$V_{q\beta}=[U_z+\beta U_{zz}x]X_q+U_{qz}x=[U_z+U_{zz}z]X_q+U_{qz}x<0\ (>0) \quad \Leftrightarrow$$

$$-[U_{zz}\frac{z}{U_z}+U_{qz}\frac{z}{U_q}\frac{U_q}{U_z}\frac{1}{\beta X_q}]<1\ (>1)$$

where use has been made of $z=\beta x$. Observing that $(U_q/U_z)/(1/(\beta X_q))=-1$ (from (B1)), the latter inequality simplifies to

$$-[U_{zz}\frac{z}{U_z}-U_{qz}\frac{z}{U_q}]=-[\varepsilon_{U_z,z}-\varepsilon_{U_q,z}]<1\ (>1) \qquad \text{(B2)}$$

where $\varepsilon_{U_z,z}$ and $\varepsilon_{U_q,z}$ are the elasticities of U_z and U_q, respectively, with respect to *z* (the first being negative and the second positive).

We now relate this condition to the elasticity of substitution, that is, the (absolute value of the) elasticity of the ratio of *z* and *q* with respect to the ratio of their marginal utilities (Sydsaeter and Hammond 1995):

$$\sigma = -\frac{d(\frac{z}{q})/(\frac{z}{q})}{d(\frac{U_z}{U_q})/(\frac{U_z}{U_q})}$$

whose inverse value can be written (using obvious notation) as

$$\frac{1}{\sigma} = -\frac{d(\frac{U_z}{U_q})/(\frac{U_z}{U_q})}{d(\frac{z}{q})/(\frac{z}{q})} = -\varepsilon_{(U_z/U_q),(z/q)} = -[\varepsilon_{U_z,(z/q)} - \varepsilon_{U_q,(z/q)}]. \quad \text{(B3)}$$

If we evaluate the rightmost expression in (B3) at the optimum (z, q), holding q constant, the elasticities with respect to z/q in (B3) are the same as the corresponding elasticities with respect to z in (B2). Thus, at the optimum we have the following equivalences:

$$\frac{dq}{d\alpha} > 0(< 0) \Leftrightarrow \frac{dq}{d\beta} < 0(> 0) \Leftrightarrow -[\varepsilon_{U_z,(z/q)} - \varepsilon_{U_q,(z/q)}] = \frac{1}{\sigma} < 1(> 1) \Leftrightarrow \sigma > 1(< 1).$$

In summary, in the myopic optimum a larger value of the habituation parameter implies a greater (smaller) optimum value of q if the elasticity of substitution is greater than (less than) unity.

Appendix C: Survey Instrument (Selected Items)

Organic food:

- "Do you buy food that is labeled as organic food?" (never; sometimes; often; always).
- If the answer is 'often' or 'always': "For how long have you been buying a significant share of organic food?" (less than one year; more than one year; more than two years; more than five years; more than ten years).
- "Do many of your friends, neighbors and relatives buy food that is labeled as organic food?" (never; sometimes; often; always).

Low-energy light bulbs:

- "Do you buy low-energy light bulbs?" (never; sometimes; often; always)

Low-energy household appliances:

- "Do you pay attention to energy efficiency when buying household appliances?" (never; sometimes; often; always).

Solar thermal energy systems:

- "Is your house equipped with a solar thermal energy system?" (yes; no)
- "Do some of your friends, neighbors and relatives use solar thermal systems (yes; no)?"

Green electricity:

- "Are you currently subscribed to so-called green electricity (e.g. wind power, water power or electricity from bio mass)?" (yes; no)
- "Are some of your friends, neighbors and relatives currently subscribed to green electricity? (yes; no)"

Environmental attitudes:

- "Environmentalists often exaggerate environmental problems." (agree completely; agree; disagree; disagree completely)
- "A change to renewable energy sources is necessary." (agree completely; agree; disagree; disagree completely)
- "In your opinion, how dangerous are nuclear power plants and nuclear waste for you and your family?" (extremely dangerous; very dangerous; dangerous; hardly dangerous; not at all dangerous

Consumption attitude

- "Please indicate your position on the following scale:
  Enjoy consumption _ _ _ _ _ feel nerved by consumption."

