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Abstract

Carbon-offset donations provide a way to mitigate the environmental damage caused by carbon emissions from aviation, but the number of fliers who choose this option is low. Information systems can support environmentally friendly decision-making in the context of carbon-offset payments. In this research in progress, we describe the research background and a prototypical online environment we developed to conduct a series of online experiments with a variety of "nudges" to promote environmentally friendly decisions. We present the results of an experiment with 150 participants, which show that proposing higher levels of default payments (presented as a slide bar) on an online flight-booking platform significantly increases the amount of carbon-offset payments. Our research contributes to the emergent body of knowledge on green information systems and behavioural economics in IS and has important practical implications, as the results may help airlines and travel agents design online flight-booking processes such that more people decide in favour of offsetting the carbon emissions caused by their air travel.

Keywords: Green IS, persuasive system, carbon-offset, behavioural economics.

1 Introduction

Aviation creates high amounts of carbon dioxide emissions (Brouwer et al., 2008), which contribute to climate change and damage to the natural environment (Solomon et al., 2009). In the absence of sustainable technologies or dramatic reductions in air travel, carbon-offsets are a short-term solution to mitigate the negative ecological impact of aviation. Carbon-offsetting is the process of compensating for the emissions of one activity by reducing the emissions of another activity with the aim of achieving neutrality (Brouwer et al., 2008). Although several airlines offer travellers the option to make carbon-offset payments, studies show that few travellers choose that option (Eijgelaar, 2009, McLennan et al., 2014). Therefore, there is a need to determine how individual behaviour can be changed toward paying more carbon-offsets. Research has shown that information systems can be used to nudge people toward acting in a sustainable manner (e.g., Baeriswyl et al., 2011, Graml et al., 2011, Loock et al., 2013, Loock et al., 2011, Loock et al., 2012), so we expect information systems also to have the potential to impact positively the carbon-offset payment decision in online flight-booking processes. Our research question is:

> RQ: *How can the carbon-offset payment decision in online flight booking processes be designed to increase carbon-offset payments?*

Our hypothesis development draws on the literature on behavioural economics and carbon-offset payment behaviour, and we test our hypothesis in an online experiment. The results indicate that proposing high default values for carbon-offset payments increases the actual carbon-offset donation over that achieved by initially proposing low default values. Our study contributes to the research on persuasive systems and green information systems by showing how to design information systems that can influence human actions that are related to the natural environment (Melville, 2010).

This research in progress focuses on *setting defaults* to increase carbon-offset donations, while our future research seeks to implement a variety of mechanisms that might nudge people into more environmentally sustainable behaviour, thus mitigating the negative impact of air travel.

The next section describes the research background of our study and develop the hypothesis to be tested. Then we present our online experimental design and show the results. Finally, we discuss the results and preview our future research agenda on digital nudging.

2 Research Background

Traditional economic theory assumes that individuals seek to maximize their utility, as unlimited cognitive resources are available to act rationally (Doucouliagos, 1994). Humans collect and evaluate information up to the point at which the incremental cost of additional information equals the incremental gains from that information (Simon, 1959). Consequently, there are three primary mechanisms for changing behaviour in economic activity: altering prices (thus increasing/decreasing the utility of an alternative/choice), providing information (thus decreasing the cost of acquiring this information), and placing restrictions (Johnson et al., 2012). However, these mechanisms are ineffective in many situations (Johnson et al., 2012). Critiques of the concept lament that humans do not have unlimited cognitive abilities, so they have to make decisions under the constraints of their thinking capabilities—that is, under the condition of bounded rationality (Doucouliagos, 1994, Simon, 1955). Research in psychology has demonstrated that people act with bounded rationality (Simon, 1955) and often make suboptimal choices because of their lack of information, attention, and/or self-control (Bailes and Hoy, 2014, Goldsmith and Cyboran, 2013). They often adopt heuristics (Mullainathan and Thaler, 2000)—simple 'rules of thumb', when making judgments or decisions (Hutchinson and Gigerenzer, 2005).

