IDENTIFYING INDIVIDUALS' PREFERENCES USING GAMES: A FIELD EXPERIMENT IN PROMOTING SUSTAINABLE ENERGY CONSUMPTION

Research-in-Progress

Michael C. Baeriswyl
ETH Zurich, D-MTEC
Scheuchzerstrasse 7, 8092 Zurich
mbaeriswyl@ethz.ch

Wojtek Przepiorka
ETH Zurich, D-GESS
Clausiusstrasse 50, 8092 Zurich
wojtek.przepiorka@soz.gess.ethz.ch

Thorsten R. Staake
ETH Zurich, D-MTEC
Scheuchzerstrasse 7, 8092 Zurich
tstaake@ethz.ch

Abstract

We present a novel approach to identify individuals' preferences in the context of sustainable energy consumption by letting them play a public good game (PGG). The study will be conducted using an energy-efficiency website developed by us and operated by an Austrian utility company that currently facilitates 9,929 users out of which 1,000 will be randomly selected as participants. Laboratory experiments on PGGs identified two types of cooperative behavior: free riders and conditional cooperators. While free riders tend to act unaffected by the behavior of others, conditional cooperators are stronger influenced by the perception of their peers. In our study, participants receive normative feedback on their consumption, and we investigate the moderating effects of the PGG's results on changes in energy consumption. The findings will contribute to the design of information systems to promote environmental sustainability because their effectiveness is increased if the consumption feedback provided reflects the recipient's preference.

Keywords: Environmental sustainability, game theory, green IS, empirical research

Introduction

Information systems have the potential to promote environmentally sustainable behaviors such as energy conservation (Melville 2010; Watson 2010). Residential energy consumption is continuously increasing. Today, households consume about one-third of the total energy generated in the U.S., where electricity generation is one of the leading sources of carbon dioxide emissions (U.S. Environmental Protection Administration, 2009). Energy conservation increases environmentally sustainability by reducing carbon dioxide emissions. The present study is concerned with the design and evaluation of a customer-oriented website called "Velix" that provides users with feedback about their energy consumption and supports them by providing energy-saving tips. The overall goal of Velix is to advance the research on promoting environmentally sustainability using information systems. We developed Velix in cooperation with an Austrian utility company. The customers of the utility company are given bonus points that encourage them to read their electricity meters on a weekly basis and enter their readings online. Since April 1st 2010, 9,929 customers have joined Velix, and those customers entered more than 217,299 meter readings. Recent studies (Abrahamse et al. 2005; Allcott 2010; Costa & Kahn 2010) have indicated that the effectiveness of consumption-related feedback depends on people's preferences. For instance, although individuals with pro-environmental preferences are more responsive to peer comparison, the latter leads to unintended consequences (e.g., increased consumption) for individuals with conservative preferences (Costa & Kahn 2010). Thus, if the same feedback is effective for environmentalists but is ineffective with conservative individuals, it is necessary to identify these individuals and provide them with targeted feedback to address all individuals in a heterogeneous population.

This planned study presents a novel approach to identifying individuals' preferences by letting them play a public good game on Velix. The public good game is a well-known game in experimental economics. Laboratory experiments on public good games have identified two types of cooperative behavior: free riding and conditional cooperating (Fischbacher et al. 2001; Gächter 2006). Whereas free riders act unaffected by the behavior of others, conditional cooperators are influenced by their perceptions regarding the behavior of others. Our study includes 1000 customers to be studied during a period of eight weeks. The customers will play the public good game and receive normative feedback that detailed average neighborhood energy consumption. We will then measure customer changes in energy consumption. Like recommendation agents that elicit the interests or preferences of individual consumers regarding products and make recommendations accordingly (Komiak and Benbasat 2006; Xiao and Benbasat 2007; Kamis et al. 2008), our approach has the potential to individually support and improve the quality of the decisions that consumers make when consuming energy at home. On the basis of the relevant literature, we expect conditional cooperators to adapt their energy consumption so that it conforms significantly more with average consumption than does that of free riders. Our study is interesting from an information systems, behavioral economics and socio-psychological perspective. Our findings will contribute to information systems research regarding environmental sustainability by investigating individual preferences and the promotion of human behavior.