Appendix D: Additional Tables

Table A: Summary statistics

	n	Minimum	Maximum	Mean	Std.-Dev.
LS	489	1.00	10.00	8.0879	1.52387
Health status	491	1.00	5.00	3.8941	.79346
Female	491	.00	1.00	.4053	.49145
Age	492	18.00	75.00	46.5122	13.65168
Age-squared	492	324.00	5625.00	2349.3740	1308.61139
Married	491	.00	1.00	.5601	.49688
Living together	491	.00	1.00	.1059	.30803
Divorced	491	.00	1.00	.0407	.19787
Separated	491	.00	1.00	.0143	.11867
Widowed	490	.00	1.00	.0469	.21172
Household size	492	1.00	20.00	2.6667	1.45211
Education level	491	1.00	7.00	5.7617	1.59151
Retired	492	.00	1.00	.1870	.39030
Employed/self employed	492	.00	1.00	.6606	.47400
Income bracket	429	.00	10.00	6.1608	3.16593
Home ownership	493	.00	1.00	.6369	.48138
Enjoy consumption	477	1.00	5.00	2.7065	1.09708
Environmental problem exaggerated	493	1.00	4.00	1.7343	.85325
Renewable energy necessary	492	1.00	4.00	3.3984	.79448
Nuclear power dangerous	493	1.00	5.00	3.8073	1.16582
Appliances	489	1.00	4.00	3.3865	.74376
Lighting	479	1.00	4.00	2.8664	.92552
Food	493	1.00	4.00	2.6308	.75817
Food2	303	1.00	2.00	1.1518	.35944
Peers_food	463	1.00	4.00	2.4363	.65774
History	296	1.00	5.00	3.7297	1.15330
Consumption5	467	1.00	6.00	4.2120	1.19370
Consumption3	475	3.00	12.00	8.8632	1.78608
Consumption4	467	1.00	5.00	3.2891	1.07045
Peers	394	1.00	4.00	2.9721	.82378

Table B: Robustness checks (joy of consumption as additional control)

	Pec = consumption3			*Pec = consumption5*			*Pec = consumption4*		
	OPM	OPM	OLS	OPM	OPM	OLS	OPM	OPM	OLS
Enjoy consumption	0.111** (2.09)	0.124** (2.16)	0.112* (1.65)	0.118** (2.18)	0.132** (2.24)	0.120* (1.73)	0.117** (2.16)	0.119** (2.09)	0.114* (1.70)
Income	0.113*** (4.61)	0.105*** (4.00)	0.110*** (4.18)	0.103*** (4.14)	0.101*** (3.75)	0.107*** (3.90)	0.103*** (4.14)	0.093*** (3.46)	0.099*** (3.61)
Pec	0.060 (1.61)	0.207** (2.17)	0.232* (1.91)	0.108* (1.87)	0.414*** (3.11)	0.459** (2.57)	0.116* (1.81)	0.514*** (3.19)	0.567*** (2.62)
Pec*Peers		-0.075** (1.98)	-0.082* (1.70)		-0.156*** (2.89)	-0.167** (2.19)		-0.218*** (2.87)	-0.238** (2.23)
Peers		0,661* (1.94)	0.683 (1.55)		0.652*** (2.73)	0.660* (1.93)		0.691*** (2.64)	0.732* (1.95)
N	386	319	319	379	314	314	379	324	324
(Pseudo-)R^2	0.117	0.112	0.306	0.114	0.117	0.318	0.114	0.116	0.317

Dependent variable: Life satisfaction (LS). Method: ordered probit (OPM), ordinary least squares (OLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption. The regressions include socio-demographic characteristics and environment-related attitudes.

