Welsch, Heinz; Kühling, Jan

Working Paper

Competitive Altruism and Endogenous Reference Group Selection in Private Provision of Environmental Public Goods

Oldenburg Discussion Papers in Economics, No. V-350-12

Provided in Cooperation with:
University of Oldenburg, Department of Economics

CARL VON OSSIETZKY universität OLDENBURG

Oldenburg Discussion Papers in Economics

Competitive Altruism and Endogenous Reference Group Selection in Private Provision of Environmental Public Goods

Heinz Welsch and Jan Kühling

V – 350 – 12

October 2012

Department of Economics
University of Oldenburg, D-26111 Oldenburg

Competitive Altruism and Endogenous Reference Group Selection in Private Provision of Environmental Public Goods

Heinz Welsch
Jan Kühling

Department of Economics
University of Oldenburg
26111 Oldenburg, Germany

Abstract
We develop and test a model of social comparison in which individuals gain status through pro-social behavior (competitive altruism) and in which they endogenously choose the reference group and associated reference standard involved in signaling status (reference group selection). In our framework of private provision of environmental public goods, the optimal reference standard involves a balance between the *magnitude* of the status signal (implying a low reference standard) and the higher *value* of the signal in a greener social environment. By using a unique set of survey data we find evidence of (a) respondents behaving in a competitively altruistic fashion and (b) reference persons' intensity of pro-environmental behavior depending on relevant attitudes of the respondents, consistent with predictions from our framework of reference group selection.

JEL classification: D64; H31; H41; Q00
Keywords: competitive altruism; reference groups; endogenous reference standard; pro-environmental behavior; private public good provision
Acknowledgements: We thank Jens Clausen (Borderstep Institute, Hanover, Germany) for providing the survey data used in this paper. Useful comments were received from Jürgen Bitzer, Udo Ebert and Susana Ferreira. This research was supported by the German Federal Ministry for Education and Research (BMBF) through grant 01UN0602C.

1. Introduction

A large body of research has found that people's subjective evaluation of economic outcomes and activities involves social comparison, that is, people evaluate their circumstances relative to those of others (see Clark 2012 for a survey). One field where social comparison may play a role is pro-social behavior. Traditional explanations of these forms of private provision of public goods involve pure altruism (other-regarding preferences) or impure altruism (the "warm glow of giving").[1] A more recent explanation considers pro-social activities as manifestations of what has been referred to as "competitive altruism".[2] Competitive altruism entails that people derive utility from pro-social behavior as a means to attain status by signaling selflessness.[3]

In addition to providing a non-standard explanation for pro-social behavior, the literature has discussed specific *channels* through which social comparison works, specifically identity and conformance seeking (Akerlof and Kranton 2010). These models feature heterogeneous individuals who self-select into those identities from which they benefit most and gain utility by conforming to the norms of the identities that they share with their chosen reference group.

In this paper, we combine the ideas of competitive altruism and endogenous reference group selection and apply them to the case of private provision of environmental public goods. In this context, the notion of "green" competitive altruism entails that pro-environmental consumption serves to gain status by signaling environmental concern, where the *magnitude* of the status signal is measured by one's "greenness" relative to some reference

[1] See Becker (1974) and Andreoni (1989, 1990), respectively.
[2] See Hardy and Van Vugt (2006), Van Vugt et al. (2007). Economists have referred to the prestige motive (Harbaugh 1998) and the reputational motive (Benabou and Tirole 2006).
[3] The probably most prominent example of social comparison in economic life refers to the acquisition and spending of income. With respect to this, contemporary research has provided empirical support of the "relative income" and "conspicuous consumption" hypotheses known in the literature for more than a century (Duesenberry 1949, Veblen 1899; see Clark et al. 2008 for a survey). More recently, extending the now-familiar framework of reference-dependent evaluation of consumption, it has been suggested that people endogenously *select* their reference consumption level (Falk and Knell 2004).

standard and the *value* (in terms of utility) of the green signal is increasing in the greenness of people's reference group (Sexton and Sexton 2011).

We develop a stylized model of pro-environmental consumption and show that green competitive altruism implies upward-sloping optimal response functions. Specifically, if the value (utility) of the green signal increases in the greenness of the reference group, then people respond to their reference persons behaving greener by behaving greener themselves. Moreover, we model the endogenous choice of the green reference standard as the choice of a reference group and its associated greenness. This choice involves balancing the gains from outperforming others (which suggests choosing low reference group greenness) against the higher value of the green signal in a greener social environment.[4] Our model involves both a "generic" motive for pro-environmental behavior (stemming from pure or impure altruism, say) and a motive deriving from competitive altruism. We show that the optimal green reference standard increases in the individual's degree of generic preference for green consumption and decreases in her degree of preference for the mere quantitative aspect of consumption.

Against this background, we use a unique set of survey data on people's environmentally friendly consumption and the corresponding behaviors of their friends and neighbors to test the predictions of our model. We find that (a) the intensity of survey respondents' pro-environmental consumption increases in the greenness of their reference persons, consistent with the conceptual model of competitive altruism, and (b) that the reference persons' greenness is systematically and significantly correlated with green attitudes of the respondents, consistent with our framework of green reference group selection. These findings are robust to several kinds of pro-environmental consumption (organic food, renewable energy), several empirical specifications and several estimation methods.

[4] The psychological literature refers to outperforming others (downward comparison) as self-enhancement. See Wood and Taylor (1991).

At the policy level, our findings concerning green competitive altruism imply that an increase in people's generic greenness (from pure and impure altruism) may have a "multiplier effect" as it triggers greener behavior of others who share their green identity. This way, "conspicuous conservation" may to some extent counteract the negative environmental implications of traditional conspicuous consumption.[5]

The endogenous selection of reference standards was modeled by Falk and Knell (2004) with respect to individuals' aggregate consumption level. In their model, the choice of a reference consumption level involves balancing the motives of self-enhancement (through downward comparison) and self-improvement (through setting an aspiration level for improving one's own economic performance). Our model differs from theirs in that we do not focus on the *level* of (own and reference) consumption, but on the *quality* (that is, greenness) of consumption. As noted above, the relevant tradeoff in our framework refers to the *magnitude* of the green signal (own greenness relative to reference group greenness) and the subjective *value* that a greener reference group attributes to the signal.[6]

Previous evidence of conspicuous conservation was found in studies of consumer behavior both in the field and in the lab (see Sexton and Sexton 2011 and Griskevicius et al. 2010, respectively). Sexton and Sexton (2011) exploit spatial variation in ownership rates of a particular environmental friendly car (the Prius) across "green" and "brown" communities in order to identify a conspicuous conservation effect. Griskevicius et al. (2010) show in experiments that conservation choices are significantly more frequent in a treatment group in which "green" norms are activated than in the control group.

Different from those papers, we use survey data on people's own pro-environmental behavior and the corresponding behavior of reference persons at the micro level. Our unique

[5] We use the terms "conspicuous conservation" and "green competitive altruism" synonymously. For the environmental effects of traditional conspicuous consumption see Brekke et al. (2003).

[6] In the model of Falk and Knell (2004) it is *implicit* that the outcome variable (consumption level) is appreciated as a status signal by the recipients and that signal recipients are homogeneous in this regard. In their model, the crucial heterogeneity refers to people's productivity, whereas we take income to be exogenous (though potentially heterogeneous).

data set allows us to study green competitive altruism jointly with green reference group selection. To our knowledge, this paper is the first to investigate competitive altruism and endogenous reference group selection in a common framework both conceptually and empirically.

Though our empirical analysis refers specifically to environmental goods, the conceptual framework of competitive altruism and endogenous reference group selection can be applied to other domains of private public good provision (charitable giving, volunteering) in which pro-social behavior allows people to define and demonstrate identity and status.

In section 2 we present our framework of competitive altruism and reference group selection and derive a set of testable predictions. Section 3 describes the data and empirical approach, and section 4 describes and discusses the empirical results. Section 5 concludes.

2. Theoretical Framework

2.1 Background and Main Ideas

In this paper we draw on several related yet distinct literatures and combine some of their main elements into a consistent framework of green competitive altruism and reference group selection.