People's decisions are often influenced by how their choices are presented (Johnson et al., 2012, Thaler et al., 2014), and there is no neutral way to present choices (Johnson et al., 2012): *Nudges*, including setting defaults, providing feedback/information, and structuring complex choices, use heuristics to change behaviour (Thaler and Sunstein, 2008). For example, changing the default option from opt-out to become an organ donor to opt-in can notably increase donor rates (Johnson and Goldstein, 2003).

Decisions that have an effect on the environment, such as those related to carbon-offset payments in booking flights, are a primary application domain for nudges (Thaler et al., 2014, Johnson et al., 2012). IS research has used nudges in designing persuasive systems that promote environmentally friendly behaviour, such as through devices that provide feedback on energy consumption (Pierce et al., 2008) in the form of goals and defaults (Loock et al., 2013), social normative feedback (Loock et al., 2012, Loock et al., 2011), consumption feedback, and social competition (Yim, 2011).

3 Hypothesis Development

People rely on mental shortcuts and apply heuristics when they evaluate alternatives (Gigerenzer, 2008), so their choices are often biased. For example, when evaluating options, people tend to apply the default heuristic (Johnson and Goldstein, 2003) and stay disproportionally often with the status quo or the pre-selected option (Samuelson and Zeckhauser, 1988).

Related to the *default heuristic* is the *anchoring and adjustment heuristic* that leads people to use an initial piece of information as an anchor for their estimates and then to adjust this anchor (Tversky and Kahneman, 1974). A survey among air travellers showed that the willingness to pay for carbon-offsets is positively anchored on the default value for the carbon-offset payment and the price of the flight ticket (Brouwer et al., 2008). The present study extends this research by means of a test of the causal relationship between setting the default values of a carbon-offset donation scale (i.e., implemented as a slide bar) and actual carbon-offset payments. Thus, we extend the work of Brouwer et al. (2008) who surveyed participants and asked for their hypothetical willingness to pay/donate. Using an experimental design, we propose that:

> *H: Anchoring the default value of a carbon-offset payment scale at the highest (lowest) value of the scale leads to higher (lower) carbon-offset payments than those of a baseline group with a default value in the middle of the scale.*

4 Methodology

4.1 Participants and Experimental Design

We recruited 150 subjects through *Prolific.ac*, a platform that provides a pool of several thousand potential participants for online studies.[1] All participants were at least eighteen years old and were native-English speakers to ensure that they fully understood the given task. (Prolific allows users to filter for participants who were born in the United Kingdom, the United States, Ireland, Australia, Canada, or New Zealand and who indicate that English is their first language.) The subjects' mean age was thirty-three years, and 51 percent were women. We conducted a single-factor repeated-measure experimental design with one treatment, which was anchoring the donation scale by default at a low, medium, or high position. (See Figure 1 for an example.) Payment for participating was consisted of two parts: a fixed show-up fee of £1and a variable payment based on the donation the participant made in the experiment (i.e., the more participants donated in the experiment, the less was paid out to them).

[1] Using such a recruitment platform instead of a convenience sample is appropriate for random-sample populations (Berinsky et al., 2012), and the collected data is at least as reliable as data collected using more traditional methods (Buhrmester et al., 2011).

4.2 Materials and Procedure

Booking system. We developed an online flight-booking system consisting of three webpages. The first page gave the participant the flight destination, and the participant selected times for the outgoing and the return flights. On the second page, the participant had to decide on a carbon-offset payment (Figure 1). On the last page, the actual donation and remaining payment were summarized.