Table C: Robustness checks (home ownership as additional control)

	Pec = consumption3			*Pec = consumption5*			*Pec = consumption4*		
	OPM	OPM	OLS	OPM	OPM	OLS	OPM	OPM	OLS
Home ownership	0.141 (0.93)	0.065 (0.38)	0.085 (0.49)	0.098 (0.72)	0.072 (0.41)	0.076 (0.44)	0.109 (0.71)	0.105 (0.62)	0.103 (0.60)
Income	0.106*** (4.26)	0.105*** (3.81)	0.109*** (3.89)	0.098*** (3.87)	0.100*** (3.55)	0.106*** (3.59)	0.098*** (3.88)	0.089*** (3.28)	0.097*** (3.36)
Pec	0.064* (1.74)	0.215** (2.36)	0.248** (2.11)	0.112** (1.99)	0.425*** (3.34)	0.485*** (2.79)	0.115* (1.85)	0.462*** (2.94)	0.530** (2.48)
Pec*Peers		-0.073** (2.07)	-0.083* (1.81)		-0.154*** (3.07)	-0.170** (2.34)		-0.187*** (2.58)	-0.215** (2.07)
Peers		0.642** (2.03)	0.690 (1.65)		0.637*** (2.91)	0.667** (2.06)		0.587** (2.34)	0.647* (1.77)
N	399	326	326	392	321	321	392	333	333
(Pseudo-)R^2	0.112	0.104	0.297	0.108	0.109	0.308	0.108	0.106	0.303

Dependent variable: Life satisfaction (LS). Method: ordered probit (OPM), ordinary least squares (OLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption. The regressions include socio-demographic characteristics and environment-related attitudes.

Table D: Robustness checks (green electricity weights)

	Pec = consumption3			*Pec = consumption5*			*Pec = consumption4*		
	WOP	WOP	WLS	WOP	WOP	WLS	WOP	WOP	WLS
Income	0.112*** (4.13)	0.114*** (3.72)	0.124*** (3.79)	0.109*** (4.00)	0.111*** (3.61)	0.121*** (3.67)	0.109*** (3.99)	0.098*** (3.25)	0.110*** (3.39)
Pec	0.065* (1.65)	0.213 (1.51)	0.294 (1.52)	0.148** (2.47)	0.513** (2.52)	0.640** (2.26)	0.166** (2.46)	0.497*** (2.82)	0.533** (2.18)
Pec*Peers		-0.063 (1.25)	-0.092 (1.36)		-0.153** (2.21)	-0.191* (1.95)		-0.193** (2.37)	-0.206* (1.77)
Peers		0.510 (1.15)	0.754 (1.22)		0.556** (1.98)	0.685* (1.66)		0.519** (2.01)	0.537 (1.40)
N	392	321	321	392	321	321	392	333	333
(Pseudo-)R^2	0.112	0.110	0.339	0.115	0.114	0.348	0.114	0.115	0.346

Dependent variable: Life satisfaction (LS). Method: weighted ordered probit (WOP), weighted least squares (WLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption. The regressions include socio-demographic characteristics and environment-related attitudes.

Table E: Robustness checks (solar heating weights)

	Pec = consumption3			*Pec = consumption5*			*Pec = consumption4*		
	WOP	WOP	WLS	WOP	WOP	WLS	WOP	WOP	WLS
Income	0.110*** (3.97)	0.088*** (2.86)	0.095*** (3.03)	0.105*** (3.79)	0.086*** (2.77)	0.093*** (2.93)	0.105*** (3.77)	0.084*** (2.75)	0.091*** (2.91)
Pec	0.086* (1.96)	0.256* (1.80)	0.288* (1.70)	0.191*** (2.67)	0.502** (2.35)	0.550** (2.12)	0.209** (2.54)	0.429** (2.26)	0.428* (1.83)
Pec*Peers		-0.067 (1.41)	-0.078 (1.42)		-0.130* (1.81)	-0.138 (1.56)		-0.136 (1.60)	-0.125 (1.16)
Peers		0.693* (1.64)	0.780 (1.53)		0.606** (2.07)	0.624 (1.61)		0.508* (1.82)	0.458 (1.23)
N	392	321	321	392	321	321	392	333	333
(Pseudo-)R^2	0.153	0.155	0.420	0.156	0.157	0.425	0.156	0.157	0.423

Dependent variable: Life satisfaction (LS). Method: weighted ordered probit (WOP), weighted least squares (WLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption. The regressions include socio-demographic characteristics and environment-related attitudes.