- *Conspicuous consumption and choice of reference standard.* For more than a century, consumption has been considered as a means of attaining positional goals, specifically a need for status and reputation (Veblen 1899). While the desire for "keeping-up with the Joneses" (Duesenberry 1949) has long been accepted as a motive for consumption, a more recent idea focuses on "choosing the Joneses" (Falk and Knell 2004). In this view, people not only compare to a reference consumption level, but choose that reference level endogenously.[7]

[7] This choice involves balancing "self-enhancement" through outperforming others and "self-improvement" through setting an aspiration level for one's own economic performance (Falk and Knell 2004).

- *Conspicuous conservation and competitive altruism.* While the economics literature has mainly focused on "conspicuous consumption" of goods that signal wealth through wastefulness, luxury and exclusivity (Frank 1985), some recent papers have considered the demonstration of austerity – specifically austerity that minimizes the environmental impact of consumption – as a means of attaining social status. In these models of "conspicuous conservation", people undertake costly actions of providing environmental goods in order to attain status benefits by signaling their "greenness" (Griskevicius et al. 2010, Sexton and Sexton 2011).[8] Since status-seeking through pro-environmental consumption relies on outperforming others in terms of "greenness", conspicuous conservation falls into the category of *competitive* altruism (Hardy and Van Vugt 2006, Van Vugt et al. 2007).
- *Identity and the value of signaling "green" type*. An obvious precondition for pro-environmental consumption to convey status is that environmental friendliness is accepted as a norm in people's social environment. As discussed by Akerlof and Kranton (2010), the norms to which people adhere are features of their self-selected "identities", and the utility of individuals is increasing in their conformance to the norms of those identities. In a "green" signaling context, this suggests that the value of signaling "green" type through conservation is increasing in the predisposition of one's reference persons toward environmental protection (Sexton and Sexton 2011).

From these strands of previous literature we take the following main ideas as elements of our conceptual framework.

- Pro-environmental consumption choices are partly motivated by competitive altruism.

[8] In a broader perspective, status-seeking has been put forward as an explanation for pro-social behavior in general. Glazer and Konrad (1996) and Harbaugh (1998) have considered a signaling explanation for charity, and Benabou and Tirole (2006) invoked a reputational motivation in their analysis of incentives and pro-social behavior. In these models, pro-social behavior need not rely on altruism but can instead be achieved by those seeking status by signaling their selflessness.

- The value of the green-consumption signal depends on the greenness of the consumer's reference persons.
- The green reference standard (that is, the greenness of one's reference group) is partly endogenous.

Our core assumption with respect to the choice of the green reference standard is that it involves a tradeoff between self-enhancement through outperforming reference persons (which suggests a low level of reference person's greenness) and the requirement that the reference persons appreciate the green signal (which suggests a high level of reference person's greenness).

Though status-seeking may be one motive for pro-environmental consumption, this does not rule out more generic predispositions to favor environmental goods (pure and impure altruism) as motives of pro-environmental consumption. Indeed, as it will be seen, the working of green competitive altruism presupposes the existence of some "generic" green preference.

2.2 The Model

We present a stylized model of green consumer choice which is designed to incorporate both competition in signaling green status through conservation and the choice of optimal reference group greenness.

As discussed above, a green competitive altruist contributes to environmental protection in order to signal selflessness. She will choose the intensity of pro-environmental consumption depending on the greenness of her reference group's consumption (Sexton and Sexton 2011). Moreover, in the framework that we propose, she will select reference group greenness in such a way as to benefit most from signaling her own greenness.

We will conceive of the individual's problem as a two-stage problem where the first stage refers to the greenness of the reference group and the second stage refers to the

greenness of her own consumption conditional on reference group greenness. The individual cannot easily modify her reference group once it has been chosen, but the greenness of the chosen reference group can change in a way exogenous to the individual. The optimal response function determined in the second stage describes how the individual's consumption responds to such exogenous changes of reference group greenness.

In view of the data employed in our empirical analysis, our model does not include specific conventional vs. green products (such as the Prius, considered in Sexton and Sexton 2011), but focuses on the intensity of green consumption overall. We thus assume that an individual derives utility, *u*, from the overall *quantity* consumed, $x \geq 0$, and the *greenness* (environmental friendliness) of consumption, $q \geq 0$. In addition, utility depends on the greenness of the individuals' reference persons, $\bar{q} \geq 0$. Moreover, individuals are heterogeneous with respect to certain attributes (characteristics and attitudes) θ. Hence we have:

$$u = U(q, \bar{q}, x, \theta), \quad U_q > 0, U_x > 0, U_{qq} < 0, U_{xx} < 0, U_{x\bar{q}} = 0.^{9} \tag{1}$$

With respect to other derivatives ($U_{\bar{q}}, U_{\bar{q}\bar{q}}, U_{q\bar{q}}, U_{xq}$) we make no specific assumptions at this point.

In order to investigate the individual's choice of environmental friendliness, we assume that there is a cost premium on greenness (Griskevicius et al. 2010, Sexton and Sexton 2011), such that the unit cost of *x* is increasing in greenness. At given income, *y*, there is thus a tradeoff between the quantity and the greenness of consumption:

$$x = X(q, y), \quad X_q < 0, X_y > 0. \tag{2}$$

[9] We use subscripts to denote partial derivatives.

By combining eqs. (1) and (2) we get

$$u = U(q, \bar{q}, X(q, y), \theta) =: V(q, \bar{q}, y, \theta)\,. \tag{3}$$

The total marginal utility of greenness is

$$\frac{du}{dq} = V_q(q, \bar{q}, y, \theta) = U_q(q, \bar{q}, X(q, y), \theta) + U_x(q, \bar{q}, X(q, y), \theta) \cdot X_q(q, y)\,. \tag{4}$$

The individual's choice of her own environmental friendliness proceeds conditional on the environmental friendliness of her reference persons' consumption. It constitutes the second stage in the two-stage choice problem described above.

Assuming strict concavity in q ($V_{qq} < 0$), the utility-maximizing choice of q is characterized by the first-order condition

$$V_q(q, \bar{q}, y, \theta) = 0\,. \tag{5}$$

This condition characterizes the optimal tradeoff between the utility of consuming more environment-friendly and the implied disutility of consuming a smaller quantity, see eq. (4). Given strict concavity, a sufficient condition for eq. (5) to yield an interior maximum is that $\lim_{q \to 0} V_q = \infty$ and $\lim_{q \to \hat{q}} V_q = -\infty$ (where $\hat{q} \in (0, \infty)$ is the maximum value q can take).

Assuming that y is fixed ($dy = 0$), totally differentiating eq. (5),

$$V_{qq}\,dq + V_{q\bar{q}}\,d\bar{q} = 0\,, \tag{6}$$

allows us to characterize the individual's optimal response function, $q = R(\bar{q}, y, \theta)$, as follows:

$$\frac{dq}{d\bar{q}} =: R_{\bar{q}}(\bar{q}, y, \theta) = -\frac{V_{q\bar{q}}}{V_{qq}} > 0\ (<0) \quad \Leftrightarrow \quad V_{q\bar{q}} > 0\ (<0)\,. \tag{7}$$

Eq. (7) tells us that the optimal response function is upward-sloping (downward-sloping) iff the marginal utility from own greenness increases (decreases) in others' greenness, i.e. iff $V_{q\bar{q}} > 0$ $(V_{q\bar{q}} < 0)$.[10]

Invoking eq. (4) and the assumption $U_{x\bar{q}} = 0$ (eq. (1)), we observe that $V_{q\bar{q}} = U_{q\bar{q}}$. We thus get

PROPOSITION 1: People respond to their reference persons behaving greener (less green) themselves iff $U_{q\bar{q}} > (<) 0$.

The former case – positive cross-derivative of the utility function – means that the value of the green signal increases in the greenness of one's reference group, which is an essential feature of green competitive altruism (Sexton and Sexton 2011). In other words, therefore, competitive altruism implies that optimal response functions are upward-sloping.

As mentioned above, we conceive of the optimal response function as the solution to a second-stage problem. It describes how the individual responds to exogenous changes in reference group greenness after having selected the latter in a first stage.