The next section reviews the findings of previous studies regarding the promotion of sustainable behavior in information systems research, public good games and conditional cooperation in economics. It also reviews relevant information regarding normative feedback in social psychology. The third section states our hypothesis. Section four describes our empirical study. Section five presents our conclusions.

Related work

Research on promoting sustainable behavior in information systems

IT enables large-scale customer engagement, providing added value while positively influencing consumption behavior (Oinas-Kukkonen & Harjumaa 2008). Researchers have started to explore the positive influence of IT on sustainability under the umbrella term "Green IS" (Watson et al. 2008). IT has the potential to promote sustainability within all areas of an organization (Watson et al. 2010). Literature reviews on Green IS have been presented by Molla (2009), Ijab et al. (2010), Bengtsson & Ågerfalk (2010), Melville (2010), and Jenkin et al. (2011). Some Green IS artifacts can be found in the academic literature. For instance, Froehlich et al. (2009) presented "UbiGreen", a mobile tool for tracking and supporting green transportation habits, and Björkskog et al. (2010) developed "Energy Life", a system using wireless sensors and mobile and ambient interfaces to promote energy conservation. Similarly, Holmes (2007) presented a public art project that measures energy usage, and Grevet et al. (2010) developed a space for social visualizations of energy conservation behavior. Finally, Graham et al. (2011) studied the effects of an online intervention on college students' driving behavior. These examples illustrate the opportunities that the combination of technological expertise and socio-psychological theory offers for IS research. From a technological standpoint, the high penetration rate of the Internet (ITU 2010), the decreasing price of broadband Internet access (ITU 2010), and the rapid diffusion of mobile devices (Pitt et al. 2011) allow ubiquitous information access by organizations and consumers (Watson et al. 2008). From a socio-psychological standpoint, the extensive use of theories from sociology and psychology has contributed to our understanding of the social context of IS (Lim et al. 2009; Sidorova et al. 2008)

Research on public good games in economics

When it comes to providing a public good, such as a clean environment, standard economic theory predicts that individuals will free ride on the contributions of others. For example, individuals free ride on the efforts of others to protect the environment. In reality, researchers have shown that individuals free ride less often than predicted. In a variety of situations, they do not behave self-interested, but rather prosocially. Motivated by these findings, a large number of studies in behavioral economics and behavioral game theory have emerged to explain individuals' prosocial behavior. This study examines the public good game (PGG). The PGG represents a social dilemma: that is, a decision situation in which individual incentives are at odds with collective interests. In the PGG, N participants are endowed with E monetary units each. Next, the participants decide individually how much of their endowment they want to invest in the PG (x_i) and how much they want to keep for themselves (E-x_i). The total amount invested in the PG is then multiplied by a factor m (where $m < N$) and equally divided. The utility that participant derives from his investment is

$$U_i = E - x_i + \frac{m}{N}\sum_{j=1}^{N} x_j \tag{1}$$

The notion of conditional cooperation emerged from the empirical finding in experimental economics that subjects base their contributions to public goods on the contribution levels of other participants (Fischbacher et al. 2001; Gächter 2006; Keser & van Winden 2000). Fischbacher et al. (2001) have suggested using the strategy method to elicit contributions from subjects in public goods games. In their experiment, the participants stated their contributions as a function of the group members' average contribution. The main advantage of this approach is that free riders contributing nothing can be separated from pessimistic conditional cooperators. On the basis of their findings, Fischbacher et al. (2001) classified their participants according to their contribution function. Whereas a free rider contributes nothing in all cases, a conditional cooperator employs a contribution scheme that is a positive function of the average contribution of the other participants. One special type is the "triangle contributor," whose contribution increases when that of others is low and decreases when that of others is high. The researchers found fifty percent of their participants to be conditional cooperators, 30% free riders, and the remainder either triangle contributors or non-classifiable. Several other experimental studies with public goods games have classified participants as free riders or conditional cooperators (e.g., Page et al. 2005). Figure 1, for instance, shows the average contribution of the different types reported by Gächter (2006). These studies have provided consistent evidence that subjects are heterogeneous in their motives for cooperating and, most important, that the behavior of the majority of subjects is conditionally cooperative. However, these studies findings are criticized because it is suggested to be unclear whether subjects' behavior in the laboratory is indicative of their behavior in the real world. The question of what laboratory experiments reveal about the real world was explicitly addressed by Levitt and List (2007). They note that unlike in a real-world setting, subjects' decisions in the laboratory are mostly subject to higher levels of perceived scrutiny, are mostly embedded in a context-free environment, mostly involve lower stakes, are mostly taken by students with an increased willingness to participate in such experiments, are always restricted to a predefined choice set, and are made within a particularly narrow time frame. All of these factors, with regard to which laboratory and real-world settings differ, are important determinants of subject cooperation and should be carefully considered when "insights gained in the lab [are] extrapolated to the world beyond."