Table F: Robustness checks (green electricity and solar heating weights combined)

	Pec = consumption3			*Pec = consumption5*			*Pec = consumption4*		
	WOP	WOP	WLS	WOP	WOP	WLS	WOP	WOP	WLS
Income	0.093*** (3.13)	0.056 (1.61)	0.061* (1.68)	0.089*** (2.96)	0.056 (1.62)	0.062* (1.73)	0.089*** (2.95)	0.057* (1.70)	0.066* (1.84)
Pec	0.079* (1.64)	0.225 (1.33)	0.269 (1.27)	0.184** (2.43)	0.526** (2.06)	0.580* (1.83)	0.211** (2.35)	0.476** (2.04)	0.425 (1.43)
Pec*Peers		-0.061 (1.06)	-0.079 (1.10)		-0.143* (1.73)	-0.157 (1.51)		-0.161 (1.60)	-0.133 (1.02)
Peers		0.635 (1.26)	0.801 (1.23)		0.615* (1.92)	0.672 (1.57)		0.520* (1.74)	0.450 (1.09)
n	392	321	321	392	321	321	392	333	333
(Pseudo-)R^2	0.166	0.175	0.476	0.169	0.178	0.482	0.169	0.178	0.478

Dependent variable: Life satisfaction (LS). Method: weighted ordered probit (WOP), weighted least squares (WLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption. The regressions include socio-demographic characteristics and environment-related attitudes.

Table 1: Regressions without peer behavior

	Pec = appliances	*Pec = lighting*	*Pec = food*	*Pec = consumption3*	*Pec = consumption5*	*Pec = consumption4*
Income	0.104*** (4.37)	0.115*** (4.92)	0.109*** (4.66)	0.111*** (4.65)	0.102*** (4.20)	0.102*** (4.20)
Pec	0.165** (2.07)	0.130* (1.94)	-0.022 (0.29)	0.066* (1.80)	0.118** (2.12)	0.122** (1.99)
Health status	0.501*** (6.11)	0.476*** (5.80)	0.499*** (6.10)	0.492*** (5.94)	0.504*** (6.12)	0.502*** (6.08)
Male	Base category					
Female	0.279** (2.15)	0.333*** (2.62)	0.303** (2.38)	0.328** (2.55)	0.330** (2.56)	0.328** (2.54)
Age	-0.068** (2.24)	-0.059** (1.97)	-0.065** (2.11)	-0.058* (1.94)	-0.057* (1.84)	-0.057* (1.82)
Age-squared	0.001** (2.42)	0.001** (2.18)	0.001** (2.38)	0.001** (2.14)	0.001** (1.98)	0.001** (1.96)
Single	Base category					
Married	-0.232 (1.30)	-0.297 (1.63)	-0.219 (1.23)	-0.282 (1.55)	-0.243 (1.32)	-0.247 (1.33)
Living together	-0.131 (0.64)	-0.206 (1.00)	-0.120 (0.58)	-0.191 (0.92)	-0.197 (0.94)	-0.199 (0.95)
Divorced	-0.448* (1.67)	-0.514* (1.88)	-0.450* (1.73)	-0.505* (1.83)	-0.515* (1.84)	-0.508* (1.81)
Separated	-0.025 (0.10)	-0.070 (0.29)	0.063 (0.25)	-0.098 (0.40)	-0.074 (0.31)	-0.071 (0.30)
Widowed	-0.408 (1.15)	0.446 (1.23)	-0.416 (1.15)	-0.444 (1.25)	-0.428 (1.20)	-0.448 (1.23)
Household size	0.027 (0.57)	0.039 (0.84)	0.021 (0.44)	0.043 (0.93)	0.019 (0.39)	0.020 (0.43)
Education level	0.052 (1.34)	0.060 (1.48)	0.050 (1.29)	0.063 (1.53)	0.058 (1.41)	0.060 (1.46)
Not employed	Base category					
Retired	0.696** (2.53)	0.854*** (3.20)	0.782*** (2.80)	0.798*** (2.98)	0.859*** (3.24)	0.856*** (3.23)
Employed/self employed	0.329* (1.74)	0.434** (2.28)	0.449** (2.30)	0.351* (1.89)	0.355* (1.89)	0.354* (1.87)
Environmental problem exaggerated	0.057 (0.69)	-0.010 (0.12)	0.046 (0.55)	0.010 (0.12)	-0.005 (0.06)	-0.005 (0.06)
Renewable energy necessary	-0.301*** (2.94)	-0.322*** (3.09)	-0.254** (2.56)	-0.333*** (3.12)	-0.329*** (3.06)	-0.326*** (3.05)
Nuclear power dangerous	0.078 (1.26)	0.061 (0.96)	0.074 (1.18)	0.069 (1.07)	0.044 (0.66)	0.045 (0.68)
n	412	402	416	399	392	392
Pseudo-R^2	0.105	0.109	0.100	0.111	0.108	0.108