It is this first stage that we now address, that is, the choice of how green one's reference group should be. To formalize the idea that, once selected, the reference group's greenness can change exogenously, we assume $\bar{q} = s + z$, where *s* captures the endogenous part (to be chosen ex ante) and *z* is the exogenous part (observed after *s* has been fixed) with $E(z) = 0$.[11]

Formally, the individual solves the following optimization problem:

$$\max_s E[V(R(s+z, y, \theta), s+z, y, \theta)] = V(R(s, y, \theta), s, y, \theta) =: \hat{V}(s, y, \theta)\,. \tag{8}$$

[10] In the terminology of Bulow et al. (1985) this corresponds to the cases of strategic complements and substitutes, respectively.

[11] We show in Appendix I that the choice of reference group greenness, *s*, can be conceptualized as attributing "proximity weights" to people in the population who differ in terms of greenness We assume that those weights, once chosen, are fixed in the short run, whereas the greenness of the persons may change. The individual's short-run response option to such changes then consists of adjusting her behavior, not her reference group.

Assuming that the objective function is strictly concave in the choice variable (an assumption to be motivated below) and appropriate boundary conditions are satisfied, the condition

$$\hat{V}_s(s, y, \theta) = 0 \tag{9}$$

yields an interior solution $s = S(y, \theta)$ for the "planned" value of $\bar{q}$.[12]

This derivation formalizes the idea of green reference group selection: People choose reference persons whose degree of greenness allows them to benefit most from signaling their own greenness, given their own predispositions captured by θ and their ability to pay captured by *y*. As will be detailed in subsection 2.3, this choice involves a tradeoff between the magnitude of the green signal (suggesting low reference group greenness) and the value of the signal (suggesting high reference group greenness). It is this tradeoff which suggests concavity of the objective function in eq. (8).

In the empirical part of the paper we will investigate the (joint) hypotheses of green competitive altruism and green reference group selection by estimating empirical versions of the system of equations $q = R(\bar{q}, y, \theta)$, $s = S(y, \theta)$, where the unobserved "planned" variable *s* will be replaced with $\bar{q}$.[13]

2.3 A Simple Specification

We address the nature of the tradeoff involved in green reference group selection in terms of a particular specification of the utility function. This specification will, in addition, allow us to study the role of some key parameters of the individual's preferences and to derive some testable predictions.

Let the individual's utility function be given by the following simple specification:

$$V = \alpha q + \beta(q - \bar{q})\bar{q} + \frac{\gamma}{2}(y - q^2), \tag{10}$$

In this formulation, $q - \bar{q}$ is the relative greenness of the individual's consumption, which represents the magnitude of the green status signal. The product $(q - \bar{q})\bar{q}$ indicates that the

[12] This condition can be recovered from a more detailed derivation involving proximity weights, see Appendix I.
[13] In the empirical analysis we assume that the determinants of *s* and *z* are orthogonal. Referring back to footnote 11 and Appendix I, the endogenous part can be thought of as reflecting "proximity weights" which the individual assigns to people in her environment whereas the exogenous part refers to shocks to those people's greenness.

marginal utility of the green signal increases in reference persons' greenness. It captures the key tradeoff of green competitive altruism: the magnitude of the green signal (which suggests a low level of reference person's greenness) on the one hand and the value of the green signal (which is higher in a greener social environment) on the other. The term $y - q^2$ represents the *quantity* of consumption, *x*, given the budget constraint $x + q^2 = y$, where q^2 captures the cost premium on green goods.[14] This cost premium implies that greater environmental friendliness of consumption implies a loss in terms of quantity foregone.

The positive parameters α and β measure the strength of the individual's "generic" pro-environmental preferences and the importance of green status-seeking, respectively. The parameter γ measures the importance of the quantity aspect of consumption.[15] These preference parameters are the key elements of the set of an individual's attributes θ. To obtain an interior solution, we assume that the importance of green status-seeking is not too large relative to the importance of quantity $(\beta < 2\gamma)$.

The first-order condition for utility maximization with respect to *q* is

$$U_q = \alpha + \beta\bar{q} - \gamma q = 0, \tag{11}$$

which implies the optimal response function

$$q = \frac{\alpha}{\gamma} + \frac{\beta}{\gamma}\bar{q} = R(\bar{q}; \alpha, \beta, \gamma). \tag{12}$$

Hence, at given $\bar{q}$, individuals with stronger pro-environmental preferences relative to the importance of the quantity consumed (α / γ) will consume more environmentally friendly. Moreover, we get the following

PROPOSITION 2: Under green competitive altruism as specified in eq. (10), environmental friendliness is positively related to the reference persons' environmental friendliness

[14] We assume the cost premium to be convex in *q* in order to obtain a concave optimization problem. A slightly more general formulation of the budget constraint would be $x + \delta q^2 = y$, but we omit the scaling parameter without loss of generality.

[15] This parameter can be taken to capture social comparison with respect to the *level* of consumption, if any, in an *implicit* fashion.

$(R_{\bar{q}} > 0)$, and the strength of the relationship increases with the importance of the green status motive relative to the importance of quantity (β/γ).

Concerning the choice of the reference standard, the first-order condition with respect to *s* evaluated at *z* = 0 (recall $\bar{q} = s + z$, where *s* is the endogenous part and *z* is the exogenous part with *E*(*z*) = 0) is

$$U_s = \beta(q - 2s) = 0 \tag{13}$$

Combining eqs. (12) and (13) and evaluating the result at *z* = 0 yields the optimal choice of reference persons' greenness as follows:

$$s = \frac{\alpha}{2\gamma - \beta} = S(\alpha, \beta, \gamma). \tag{14}$$

This result has the intuitive property that a positive level of the green reference standard arises only if there is at all some generic preference for green consumption (that is, if $\alpha > 0$). In addition, it implies

PROPOSITION 3: The optimal greenness of reference persons increases in the strength of generic pro-environmental preferences (α) and the importance of the green status motive (β), and decreases in the importance of the quantity consumed (γ).

In the empirical analysis we will replace s with its observed value $\bar{q}$. We will study the evidence concerning PROPOSITIONS 2 and 3 by introducing attitude variables as proxies for the parameters α, β, γ. Since we do not have an appropriate proxy for β, some of our regressions refer to the case that β is proportional to α.

3. Empirical Framework

3.1 The Data

Our empirical analysis is based on a survey on several types of pro-environmental behavior – organic food, renewable electricity and solar thermal units – which was conducted from July

to September 2007 in the region of Hanover, Germany (Clausen 2008).[16] 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. Initially, 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.[17] The survey instrument is documented in Appendix II.[18]

With respect to pro-environmental consumption, the survey includes questions on the intensity of buying organic food (variable *Food*).[19] Response options and their coding are as follows: never = 0, occasionally = 1, regularly = 2, always = 3. In addition, respondents were asked whether they possess a solar thermal heating system (*Heat*) and whether they are subscribers to 'green' electricity (*Electricity*), with response options no = 0, yes = 1 in both cases. Respondents were asked to provide the same information concerning the corresponding behaviors of their friends and neighbors, the variables being denoted as *FoodRef*, *HeatRef* and *ElectricityRef*.

In order to provide a more aggregate picture of the intensity of pro-environmental consumption, our empirical analysis employs two composite indicators of environmental friendliness. The first is *Energy: = Heat + Electricity*, which takes values 0, 1, 2; *EnergyRef* is defined correspondingly. The second composite indicator, which is the most comprehensive one, is *Conservation*: = 1/3 *Food* + *Heat* + *Electricity*, taking values 0, 1/3, 2/3, …, 3; the indicator *ConservationRef* is defined accordingly. With respect to *Conservation* and *ConservationRef* it should be noted that the factor 1/3 serves to scale the range of the variable *Food* from [0, 3] to [0, 1], which is the range occupied by *Heat* and *Electricity*. This way, the three elements effectively have the same weight in the composite indicator. As a robustness

[16] The region of Hanover has about 1.1 million inhabitants. In this region, as in Germany overall, customers can choose their electricity provider and the input mix of the electricity they purchase.

[17] 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.

[18] 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). In robustness checks we will use those weights (12 percent, 2.5 percent) in weighted regressions to see whether our results are influenced by the structure of our sample.