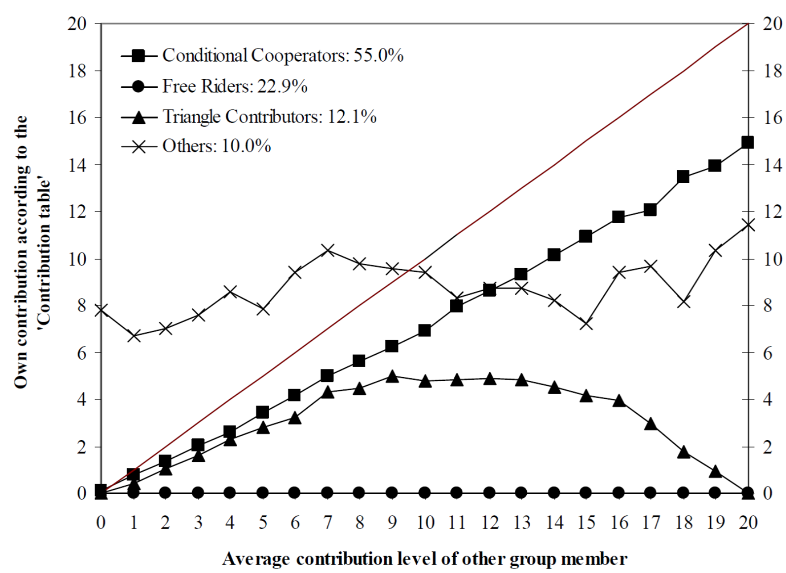

Figure 1. Average contribution functions (Fischbacher & Gächter 2006)

Several findings from field experiments are consistent with laboratory evidence of conditional cooperation (for a review, see Gächter 2006). For instance, Frey and Meier (2005) compared students' beliefs about other students' contributions to a fund for needy or foreign students and their own contributions to the fund. The researchers found a moderate correlation between stated expectations and behavior. However, because people may form expectations about others to justify their own behavior, the researchers also varied expectations about others' behavior experimentally. The two treatments offered feedback that reported a high (64%) or low (46%) percentage of students to have contributed to the fund, respectively. After controlling for subjects' previous contribution behavior, the researchers found a considerable positive effect of the high-feedback condition. Shang & Croson (2005) conducted a field experiment on donations to a public radio station. At a radio fundraiser, people called in to make a donation were told what others had donated in the past. Callers who were informed of a previous pledge donated on average more than the people in the reference group, who were not confronted with that information. Heldt (2005) tested for conditional cooperation among tourists who use a cross-country skiing slope for whose preparation they are asked to donate. The author found that tourists who were informed that 70% of all tourists had donated to the fund for preparing the slope contributed more on average than did those who were not informed about others' contributions.

Research on normative feedback in social psychology

The notion of conditional cooperation does not imply anything about individuals' motives for aligning behavior with that of others in a normative setting. In this regard, this concept overlaps with that of social norms as familiar from a growing body of literature in sociology and social psychology. For instance, the provision of normative feedback causes people to reduce littering (Cialdini et al. 1990), increase recycling (Cialdini 2003), and increase towel reuse when staying in hotels (Goldstein et al. 2008). In the context of energy conservation, several field experiments have reported the positive effect of providing people with information about the level of energy consumption of their peers (e.g., Allcott 2010; Schultz et al. 2007). These studies indicate that peer comparison decreased consumption by 1 to 2 percent. Schultz et al. (2007) demonstrated that normative feedback regarding personal and average neighborhood energy consumption induces people to adjust their energy consumption to make it closer to average consumption. Interestingly, descriptive feedback alone causes both below-average and above-average energy consumers to adjust their consumption so that it is closer to average consumption. However, recent studies have indicated that the effect of social norms is limited to persons with specific preferences (Abrahamse et al. 2005; Allcott 2010; Costa & Kahn 2010). Costa & Kahn (2010) have argued that the effectiveness of peer comparison depends on people's preferences. The researchers found that persons with pro-environmental and liberal preferences are more responsive to peer comparison than is the average person. In contrast, for certain subsets of republicans, peer comparison actually increased energy consumption in that study. The authors concluded that if the same message is effective for environmentalists but is ineffective with conservative individuals, a "mixed-message strategy" is necessary to reach all individuals in a heterogeneous population.