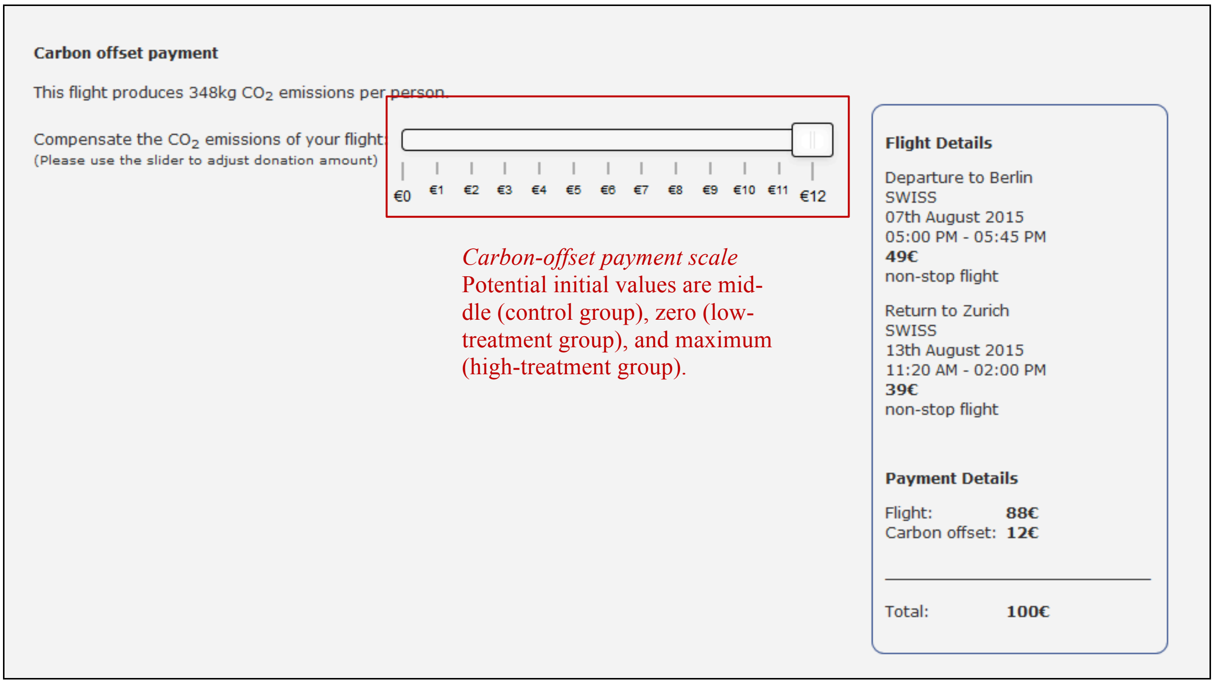

Figure 1. *Design of carbon-offset payment decision*

Procedure: The entire procedure was conducted online. Before the experiment, participants were given instructions. Then they were asked to book nine flights (representing our repeated-measures design (Gelman and Hill, 2006)). Each flight scenario (Table 1) had a particular destination and was in this way related to a specific amount of CO_2 emissions per passenger[2]. Airfares varied between €88 and €92. For each scenario, participants had a budget of €100 to book the flight, so the remaining budget for the carbon-offset donation varied between €8 and €12. After all booking scenarios had been completed, data on participants' demographics was collected through a survey.

[2] We used the CO_2 calculator from myclimate.org to calculate the flights' CO_2 emissions.

City	CO_2 emissions per passenger (kg)	Price of outgoing flight (€)	Price of return flight (€)	Sum (€)	Remaining budget (€)
London	387	39	49	88	12
Berlin	348	49	39	88	12
Budapest	392	40	50	90	10
Rome	357	45	45	90	10
Toulouse	360	39	53	92	8
Split	373	45	45	90	10
Bratislava	345	49	43	92	8
Hamburg	358	48	40	88	12
Nantes	380	40	52	92	8

Table 1. Flight-booking scenarios presented in random order to the participants

Treatment. To test the influence of setting a default value for offset payments on actual payments, the rating scale was anchored on three positions: (1) the mid-point of the scale (control condition); (2) €0 (low treatment condition); (3) the highest possible value of the scale (high treatment condition). Because of our between-subject repeated-measures design, the default position of the slider for each condition remained unchanged for all scenarios. Figure 1 shows the situation for the high treatment group (default anchored in the highest possible point of the donation scale) for a round-trip flight from Zurich to Berlin. Anchors were coded as 0 = low; 1 = medium; and 2 = high.

4.3 Measures

Absolute donation and relative donation. Absolute donation is the participant's selected carbon-offset donation. To normalize the values, we calculated the relative donation (= absolute donation / remaining budget after flight booking).