[19] In addition to environmental concerns, buying organic food may be motivated by (private) health benefits from, say avoiding toxic chemicals in fertilizers. Our data does not permit to differentiate between these motives.

check we will consider an alternative composite indicator of the form 2/3 *Food* + *Heat* + *Electricity*. In this indicator, *Food* and *Energy* (= *Heat* + *Electricity*) both occupy the range [0, 2] and thus have the same weight. The alternative composite indicator thus occupies the range [0, 4].

Environmental attitudes are captured by how much respondents agree to the assertion that environmentalists *exaggerate* the severity of environmental problems. The variable *Environmentalism* takes values 1, 2, …5 (1 if respondents completely agree to this statement, 5 if they completely disagree). The attitudes towards consumption are captured by a question on how much respondents enjoy consumption. The variable *Materialism* takes values 1, 2, …, 5 (1 if respondents do not enjoy consumption at all, 5 if they enjoy consumption a lot).

An additional set of items in the survey refers to respondents' socio-demographic characteristics (age, sex, marital status, household size, employment status, housing situation, educational attainment, and household income).[20]

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

3.2 The Empirical Model and Strategy

We want to check the qualitative properties of the system of equations $q = R(\bar{q}, y, \theta)$, $s = S(y, \theta)$, as formulated in PROPOSITIONS 1 – 3..To this purpose we estimate the following empirical model:

$$Pec_i = a_0 + a_1 Environmentalism_i + a_2 Materialism_i + a_3 PecRef_i + a_4 Controls_i + \varepsilon_i \qquad (15a)$$

$$PecRef_i = b_0 + b_1 Environmentalism_i + b_2 Materialism_i + b_3 Controls_i + \eta_i \qquad (15b)$$

where Pec_i (*p*ro-*e*nvironmental *c*onsumption of respondent *i*) corresponds to the theoretical variable *q* and is captured by the indicators *Food*, *Energy* and *Conservation* introduced above ($PecRef_i$ is defined accordingly and corresponds to $\bar{q}$). The *Controls* are household income, age, age-squared, sex, marital status, household size, employment status, housing situation, and educational attainment. ε_i and η_i are error terms.

The variables *Environmentalism*, *Materialism* and the socio-demographic *Controls* correspond to the attributes θ in the theoretical model. In the light of the more specific model from subsection 2.3 ($q = (\alpha/\gamma) + (\beta/\gamma)\bar{q}$, $\bar{q} = \alpha/(2\gamma - \beta)$), the variable *Environmentalism*

[20] 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).

can be taken to proxy the individual-specific parameter α (which measures the strength of "generic" pro-environmental preferences) and *Materialism* to proxy γ (which measures the importance of the quantity consumed). Thus we expect the coefficient on the former to be positive and the coefficient on the latter to be negative in both equations.[21]

In an extended version of model (15) we will include the expression $a_3(Environmentalism_i/Materialism_i)*PecRef_i$ instead of $a_3 PecRef_i$. In this model, the term $a_3(Environmentalism_i/Materialism_i)$ is intended to capture β/γ with β taken to be proportional to α as we do not have an appropriate proxy for β (the importance of competitive altruism). This specification will allow us to study the evidence concerning PROPOSITION 2, which entails that the strength of the relationship between own pro-environmental consumption and reference persons' greenness depends on one's environment-related and consumption-related attitudes.

The system (15) captures the effects of the respondents' exogenous attitudes towards the environment and towards consumption on peer selection and on respondents' own behavior. This system is recursive in that *Pec* depends on the exogenous variables directly through (15a) and indirectly through (15b). Given this recursive structure and the possible cross-equation correlation of the errors, an appropriate estimation method is seemingly unrelated regressions (SUR).[22] In robustness checks we will also employ ordinary least squares (to check the correlation of errors), an ordered probit estimator (to account for the discrete and potentially non-cardinal nature of some of our dependent variables) and weighted least squares (to account for the stratified nature of our sample).

3.3 Some Methodological Issues

A first issue to be mentioned is that organic food and renewable electricity are not particularly "visible" or salient forms of consumption. Nevertheless, it is reasonable to assume that people have some knowledge about their friends' respective behaviors. In this regard, our focus on friends and neighbors as reference persons makes "visibility" a less important feature of competitive altruism than if the reference group is the entire community (as in Sexton and

[21] As discussed above, the variable *Materialism* is defined as the response to the assertion "I enjoy consumption a lot". Hence we cannot rule out a priori that it captures some qualitative aspect (greenness). However, our empirical results (negative coefficients) suggest that this is not the case.

[22] SUR takes account of heteroskedasticity and correlation of errors across equations. Estimation techniques more sophisticated than SUR are not required in the present case: For the linear model corresponding to eqs. (15) the matrix of coefficients of the endogenous variables is triangular, implying that its determinant is 1. Thus the Jacobian term in the loglikelihood function for the system (15) vanishes, and the loglikelihood function has the same form as the loglikelihood function for a set of linear seemingly unrelated regressions (Davidson and McKinnon 1993, 644-645).

Sexton 2011). In fact, the large number of responses concerning friends' and neighbors' behavior (see Table A in Appendix III) suggests that people have an idea about the relevant behaviors of their friends and neighbors.

A second 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. However, 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.

A final 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 three to ten points and are the best ones available in view of data limitations.[23] In addition, we will carry out robustness checks by using an estimator for discrete data.

4. Empirical Results

4.1 Results for the Basic Model

Table 1 presents the main estimation results for model (15). More detailed results are shown in Table B in Appendix III. Considering the case of *Food*, the most important result is that *FoodRef* has a highly significant positive coefficient. The coefficient size of 0.521 indicates that an increase of reference persons' intensity of organic food consumption by one unit (on the scale 0, 1, 2, 3) is associated with an increase in respondents' organic food intensity by about one half units. In addition, *Environmentalism* has the expected positive coefficient and *Materialism* has the expected negative coefficient, both of which are highly significant and of a sizeable magnitude. Regarding the *Controls, Food* is positively and significantly related to age and negatively and significantly related to age-squared (the turning point occurring in people's late 40s) and positively related to income (see Table B in Appendix III).[24]

Reference persons' intensity of organic food consumption, *FoodRef*, is positively and highly significantly related to the respondents' degree of *Environmentalism* and negatively

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

[24] In the text we mention those controls that are significant at least at p = 10 percent.

and significantly related to their degree of *Materialism*. Regarding other respondent characteristics, *FoodRef* is positively and significantly related to respondents' level of education, to being female, and to being out of the labor force. Assuming that the latter refers to persons active in the household, this result suggests that the propensity of choosing organic food consumers as reference persons is large particularly for highly educated housewives, which appears quite intuitive.

With respect to *Energy*, we find it positively and significantly related to *EnergyRef* with coefficient size 0.121. *Environmentalism* has the expected positive coefficient and *Materialism* has the expected negative coefficient, both of which are highly significant and of a sizeable magnitude. *Energy* is positively and significantly related to being a home owner and negatively and significantly related to being female. Reference persons' renewable energy consumption, *EnergyRef*, is positively and highly significantly related to the respondents' degree of *Environmentalism* and negatively but insignificantly related to their degree of *Materialism*. In addition, *EnergyRef* is positively related to respondents' income, that is, the propensity that reference persons are renewable energy consumers is high for wealthy people. Considering that their friends are likely to be wealthy too, this makes sense as installing a solar system at home requires a costly investment.

With respect to overall *Conservation*, we find it positively and significantly related to *ConservationRef* with coefficient size 0.201. *Environmentalism* has a positive coefficient and *Materialism* has a negative coefficient, both of which are highly significant and of a sizeable magnitude. In addition, *Conservation* is positively and significantly related to income and to being a home owner. Reference persons' overall greenness, *ConservationRef*, is positively and highly significantly related to the respondents' degree of *Environmentalism* and negatively but insignificantly related to their degree of *Materialism*, and it is positively related to income and the education level.

The result that respondents' intensity of pro-environmental consumption is positively related to their friends' and neighbors' environmental friendliness is consistent with the first statement of PROPOSITION 2. The result that reference persons' pro-environmental behavior is positively related to respondents' degree of *Environmentalism* and negatively (though insignificantly in the cases of *Energy* and *Conservation*) related to their degree of *Materialism* is consistent with PROPOSITION 3.