Hypothesis

Our study draws from the literature on promoting sustainable behavior in information systems research, conditional cooperation in economics and normative feedback in social psychology. Our main conjecture is that individuals differ in their propensity to respond to normative feedback about energy consumption and that this heterogeneity can be captured by these individuals' behavior in a public goods game conducted using an IT platform.

H1: *Subjects identified as conditional cooperators in the PGG are significantly more responsive to normative feedback than subjects identified as self-interested.*

This hypothesis implies that conditional cooperators adjust their energy consumption to the level of the reference group irrespective of whether their level was previously above or below that level. Self-interested subjects, on the other hand, can be expected to behave differently depending on their relative consumption level. There is no reason to expect that self-interested individuals will adjust their consumption upwards if it is below average. If it is above average, however, they may start trading off the costs of energy conservation against the benefits. Essentially, those for whom it pays to save energy will adjust their consumption downwards, whereas the others will not. Note that conditional cooperators are not precluded from trading off costs against benefits as self-interested subjects are. Conditional cooperators, however, have an additional motive that makes them more likely to adjust their energy consumption to the average level than are self-interested types. We tested our hypothesis in a field experiment that combined a public goods game with normative feedback about individuals' energy consumption.

Empirical study

Technological platform

We developed an energy efficiency website called Velix in cooperation with an Austrian utility company to provide the company's customers with feedback on their electricity consumption and to support them by presenting them with energy-saving tips. The website serves as the basis for an energy-saving campaign for the company and is available to all household customers, who can easily register online. To promote the website, the utility company informed its customers via its customer magazine and collaborated with a local media corporation that placed ads in newspapers and the news website. Velix combines energy record-keeping with game-like tasks. Customers receive bonus points that encourage them to read their electricity meter on a weekly basis and enter the readings online. The meter readings are checked for plausibility using an algorithm the utility employs to prevent incorrect data input in self-reading processes used for billing. Once the second meter reading has been entered, Velix calculates the corresponding energy consumption figures and provides each user with feedback intended to stimulate energy conservation (see Figure 1). Since April 1st 2010, 9,929 customers have joined Velix, and they entered more than 217,299 meter readings. The average time spent on Velix is about 5.5 minutes. To assure the reliability of the meter readings, we used multiple strategies. First, we instructed participants regarding where to find and how to read the electricity meter. Then, we implemented algorithms intended to verify the validity of the meter readings. For example, if a participant had entered a negative value or a meter reading lower than the previous one, he or she would receive an error notification. Additionally, we determined the validity of the self-reported data for a subset of customers. Finally, we compared the yearly energy consumption figures for 2010 and 2011. It was expected that the resulting correlation would confirm the validity of the self-reported data.