Dependent variable: Life satisfaction (LS). Method: ordered probit (OPM). Heteroskedasticity robust z-statistics in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption (*appliances* = 1, 2, …,4; *lighting* = 1, 2, …, 4; *food* = 1, 2, …,4; *consumption3* = food, lighting, appliances = 3, 4, ..., 12; *consumption4* = lighting (0-1), appliances (0-1), solar, electricity = 1,2, …5; *consumption5* = food (0-1),lighting (0-1), appliances (0-1), solar, electricity = 1,2, …6).

Table 2: Regressions with peer behavior

	Pec = food		*Pec = consumption3*		*Pec = consumption5*		*Pec = consumption4*	
	OPM	OLS	OPM	OLS	OPM	OLS	OPM	OLS
Income	0.118*** (4.85)	0.133*** (4.89)	0.107*** (4.06)	0.112*** (4.14)	0.102*** (3.82)	0.108*** (3.85)	0.092*** (3.47)	0.099*** (3.54)
Pec	0.263 (1.03)	0.485 (1.56)	0.216** (2.37)	0.250** (2.13)	0.429*** (3.29)	0.489*** (2.83)	0.475*** (3.05)	0.544*** (2.58)
Pec*Peers	-0.139 (1.46)	-0.205* (1.79)	-0.074** (2.08)	-0.083* (1.83)	-0.154*** (3.08)	-0.170** (2.35)	-0.190*** (2.64)	-0.218** (2.13)
Peers	0.457* (1.70)	0.583* (1.84)	0.646** (2.05)	0.697* (1.67)	0.639*** (2.93)	0.670** (2.08)	0.603** (2.45)	0.664* (1.85)
N	396	396	326	326	321	321	333	333
(Pseudo-)R^2	0.104	0.308	0.104	0.296	0.109	0.307	0.106	0.302