4.2 Results for the Extended Model

As mentioned above, we estimated an extended version of our empirical model in which the relationship between own pro-environmental consumption and the corresponding behavior of reference persons is allowed to vary with the ratio *Environmentalism*/*Materialism*.

Table 2 presents the main estimation results for this model. Since the qualitative results for the *Controls* are the same as in the basic model, we do not present the detailed estimation results.

Similar as in the basic model, there is a positive and significant coefficient on *Environmentalism* in both the *Food* and *FoodRef* equation and a negative and significant coefficient on *Materialism* in both equations. The coefficient on (*Environmentalism*/ *Materialism*)**FoodRef* in the *Food* equation is positive and significant at p = 6.1 percent.

Similar qualitative results hold with respect to renewable energy, except that *Materialism* is insignificant in the *EnergyRef* equation (as in the basic model). The coefficient on (*Environmentalism/Materialism*)**EnergyRef* in the *Energy* equation is positive and significant at p = 6.8 percent. With respect to the *Conservation* and *ConservationRef* equations, we obtain significant positive coefficients on *Environmentalism* and negative coefficients on *Materialism* in both equations, the coefficient in the *ConservationRef* equaton being insignificant. The variable (*Environmentalism/Materialism*)**ConservationRef* in the *Conservation* equation is positive and significant at p = 6.8 percent.

Overall, the extended model confirms that *Environmentalism* affects respondents' pro-environmental consumption positively whereas *Materialism* has the opposite effect. In addition, the strength of the response of own green consumption to the greenness of reference persons increases in *Environmentalism/Materialism*. Finally, the greenness of respondents' reference persons is positively related to respondents' degree of *Environmentalism* and negatively related to their degree of *Materialism*. All of this is in line with the conceptual model of green competitive altruism and reference group selection from subsection 2.3 (PROPOSITIONS 2 and 3).

4.3 Some Robustness Checks

We conducted a number of robustness checks with respect to the estimation method for both the basic and the extended model. These checks refer to the cross-equation correlation of errors, and the cardinality and the weighting of our data. In addition, we considered an alternative aggregate indicator of pro-environmental consumption.

Table C in Appendix III presents the main estimation results from ordinary least squares for both the basic and the extended model. With respect to the basic model, all of the

results of the SUR estimation concerning the sign and significance of the main variables of interest are preserved. This statement also holds for the controls. In the equations for *Food* and *Energy*, the size of the coefficients is practically identical to the SUR estimates, as is the R^2. In the *Conservation* equation, the coefficients are slightly different, and the R^2 is higher (0.309 instead of 0.182). The rather small differences between the OLS and the SUR results reflect the circumstance that the correlation of errors across the respective *Pec* and *PecRef* equations is very small ($r < 0.05$).

With respect to the extended model, we also find the major qualitative results from SUR preserved, but the coefficient sizes are now different. Interestingly, the coefficients on (*Environmentalism*/*Materialism*)**PecRef* are now highly significant (not just weakly significant as in the case of SUR). Also, the R^2 is now higher in the cases of *Food* and *Conservation*. However, there is now a non-negligeable cross-equation correlation of errors in these two cases (*Food*: $r = 0.31$; *Conservation*: $r = 0.12$), which suggests that SUR is a more appropriate method for the extended model.

Table D shows the results from applying an ordered probit rather than a linear estimator to the *Food* and *Energy* equations. This check is motivated by the circumstance that the dependent variables in these equations are derived from ordinal or binary variables, taking values 0, 1, 2, 3 in both cases. We apply the ordered probit to the basic model, not to the extended model because the comparison of SUR and OLS results suggests that in the extended model the *Pec* and *PecRef* equations should be estimated jointly. As can be seen, all of the results concerning the signs and significance of the coefficients are confirmed.

Table E presents the analogs to the previous results using weighted least squares. This exercise is intended to check whether our findings with respect to our specific sample (in which subscribers to green electricity and owners of solar heating panels are over-represented) may apply to a representative German sample as well. We use weights that capture the share of green electricity subscribers and owners of solar heating panels in the German population.[25] We apply weighted least squares to the basic model only because, as noted above, the *Pec* and *PecRef* equations should be estimated jointly in the extended model. As seen, practically all of the previous results concerning the sign and significance of our variables of interest are preserved.[26] Our results, therefore do not just apply to our particular sample, but may be valid for the German population in general.

[25] For the weights see footnote 18.

[26] The main difference is that the variable *Materialism* in the *FoodRef* equation, which is weakly significant in the preceding estimations, loses its significance.

As a final robustness check, we re-estimated both the basic and the extended model with an alternative dependent variable of aggregate pro-environmental consumption. Specifically, we used a version of *Conservation* and *ConservationRef* in which *Food* and *Energy* (= *Heat* + *Electricity*) have the same weight, rather than attributing equal weights to the three elements *Food, Heat* and *Electricity* (see subsection 3.1 for the definition of indicators). The SUR estimation results are shown in Table F in Appendix III. In the alternative *Conservatio*n equation of the basic model, all explanatory variables of interest have highly significant coefficients of the expected signs. In the corresponding *ConservationRef* equation *Environmentalism* is highly significantly positive and *Materialism* weakly significantly negative (whereas the latter variable was insignificant under the original definition of the dependent variable). In the extended model, all of the qualitative results under the original definition of the dependent variable are also preserved. In addition, all of these qualitative findings are confirmed when using the alternative estimation methods mentioned above (results not shown).

4.4 Discussion

Our empirical results provide strong evidence that people's intensity of pro-environmental consumption is increasing in the corresponding behavior of their friends and neighbors. In addition, the strength of this relationship increases in people's "generic" green preference (*Environmentalism*) and decreases in the importance they attach to the quantitative aspect of consumption (*Materialism*). These findings are consistent with predictions of our conceptual model of competitive altruism (PROPOSITION 2).

In addition, our results suggest that the "greenness" of respondents' friends and neighbors is systematically and significantly related to respondents' attitudes towards the environment and towards consumption. Specifically, we found that the greenness of reference persons increases in respondents' "generic" green preference (*Environmentalism*) and decreases in their preference for the quantity consumed (*Materialism*). These results are consistent with our conceptual model of reference group selection (PROPOSITION 3)

In addition to environment-related and consumption-related attitudes, our results suggest that people's objective attributes also have an influence on the greenness of their reference group and that the relevant attributes are different for different types of pro-environmental consumption. In particular, the propensity that reference persons are intensive buyers of organic food is higher for well-educated women that are not in the labor force than for other persons, whereas the propensity that reference persons are renewable energy

consumers is higher for wealthier people than for less wealthy people. Interestingly, these attributes (being female, educated, not in the labor force and, respectively, being wealthy) do not affect people's pro-environmental behavior directly, but only indirectly through the chosen reference persons' behavior, to which people respond. This strongly suggests that those attributes are in fact drivers of reference group selection.

5. Conclusions

In this paper we have investigated the idea of social comparison being a driver of pro-social behavior (in addition to pure and impure altruism) and of people choosing endogenously the standard to which to compare. Using a unique set of survey data which contains information on several types of respondents' pro-environmental consumption and the corresponding consumption behavior of their friends and neighbors, we found that friends' and neighbors' intensity of pro-environmental consumption (greenness) is systematically and significantly related to certain characteristics (age, sex, education level, income) and attitudes (environmentalism, materialism) of the respondents. We take this as evidence of an endogenous choice of reference group greenness and hence of the green reference standard. In addition, if reference persons behave greener, people respond by behaving greener themselves, and the strength of the response increases in people's degree of environmentalism and decreases in their degree of materialism. We take this as evidence of social comparison being a driver of pro-environmental behavior or, in other words, as evidence of green competitive altruism.

An implication of green competitive altruism is that own and reference persons' pro-environmental consumption mutually reinforce each other. Whereas social comparison with respect to affluence (conspicuous consumption) is likely to create externalities to the disadvantage of the environment, social comparison with respect to environmental friendliness (conspicuous conservation) works in the opposite direction. It may thus act as a complement to environmental regulation.