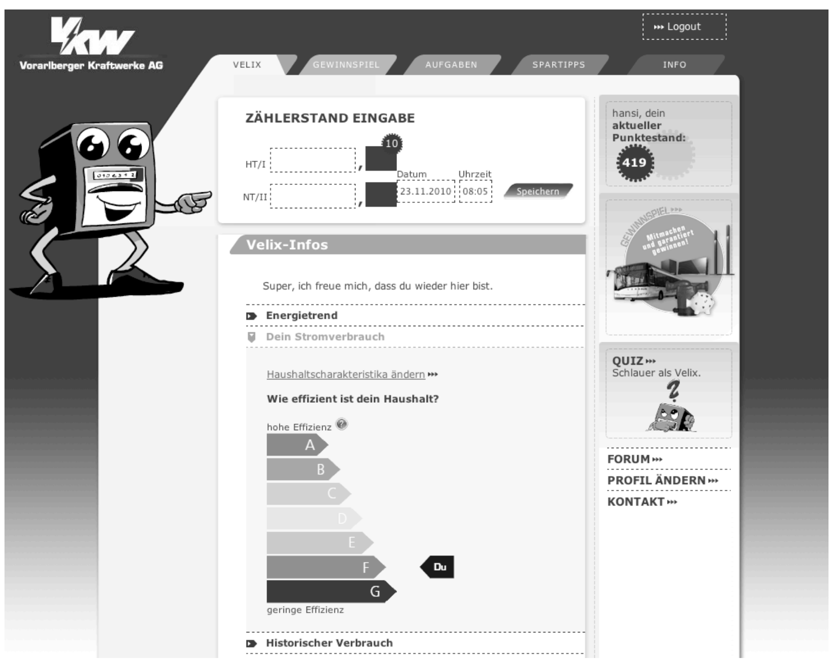

Figure 2: Data entry and energy consumption reports provided by Velix

We created Velix for two reasons. First, we wanted to motivate a large number of users to engage in energy conservation by providing them with feedback on their consumption behavior. Second, we intended to experimentally assess which socio-psychological concepts (e.g., social norms) are best suited to promote residential energy conservation. Velix has allowed us to evaluate these concepts by conducting experiments with a large number of users in a real-world setting. Every new user is automatically assigned to an experiment after registration. On the basis of the assignment, Velix then provides the participant with a different type of feedback based on a specific socio-psychological concept.

Methodology

The experiment will include 1000 or more customers of an Austrian utility company and will begin on June 1st, 2011. Figure 3 summarizes the experimental design. We will first conduct a survey in which we identify the participants' personality (e.g., environmental awareness and previous efforts to conserve energy) and socio-demographic status (e.g., age, education, work, income, household size, and number of household members). This allows us to investigate whether or not the participants have distinct characteristics and to ensure the generalizability of the study. At the same time, we will measure all participants' baseline energy consumption. Their baseline energy consumption will be determined using the meter readings obtained during the first two weeks of the study. Then, participants will be randomly assigned to a treatment or a control group with 500 participants in each. Next, half of the participants will play the one-shot PGG. To avoid a potential sequence effect, the other half of the participants will play the PGG after the main manipulation. In total, 100 games will be played, to each of which 10 participants will be assigned randomly. A detailed description of the implementation of the PGG can be found in the next subsection. The participants in the treatment group will receive normative feedback (see Figure 4). The feedback will consist of a scale that compares the participant's weekly energy consumption (in kWh) to the average energy consumption of the treatment group. Participants in the control group will receive no such feedback. A customer-care hotline, a contact form, and a forum will be used to contact the utility company with questions regarding feedback. However, all participants will receive instructions regarding how to reduce their energy consumption. All participants' energy consumption will be monitored on a weekly basis for another five weeks. In a short follow-up survey, we will ask participants whether or not they tried to save energy during the previous few weeks and for what reasons they did or did not do so. Their answers will allow us to test the validity of our experimental results.