Controls. Based on findings from previous research on donation behaviour and dictator games, we considered several control variables. The situation in our experiment, where a subject is given an amount of money and asked to make a voluntary decision to donate part of it, is also known as a dictator game (Aguiar et al., 2008). A meta-analysis on dictator games showed that dictators donate an average of about 30 percent of the money they are given (Engel, 2011) and that several variables influenced the share of the donation: age (Engel, 2011, Lee and Chang, 2007), gender (Eckel and Grossman, 1998, Engel, 2011, Lee and Chang, 2007), income (Schlegelmilch et al., 1997, Brouwer et al., 2008), children (Lee and Chang, 2007), and environmental concern (Brouwer et al., 2008). To calculate the environmental concern, we used the New Ecological Paradigm, which measures the degree of a pro-ecological world view (Dunlap et al., 2000).

5 Results

We conducted our analysis using the statistical software package *R* (R Core Team, 2014), specifically the packages *lme4* for multilevel modelling (Bates et al., 2015) and *ggplot2* for visualization (Wickham, 2009). Table 2 provides a summary of the statistics of our study.

Variable	Unit	Mean	Median	Std. dev.	Min	Max
Absolute donation	€	3.91	3.00	3.28	0.00	12.00
Relative donation	%	39.20	37.50	32.26	0.00	100.00
Age	Years	32.57	30.00	11.20	18.00	72.00
Gender	(men = 2)	1.49	1.00	0.50	1.00	2.00
Yearly income	€	24,247	20,000	26,297	0.00	200.000
Children	No.	0.55	0.99	0.96	0.00	4.00
Environmental concern	1 to 5	3.67	3.67	0.59	1.47	5.00

Table 2. Descriptive Statistics

Figure 2 shows the box plots for the three anchors. Means differ among the three treatment conditions, providing first support for our hypothesis.

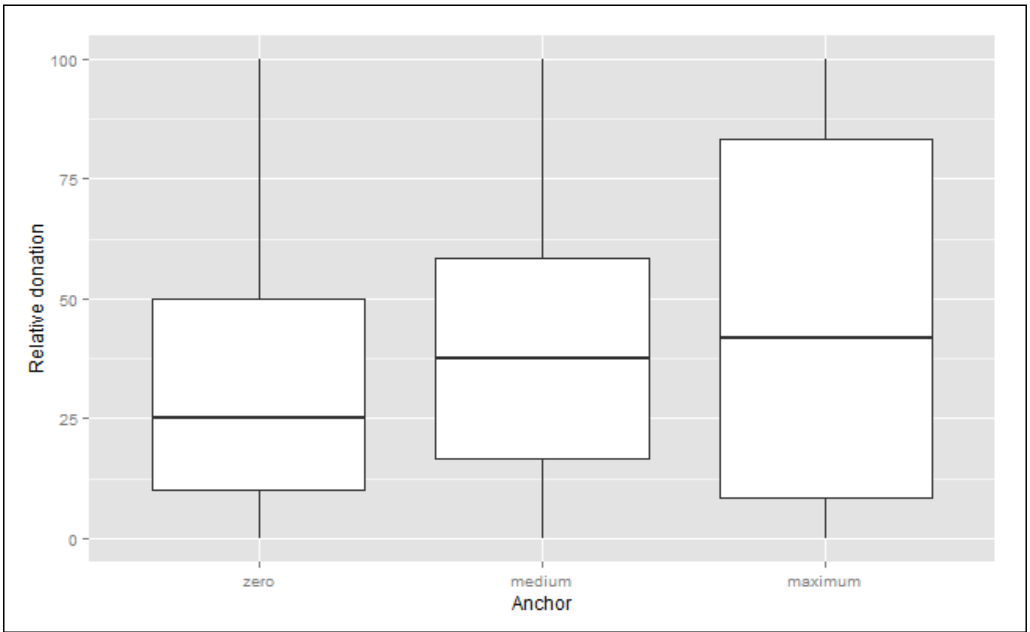

Figure 2. Percentage of carbon-offset budget donated, grouped by default level

Because of our repeated-measures design (i.e., each participant had to book nine flights), we assume that observations are not independent but clustered within participants. Therefore, we conducted a multilevel regression analysis (Gelman and Hill, 2006), using a varying-intercept model:

$$Relative\ Donation_s = \alpha_{i[s]} + \beta_1 \cdot Anchor_s + \gamma' \cdot Controls_s + \varepsilon_s, \text{ for } s = 1, \ldots, n,$$

where *i[s]* indexes the individual *i* corresponding to scenario observation *s*, β_1 is the effect of the *Anchor*, and $\alpha_{i[s]}$ refers to individual intercepts.