In view of data availability, our empirical analysis has referred specifically to environmental goods. It may be noted, however, that the conceptual framework of competitive altruism and endogenous reference group selection can be applied to other domains of private public good provision (charitable giving, volunteering) in which pro-social behavior allows people to define and demonstrate identity and status.

References

Akerlof, G.A., Kranton; R.E. (2010), *Identity Economics: How Our Identities Shape Our Work, Wages, and Well-being*, Princeton University Press

Andreoni; J. (1989), Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence; *Journal of Political Economy* 97, 1447–1458.

Andreoni, J. (1990), Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving, *Economic Journal* 100, 464-477.

Becker, G.S. (1974), A Theory of Social Interactions, *Journal of Political Economy* 82, 1063–1093.

Benabou, R., Tirole, J. (2006), Incentives and Pro-social Behavior, *American Economic Review* 96, 1652–1678.

Brekke, K.A., Howarth, R.B., Nyborg, K. (2003), Status-Seeking and Material Affluence: Evaluating the Hirsch Hypothesis, *Ecological Economics* 45, 29-39.

Bulow, J.I., Geanakoplos, J.D., Klemperer, P.D. (1985), Multimarket Oligopoly: Strategic Substitutes and Complements, *Journal of Political Economy* 93, 488-511.

Clark, A.E. (2012), Happiness, Habits and High Rank: Comparisons in Economic and Social Life, in: S. Bartonini (ed.), *Policies for Happiness*, Oxford: Oxford University Press.

Clark, A.E., Frijters, P., Shields, M.A. (2008), Relative Income, Happiness and Utility: An Explanation for the Easterlin Paradox and Other Puzzles, *Journal of Economic Literature* 46, 95-144.

Clausen, J. (2008), Feldvermessungsstudie Energie, Borderstep Institute, Hanover, Germany.

Davidson, R., McKinnon, J.G. (1993), *Estimation and Inference in Econometrics*, New York, Oxford: Oxford University Press.

Duesenberry; J. (1949), *Income, Saving, and the Theory of Consumer Behavior*, Cambridge and London: Harvard University Press.

Falk, A., Knell, M (2004), Choosing the Joneses: Endogenous Goals and Reference Standards, *Scandinavian Journal of Economics* 106, 417-435.

Frank, R.H..(1985), The Demand for Unobservable and Other Non-positional Goods, *American Economic Review* 75, 101–116.

Glazer, A., Konrad, K.A. (1996). A Signaling Explanation for Charity, *American Economic Review* 86, 1019–1028.

Griskevicius, V., Tybur, J.M., Van den Bergh, B. (2010), Going Green to Be Seen: Status, Reputation, and Conspicuous Conservation, *Journal of Personality and Social Psychology* 98, 392–404.

Harbaugh, W.T. (1998), What Do Donations Buy? A Model of Philanthropy based on Prestige and Warm Glow, *Journal of Public Economics* 67, 269-284.

Hardy, C.L., Van Vugt, M. (2006), Nice Guys Finish First: The Competitive Altruism Hypothesis, *Personality and Social Psychology Bulletin* 32, 1402, 2006.

Sexton, S.E., Sexton, A.L., (2011), Conspicuous Conservation: The Prius Effect and Willingness to Pay for Environmental Bona Fides, mimeo.

Van Vugt, M., Roberts, G., Hardy, C. (2007), Competitive Altruism: Development of Reputation-based Cooperation in Groups, *Handbook of Evolutionary Psychology*, 531–540.

Veblen, T. (1899), *The Theory of the Leisure Class*, London: Mcmillan and Unwin.

Wood, J.V., Taylor, K.L. (1991), Serving Self-Relevant Goals through Social Comparison, in: Suls, J. and Wills, T.A. (eds.), *Social Comparison: Contemporary Theory and Research*, New Jersey: Lawrence Erlbaum Associates Publishers, 23-49.

Table 1: Main Estimation Results for Basic Model

	Food		Energy		Conservation	
	Pec	PecRef	Pec	PecRef	Pec	PecRef
Environmentalism	0.169*** (0.040)	0.197*** (0.039)	0.130*** (0.037)	0.158*** (0.050)	0.202 *** (0.046)	0.233*** (0.055)
Materialism	-0.102*** (0.029)	-0.056** (0.029)	-0.097*** (0.027)	-0.039 (0.037)	-0.125 *** (0.033)	-0.061 (0.041)
PecRef	0.521*** (0.050)		0.121*** (0.04)		0.201 *** (0.044)	
Significant Controls	Age, Age^2, Income	Female, education level, not in labor force	Home owner, Male	Income	Income, Home owner	Income, Education level
N	391	391	347	347	337	337
R2	0.362	0.152	0.291	0.092	0.182	0.116

Method: Seemingly unrelated regressions. Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level. “Significant controls” are those significant at least at the 10 percent level.

Table 2: Main Estimation Results for Extended Model

	Food		Energy		Conservation	
	Pec	PecRef	Pec	PecRef	Pec	PecRef
Environmentalism	0.236*** (0.046)	0.197*** (0.040	0.126*** (0.038)	0.158*** (0.050	0.215*** (0.049)	0.233*** (0.055)
Materialism	-0.087** (0.039)	-0.056** (0.029)	-0.077** (0.031)	-0.039 (0.037)	-0.097** (0.040)	-0.061 (0.041)
(Env/Materialism* PecRef	0.043* (0.023)		0.036* (0.020)		0.039* (0.021)	
Significant Controls	Age, Age^2, Income	Female, education level, not in labor force	Home owner, male	Income	Income, Home owner	Income, Education level
N	391	391	347	347	337	337
R2	0.220	0.152	0.284	0.092	0.158	0.116

Method: Seemingly unrelated regressions. Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level. “Significant controls” are those significant at least at the 10 percent level.

Appendix I: Choice of Reference Group Greenness

We show how the choice of reference group greenness described in the main text can be conceptualized as attributing optimal proximity weights to people with different degrees of greenness.

Let the decision maker be indexed by *i* and let the greenness of people different from *i* be denoted by $q_j, j \neq i$. Then, individual *i*'s reference group greenness, which will enter her second-stage problem, is defined as $\bar{q}_i := \sum_{j \neq i} w_j q_j$, where w_j with $\sum_{j \neq i} w_j = 1$ denotes non-negative subjective weights which the individual applies. The individual's aim at the first stage is the optimal choice of those weights. Other people's greenness *observed at the first stage* is denoted by $\hat{q}_j$, and we assume $q_j = \hat{q}_j + \Delta_j$ with Δ_j denoting exogenous changes occurring after the weights have been selected, and ex ante expectations being $E(\Delta_j) = 0$. Hence we have $\bar{q}_i = \sum_{j \neq i} w_j (\hat{q}_j + \Delta_j) = \sum_{j \neq i} w_j \hat{q}_j + \sum_{j \neq i} w_j \Delta_j =: s_i + z_i$ with $E(z_i) = 0$, which implies $E(\bar{q}_i) = s_i$.

The optimization problem stated in eq. (8), $\max_s \hat{V}(s, y, \theta)$, can now be restated as $\max_{w_j} \hat{V}(\sum_{j \neq i} w_j \hat{q}_j, y, \theta) + \lambda(1 - \sum_{j \neq i} w_j)$. This problem yields first-order conditions $\hat{V}_s(\sum_{j \neq i} w_j \hat{q}_j, y, \theta) \cdot \hat{q}_j - \lambda = 0 \; \forall j$, which imply $\hat{V}_s(.) \cdot (\hat{q}_k - \hat{q}_l) = 0$ for any pair of *k*, *l*. With $\hat{q}_k \neq \hat{q}_l$ for at least one such pair, this implies condition (9), $\hat{V}_s(s, y, \theta) = 0$, in the main text.

This more detailed derivation illustrates how reference group greenness is composed of an endogenous part (reflecting the chosen weights conditional on ex ante observations of other people's greenness) and an exogenous part (reflecting shocks to other people's greenness after weights have been chosen). It justifies the notion of optimal response of own consumption to changes in the exogenous component of reference group greenness.