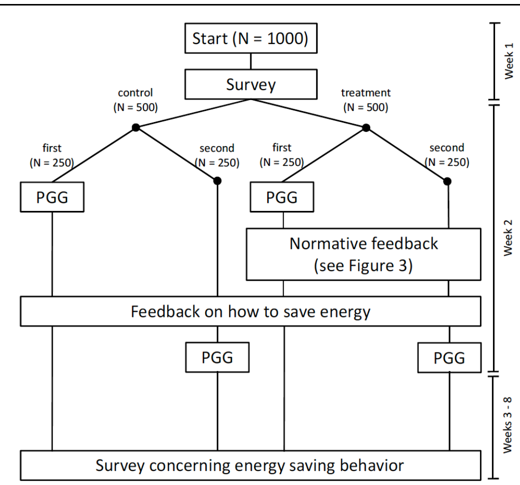

Figure 3. Experimental design

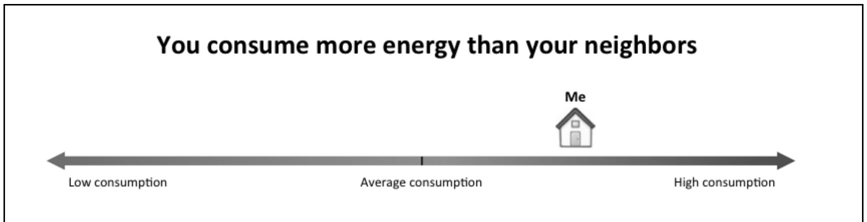

Figure 4. Normative feedback

Implementation of the PGG

The following section presents a detailed description of the implementation of the PGG. The PGG will begin with the instruction screen (see Figure 5). This screen describes the decision situation and explains how the participant's decision and the decisions of the other group members affect the payoff. The participants will be told that the payoffs are points that later can be exchanged for entertainment goods using the website's online store. Next, the participants will take a quiz consisting of 5 questions about the instructions. The correct answers will be shown on the next screen. Then, the participants will have to state how many of their points they want to keep for themselves and how many they want to contribute to the public good (PG). The points in the public good will be tripled and equally distributed to all 10 group members. The participants will have to state their unconditional (irrespective of what the other group members do) and conditional contributions (respective of what the other group members do) to the PG. Both decisions will be incentivized because the participants will be told that their payoffs will be calculated based on either their unconditional or conditional decision (with equal probability). Next, the participants will be asked a question about what they understand about the instructions and the decision situation. As soon as all group members have stated their contributions, the final screen, detailing the participant's payoff, will appear. The payoffs of the first five participants will be calculated according to their unconditional contributions and the payoff of the other five participants will be calculated according to their conditional contributions given the other group members' unconditional contributions (see Fischbacher et al. 2001).

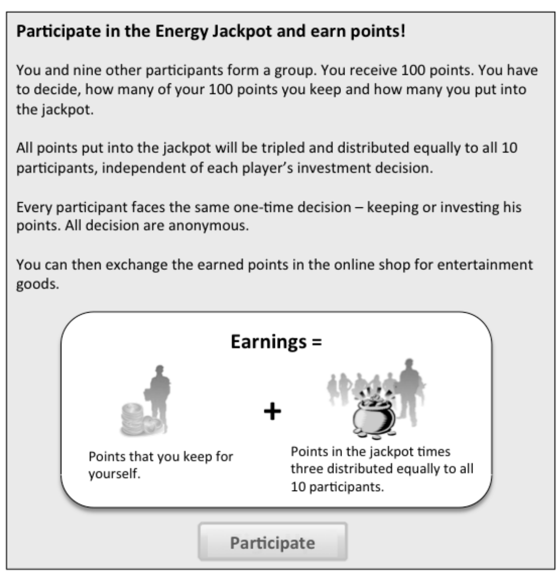

Figure 5. Instruction screen of the public good game

Data analysis

Given the data about the participants' energy consumption behavior and their behavior in the PGG, we will analyze if the PGG indicates participants responsiveness to normative feedback in the context of energy consumption. We will use the R statistical software including the lme4 package to aggregate and analyze the data. We will apply generalized linear mixed models to deal with the autocorrelation of errors in the longitudinal data structure.

Potential contributions

Our study may make four potential contributions. First, our findings will contribute to IS research on environmental sustainability by investigating the detection of individual preferences and the promotion of human behavior. Second, our potential findings may help us to better understand and identify individuals' preferences regarding energy conservation. These findings might also help practitioners designing energy conservation interventions to develop more user-oriented and effective interventions. Third, the PGG has been extensively investigated in experimental social science for the last three decades, but little research has been conducted on factors that might promote or prevent cooperation in real-world public good dilemmas. The findings of our study might help to bridge the gap between experimental and real-world economics and social science. Our findings may show that motives relevant for cooperation in experimental games also have an impact on real-world behavior. Finally, follow-up studies may show that the same method might be applied using the platform Velix for different topics, such as fuel or water consumption.

Conclusion

In the study detailed in this paper, we will evaluate a customer-oriented website called Velix that provides customers with feedback about their energy consumption and supports them by providing energy-saving tips. This paper presents a novel approach to identifying individuals' preferences: that of letting them play a public good game on Velix. The results of this study will help to identify individual preferences and provide individuals with targeted feedback, which in turn will help us to reach out to all of the individuals in a heterogeneous population.

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