Table 3 shows the results. Model 1 includes the treatment (i.e., *Anchor*) as a fixed factor as well as *participants* as a random factor. The estimate for *Anchor* is 6.65 ($p < 0.05$), so there is a significant difference between our treatment groups. With an increasing default value, *Relative Donation* increases. We used the likelihood ratio test to compare this model against a model without the effect of the *Anchor* (i.e., an intercept-only model) and found that including *Anchor* significantly improves the model (χ^2 (1) = 5.16, $p < 0.05$). Therefore, our data supports our hypothesis.

In the next step, we added control variables (i.e., age, income, gender, children, and environmental concern) to the model (Model 2). The estimate for *Anchor* is 6.13 ($p < 0.05$). Adding controls improved the model (χ^2 (5) = 14.51, $p < 0.05$)[3].

To test for robustness, we conducted two pooled linear regressions. Model 3 includes the treatment only, whereas Model 4 includes control variables as well. The estimates for *Anchor* are 6.65 (Model 3) and 6.13 (Model 4), indicating that the results are robust across models.

DV: Relative Donation	**Multilevel Models**		**Pooled Regression Models**	
	(1)	**(2)**	**(3)**	**(4)**
Anchor	6.65* (2.90)	6.13* (2.88)	6.65*** (1.05)	6.13*** (1.05)
Intercept	32.37*** (3.82)	17.39 (17.48)	32.37*** (1.38)	17.39** (6.38)
Controls	NO	YES	NO	YES
Individual effects	YES	YES	NO	NO
N	1,350	1,350	1,350	1,350
AIC	11344.9	11340.4		
BIC	11365.7	11387.2		
Adj. R2			0.03	0.10
F-statistic			40.15*** (df = 1; 1348)	26.28*** (df = 6; 1343)
Notes: * p < .05, ** p < .01, *** p < .001; Standard errors are in parentheses.				

Table 3. Regression Results

6 Discussion

Our results confirm previous results on the effect of defaults and anchoring and adjustment heuristics. Our study shows how design decisions about information systems (i.e., decisions about how to design carbon-offset payment decisions in online flight booking processes) can be used to encourage environmentally friendly decision-making. Thus, our work contributes to the emergent body of knowledge on green information systems. We extend prior studies (i.e., Brouwer et al., 2008) by showing that defaults in carbon-offset decision environment not only influence the intention to donate but also the behaviour.

Our results also have important implications for practice. Developers of online booking platforms can use the results to adjust their online decision environments. Knowledge about how to design platforms that promote environmentally friendly behaviour are also of interest to policy-makers and other stakeholders. Airlines can use increased carbon-offset payments to react to cultural-cognitive, normative, and regulative pressures exerted by their stakeholders. However, airlines must comply with existing regulations on consumer rights (e.g., Directive 2011/83/EC in the European Union), as start values greater than zero, for instance, might be considered hidden costs.

[3] All assumptions were met. Visual inspection of residual plots of both models did not reveal any obvious deviations from linearity, homoscedasticity or normality.

Our study has some limitations. We conducted an online experiment and recruited participants through an online recruitment platform, so our sample might not reflect the whole population of those who book flights online. However, research has shown that a sample retrieved through an online recruitment platform is an appropriate sample for random sample populations (Berinsky et al., 2012) and that the data is at least as reliable as that from more traditional data collection methods (Buhrmester et al., 2011).We also used a reduced form of an online flight-booking process, so future research might apply the described mechanism using a real online flight-booking process to validate our results through a field experiment and increase external validity. In addition, our results are restricted to the specific context of air travel and cannot necessarily be generalize to other forms of travel (e.g., bus, train, car rental) or other types of carbon-offset offerings (e.g., retail goods). Future research could extend our results to a broader set of contexts.