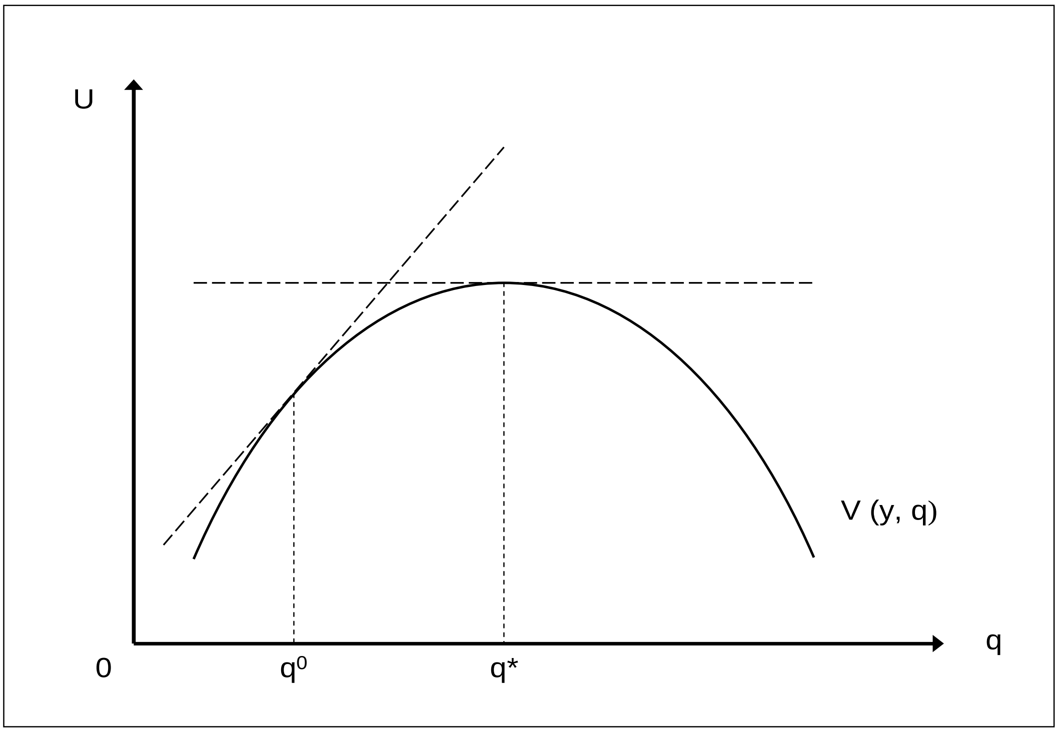
Dependent variable: Life satisfaction (LS). Method: ordered probit (OPM), ordinary least squares (OLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. *pec* = pro-environmental consumption (*food* = 1, 2, …,4; *consumption3* = food, lighting, appliances = 3, 4, ..., 12; *consumption4* = lighting (0-1), appliances (0-1), solar, electricity = 1,2, …5; *consumption5* = food (0-1),lighting (0-1), appliances (0-1), solar, electricity = 1,2, …6). The regressions include socio-demographic characteristics and environment-related attitudes. Note: In the case of *pec* = *food*, the relevant 'peers' variable is peers_food (see Table A).

Table 3: Regressions with peer behavior and history (restricted sample)

	No interactions		Interaction with peer behavior		Interaction with history		Interactions with peer behavior and history	
	OPM	OLS	OPM	OLS	OPM	OLS	OPM	OLS
Income	0.098*** (3.17)	0.121*** (3.49)	0.095*** (3.00)	0.116*** (3.21)	0.096*** (3.07)	0.118*** (3.34)	0.093*** (2.89)	0.113*** (3.08)
Food2	-0.242 (1.38)	-0.131 (0.62)	1.921** (2.00)	1.548 (1.47)	-1.396** (2.23)	-1.314 (1.53)	0.819 (0.72)	0.448 (0.33)
Food2* Peers_food			-0.747** (2.36)	-0.569 (1.59)			-0.856** (2.51)	-0.664* (1.76)
Peers_food			2.480** (2.39)	1.817 (1.52)			2.870*** (2.59)	2.161* (1.73)
Food2* history					0.278* (1.87)	0.286 (1.48)	0.340** (2.14)	0.330 (1.62)
History					-0.352* (1.88)	-0.370 (1.55)	-0.442** (2.22)	-0.430* (1.72)
n	263	263	257	257	263	263	257	257
(Pseudo-)R^2	0.095	0.283	0.102	0.289	0.098	0.290	0.107	0.298

Dependent variable: Life satisfaction (LS). Sample restricted to *food* = often, always. Method: ordered probit (OPM), ordinary least squares (OLS). Heteroskedasticity robust z-statistics (t-statistics) in parentheses. ***, ** and * denotes significance at the 1, 5 and 10 percent level, respectively. The regressions include socio-demographic characteristics and environment-related attitudes.

Figure 1: Reduced-form utility function



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