Appendix II: Survey Instrument (Selected Items)

Organic food:

- "Do you buy food that is labeled as organic food?" (never; occasionally; regularly; always).
- "Do many of your friends and neighbors buy food that is labeled as organic food?" (never; occasionally; regularly; always).

Solar thermal energy systems:

- "Is your house equipped with a solar thermal energy system?" (yes; no)
- "Do some of your friends and neighbors 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 and neighbors currently subscribed to green electricity? (yes; no)"

Environmental attitude:

- "Environmentalists often exaggerate environmental problems." (agree completely; agree; disagree; disagree completely)

Consumption attitude:

- "Please indicate your position on the following scale:
  Enjoy consumption a lot _ _ _ _ _ Do not enjoy consumption at all."

Appendix III: Additional Tables

Table A: Summary statistics

	n	Minimum	Maximum	Mean	Std.-Dev.
Food	493	.00	3.00	1.6308	.75817
FoodRef	463	.00	3.00	1.4363	.65774
Energy	486	.00	2.00	.7099	.6519
EnergyRef	415	.00	2.00	1.0265	.7720
Conservation	485	.00	3.00	1.2570	.7852
ConservationRef	394	.00	3.00	1.5119	.8447
Environmentalism	493	1.00	4.00	3.2657	.85325
Materialism	477	1.00	5.00	2.7065	1.09708
Income bracket	429	.00	10.00	6.1608	3.16593
Home ownership	493	.00	1.00	.6369	.48138
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
Cohabutating	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
Not in labor force	492	.00	1.00	.1870	.39030
Employed/self employed	492	.00	1.00	.6606	.47400

Table B: Detailed Results for Basic Model

	Food		**Energy**		**Conservation**	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Environmentalism	0.1690***	0.0402	0.1300***	0.0367	0.2028***	0.0458
Materialism	-0.1025***	0.0286	-0.0970***	0.0272	-0.1244***	0.0334
PecRef	0.5206***	0.0504	0.1210***	0.0388	0.2056***	0.0439
Income bracket	0.0369***	0.0140	0.0205	0.0137	0.0317*	0.0166
Home ownership	0.0181	0.0850	0.2371***	0.0796	0.2234**	0.0983
Female	0.0149	0.0702	-0.1201*	0.0658	-0.0978	0.0816
Age	0.0420**	0.0175	0.0096	0.0176	0.0227	0.0215
Age-squared	-0.0003**	0.0002	-7.24E-05	0.0002	-0.0001	0.0001
Married	-0.0546	0.1098	-0.0028	0.1075	-0.0161	0.1313
Cohabitating	0.2169	0.1157	-0.2146	0.1111	-0.1845	0.1360
Divorced	0.0417	0.1758	-0.0597	0.1630	-0.0507	0.1979
Separated	0.1058	0.2577	0.1874	0.2138	0.2466	0.2784
Widowed	-0.1444	0.1817	-0.0523	0.1924	0.0335	0.2334
Household size	-0.0161	0.0308	-0.0003	0.0291	0.0018	0.0362
Education level	0.0100	0.0227	0.0224	0.0207	0.0120	0.0264
Not in labor force	0.0078	0.1653	0.1039	0.1535	0.1301	0.1896
Empl'd/self empl'd	-0.1721	0.1109	0.1644	0.1104	0.1096	0.1340
	FoodRef		**EnergyRef**		**ConservationRef**	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Environmentalism	0.1972***	0.0391	0.1582***	0.0496	0.2329***	0.0551
Materialism	-0.0563**	0.0286	-0.0387	0.0374	-0.0613	0.0411
Income bracket	-0.0093	0.0142	0.0544**	0.0183	0.0503**	0.0203
Home ownership	-0.0641	0.0851	0.1154	0.1106	0.0873	0.1226
Female	0.1201*	0.0702	-0.0278	0.0914	-0.0027	0.1015
Age	-0.0200	0.0177	0.0182	0.0239	0.0080	0.0265
Age-squared	0.0000	0.0002	-0.0003	0.0003	-0.0002	0.0003
Married	0.0399	0.1100	-0.1417	0.1478	-0.0965	0.1619
Cohabitating	-0.1845	0.1159	0.0393	0.1516	0.0147	0.1662
Divorced	0.0571	0.1764	-0.2800	0.2264	-0.2492	0.2466
Separated	0.1965	0.2583	-0.1019	0.2979	-0.0201	0.3479
Widowed	-0.1465	0.1824	-0.1983	0.2676	-0.2731	0.2912
Household size	-0.0149	0.0309	-0.0354	0.0403	-0.0602	0.0448
Education level	0.0684***	0.0223	0.0317	0.0286	0.0569*	0.0325
Not in labor force	0.4335***	0.1646	0.1967	0.2112	0.3776	0.2333
Empld/self empl'd	0.1511	0.1112	-0.0593	0.1519	0.0102	0.1655

Method: Seemingly unrelated regressions. Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level. The omitted base categories are male, single, unemployed.

Table C: Main Estimation Results Using Ordinary Least Squares

Basic Model	Food		Energy		Conservation	
	Pec	PecRef	Pec	PecRef	Pec	PecRef
Environmentalism	0.169*** (0.042)	0.197*** (0.040)	0.130*** (0.055)	0.158*** (0.049)	0.203*** (0.044)	0.233*** (0.057)
Materialism	-0.102*** (0.032)	-0.056* (0.031)	-0.097*** (0.036)	-0.039 (0.038)	-0.125*** (0.034)	-0.061 (0.042)
PecRef	0.521*** (0.057)		0.121*** (0.037)		0.206*** (0.043)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	391	391	347	347	337	337
R2	0.362	0.152	0.291	0.092	0.309	0.117

Extended Model	Food		Energy		Conservation	
	Pec	PecRef	Pec	PecRef	Pec	PecRef
Environmentalism	0.160*** (0.052)	0.197*** (0.040)	0.116*** (0.037)	0.158*** (0.049)	0.185*** (0.049)	0.233*** (0.057)
Materialism	0.009 (0.047)	-0.056* (0.031)	-0.066** (0.028)	-0.039 (0.038)	-0.062 (0.041)	-0.061 (0.042)
(Env/Materialism)* PecRef	0.135*** (0.027)		0.052*** (0.020)		0.072*** (0.023)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	391	391	347	347	337	337
R2	0.249	0.152	0.285	0.092	0.288	0.117

Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level.

Table D: Main Estimation Results Using Ordered Probit

Basic Model	Food		Energy	
	Pec	PecRef	Pec	PecRef
Environmentalism	0.322*** (0.080)	0.378*** (0.076)	0.305*** (0.086)	0.242*** (0.075)
Materialism	-0.193*** (0.062)	-0.109* (0.057)	-0.232*** (0.063)	-0.061 (0.057)
PecRef	1.006*** (0.117)		0.300*** (0.085)	
Controls	Yes	Yes	Yes	Yes
N	391	391	347	347
Pseudo R2	0.200	0.083	0.190	0.044

Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level.

Table E: Main Estimation Results Using Weighted Least Squares

Basic Model	Food		Energy		Conservation	
	Pec	PecRef	Pec	PecRef	Pec	PecRef
Environmentalism	0.107* 0.057)	0.227*** (0.060)	0.024*** (0.007)	0.160*** (0.073)	0.070*** (0.025)	0.242** (0.084)
Materialism	-0.125*** (0.048)	-0.010 (0.047)	-0.019*** (0.006)	-0.015 (0.052)	-0.052** (0.022)	0.004 (0.060)
PecRef	0.554*** (0.074)		0.027** (0.011)		0.121*** (0.026)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	391	391	347	347	337	337
R2	0.422	0.277	0.085	0.245	0.235	0.223

Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level.