7 Outlook

The study presented in this research in progress is the first in a set of experiments in a larger research program on digital nudging, where we intend to test several design mechanisms in the context of carbon-offset payment decisions. The next step is to examine the (interaction) effect of providing additional information about CO_2 emissions in the flight-booking process (Figure 3). Knowledge about and even awareness of the impact of air travel on the climate is limited (Becken, 2007), decreasing travellers' willingness to make carbon-offset payments (Brouwer et al., 2008). We propose to focus on CO_2 emissions, as they are the primary cause of the harmful impact of air travel on the environment (Brouwer et al., 2008), and carbon-offset payments are directly related to these emissions. Such information should be presented to travellers in a way that is easy to understand (Dolan et al., 2012). In particular, when numbers are presented, an evaluation context that indicates whether a value is "good" or "bad" should be provided to simplify the evaluation process (Peters et al., 2009).

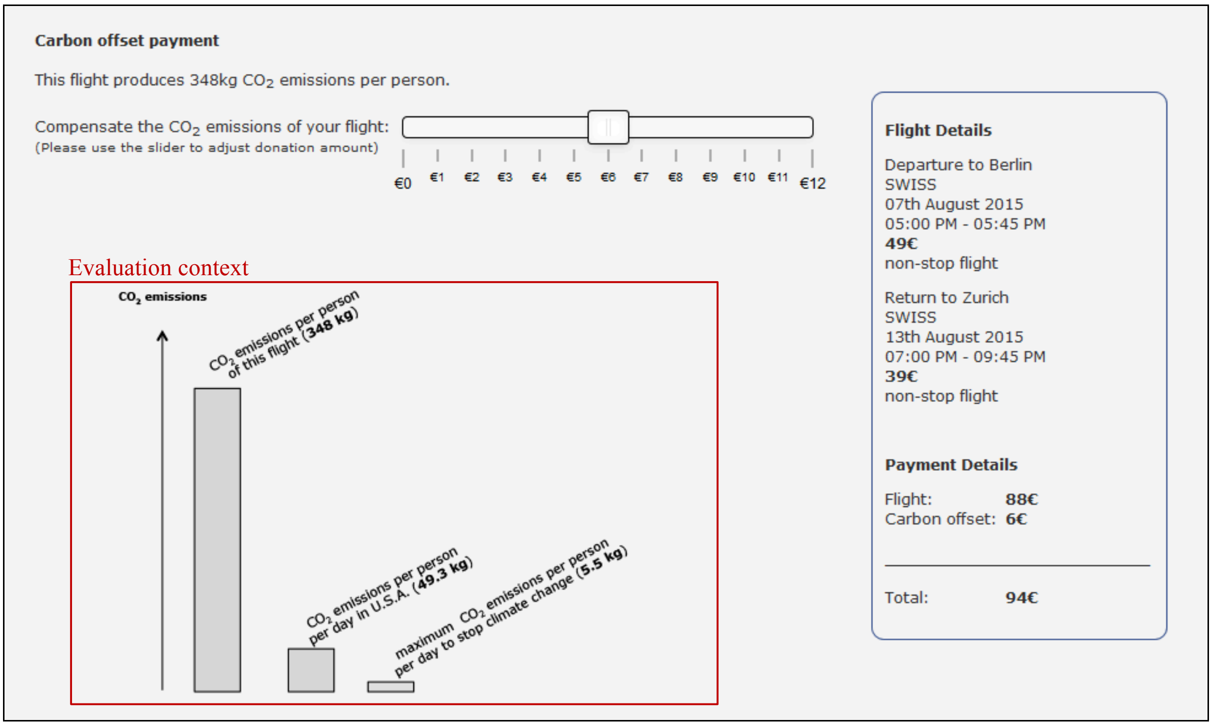

Figure 3. Design of carbon-offset payment decision, including the evaluation context

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