Table F: Estimation Results for Alternative Indicator of Conservation

	Basic Model		Extended Model	
	Pec	PecRef	Pec	PecRef
Environmentalism	0.254*** (0.056)	0.301*** (0.062)	0.294*** (0.062)	0.301*** (0.062)
Materialism	-0.153*** (0.041)	-0.078* (0.046)	-0.119*** (0.052)	-0.078* (0.046)
PecRef	0.293*** (0.048)			
(Env/Materialism)* PecRef			0.041* (0.002)	
Significant Controls	Income, Home owner	Income, Education level, Not in labor force	Income, Home Owner	Income, Education level, Not in labor force
N	337	337	337	337
R2	0.322	0.133	0.269	0.133

Estimation method: SUR. Robust standard errors in parentheses. *** (**, *) denote significance at the 1 percent (5 percent, 10 percent) level. “Significant controls” are those significant at least at the 10 percent level. The alternative conservation indicator is defined as 2/3 *Food* + *Heat* + *Electricity* (range: [0, 4]).

Zuletzt erschienen /previous publications:

V-297-07 **Christoph Böhringer and Carsten Helm**, On the Fair Division of Greenhouse Gas Abatement Cost

V-298-07 **Christoph Böhringer**, Efficiency Losses from Overlapping, Regulation of EU Carbon Emissions

V-299-07 **Udo Ebert**, Living standard, social welfare and the redistribution of income in a heterogeneous population

V-300-07 **Udo Ebert**, Recursively aggregable inequality measures: Extensions of Gini's mean difference and the Gini coefficient

V-301-07 **Udo Ebert**, Does the definition of nonessentiality matter? A clarification

V-302-07 **Udo Ebert**, Dominance criteria for welfare comparisons: Using equivalent income to describe differences in needs

V-303-08 **Heinz Welsch, Jan Kühling**, Pro-Environmental Behavior and Rational Consumer Choice: Evidence from Surveys of Life Satisfaction

V-304-08 **Christoph Böhringer and Knut Einar Rosendahl**, Strategic Partitioning of Emissions Allowances Under the EU Emission Trading Scheme

V-305-08 **Niels Anger, Christoph Böhringer and Ulrich Oberndorfer**, Public Interest vs. Interest Groups: Allowance Allocation in the EU Emissions Trading Scheme

V-306-08 **Niels Anger, Christoph Böhringer and Andreas Lange**, The Political Economy of Environmental Tax Differentiation: Theory and Empirical Evidence

V-307-08 **Jan Kühling and Tobias Menz**, Population Aging and Air Pollution: The Case of Sulfur Dioxide

V-308-08 **Tobias Menz, Heinz Welsch**, Population Aging and Environmental Preferences in OECD: The Case of Air Pollution

V-309-08 **Tobias Menz, Heinz Welsch**, Life Cycle and Cohort Effects in the Valuation of Air Pollution: Evidence from Subjective Well-Being Data

V-310-08 **Udo Ebert**, The relationship between individual and household welfare measures of WTP and WTA

V-311-08 **Udo Ebert**, Weakly decomposable inequality measures

V-312-08 **Udo Ebert**, Taking empirical studies seriously: The principle of concentration and the measurement of welfare and inequality

V-313-09 **Heinz Welsch**, Implications of Happiness Research for Environmental Economics

V-314-09 **Heinz Welsch, Jan Kühling**, Determinants of Pro-Environmental Consumption: The Role of Reference Groups and Routine Behavior

V-315-09 **Christoph Böhringer and Knut Einar Rosendahl**, Green Serves the Dirtiest: On the Interaction between Black and Green Quotas

V-316-09 **Christoph Böhringer, Andreas Lange, and Thomas P. Rutherford**, Beggar-thy-neighbour versus global environmental concerns: an investigation of alternative motives for environmental tax differentiation

V-317-09 **Udo Ebert,** Household willingness to pay and income pooling: A comment

V-318-09 **Udo Ebert,** Equity-regarding poverty measures: differences in needs and the role of equivalence scales

V-319-09 **Udo Ebert and Heinz Welsch**, Optimal response functions in global pollution problems can be upward-sloping: Accounting for adaptation

V-320-10 **Edwin van der Werf,** Unilateral climate policy, asymmetric backstop adoption, and carbon leakage in a two-region Hotelling model

V-321-10 **Jürgen Bitzer, Ingo Geishecker, and Philipp J.H. Schröder,** Returns to Open Source Software Engagement: An Empirical Test of the Signaling Hypothesis

V-322-10 **Heinz Welsch, Jan Kühling**, Is Pro-Environmental Consumption Utility-Maximizing? Evidence from Subjective Well-Being Data

V-323-10 **Heinz Welsch und Jan Kühling**, Nutzenmaxima, Routinen und Referenzpersonen beim nachhaltigen Konsum

V-324-10 **Udo Ebert**, Inequality reducing taxation reconsidered

V-325-10 **Udo Ebert**, The decomposition of inequality reconsidered: Weakly decomposable measures

V-326-10 **Christoph Böhringer and Knut Einar Rosendahl**, Greening Electricity More Than Necessary: On the Excess Cost of Overlapping Regulation in EU Climate Policy

V-327-10 **Udo Ebert and Patrick Moyes**, Talents, Preferences and Inequality of Well-Being

V-328-10 **Klaus Eisenack**, The inefficiency of private adaptation to pollution in the presence of endogeneous market structure

V-329-10 **Heinz Welsch**, Stabilität, Wachstum und Well-Being: Wer sind die Champions der Makroökonomie?

V-330-11 **Heinz Welsch and Jan Kühling**, How Has the Crisis of 2008-2009 Affected Subjective Well-Being?

V-331-11 **Udo Ebert**, The redistribution of income when needs differ

V-332-11 **Udo Ebert and Heinz Welsch**, Adaptation and Mitigation in Global Pollution Problems: Economic Impacts of Productivity, Sensitivity, and Adaptive Capacity

V-333-11 **Udo Ebert and Patrick Moyes**, Inequality of Well-Being and Isoelastic Equivalence Scales

V-334-11 **Klaus Eisenack**, Adaptation financing as part of a global climate agreement: is the adaptation levy appropriate?

V-335-11 **Christoph Böhringer and Andreas Keller**, Energy Security: An Impact Assessment of the EU Climate and Energy Package

V-336-11 **Carsten Helm and Franz Wirl**, International Environmental Agreements: Incentive Contracts with Multilateral Externalities

V-337-11 **Christoph Böhringer, Bouwe Dijkstra, and Knut Einar Rosendahl**, Sectoral and Regional Expansion of Emissions Trading

V-338-11 **Christoph Böhringer and Victoria Alexeeva-Talebi**, Unilateral climate policy and competitiveness: The implications of differential emission pricing

V-339-11 **Christoph Böhringer, Carolyn Fischer, and Knut Einar Rosendahl**, Cost-Effective Unilateral Climate Policy Design: Size Matters

V-340-11 **Christoph Böhringer, Jared C. Carbone, Thomas F. Rutherford**, Embodied Carbon Tariffs

V-341-11 **Carsten Helm and Stefan Pichler**, Climate Policy with Technology Transfers and Permit Trading

V-342-11 **Heinz Welsch and Jan Kühling**, Comparative Economic Performance and Institutional Change in OECD Countries: Evidence from Subjective Well-Being Data

V-343-11 **Heinz Welsch and Jan Kühling**, Anti-Inflation Policy Benefits the Poor: Evidence from Subjective Well-Being Data

V-344-12 **Klaus Eisenack und Leonhard Kähler**, Unilateral emission reductions can lead to Pareto improvements when adaptation to damages is possible

V-345-12 **Christoph Böhringer, Brita Bye, Taran Fæhn, Knut Einar Rosendahl** Alternative Designs for Tariffs on Embodied Carbon: A Global Cost-Effectiveness Analysis

V-346-12 **Christoph Böhringer, Jared C. Carbone, Thomas F. Rutherford**, Efficiency and Equity Implications of Alternative Instruments to Reduce Carbon Leakage

V-347-12 **Christoph Böhringer, Andreas Lange, Thomas F. Rutherford,** Optimal Emission Pricing in the Presence of International Spillovers: Decomposing Leakage and Terms-of-Trade Motives

V-348-12 **Carsten Helm, Dominique Demougin,** Incentive Contracts and Efficient Unemployment Benefits in a Globalized World

V-349-12 **Heinz Welsch,** Organic Food and Human Health: Instrumental Variables Evidence

V-350-12 **Heinz Welsch, Jan Kühling**, Competitive Altruism and Endogenous Reference Group Selection in Private Provision of Environmental Public Goods