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Nudging low-carbon consumption through advertising and social norms

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ABSTRACT

Widespread advertising of high-carbon goods challenges a shift to low-carbon consumption which is needed to limit climate change. We test the pure and combined effects of advertising and communicating a social norm on low- and high-carbon consumption. This involved presenting to 2728 US citizens an imitation Facebook homepage containing green and non-green advertising as well as weak and strong social norms to nudge low-carbon consumption. In isolation, both green advertising and social norms were effective in promoting low-carbon choices. But when combined, advertising dominated choice and counteracted the positive effects of the social norm. We show that this result is due to advertising affecting more decision channels than the social norm. It suggests that low-carbon norms have a limited effectiveness in changing consumer preferences in a world dominated by advertising.

1. Introduction

Mitigating climate change requires that consumption patterns change towards low-carbon. At the same time, consumers are being swamped with product advertisements incentivizing high-carbon consumption. It is estimated that the average American is exposed to around 4000 to 10,000 advertisements daily (Marshall, 2013), the majority of which are for high-carbon products, that is, those which emit considerable CO_2 emissions over their lifecycle (Annala & Vinnari, 2019). Moreover, targeted advertisements made possible by online platforms such as Facebook and Google have dramatically increased the effectiveness of commercial advertising (Mochon et al., 2017). Studies indicate that advertising may explain up to 65% of the total variance in consumption patterns (Brulle & Young, 2007). Against this background, relevant questions are whether advertising for high-carbon products reduces the effectiveness of climate policies aimed at controlling emissions associated with consumption, and whether green advertising, i.e. advertising for low-carbon products, can promote consumption of low-carbon alternatives.

Advertising can be regarded as a type of information provision (Ekelund et al., 1995; Nelson, 1974). This allows it to be considered in a broader setting of motivations, incentives and policies that involve providing information to consumers with the aim to nudge their purchases towards low-carbon options. Nonetheless, it is likely that different types of information provision set in motion unique psychological mechanisms which affect environmentally-relevant behaviors. Advertising influences choices by providing repeated information that appeals to goals, self-concepts and desirable product qualities, in turn creating emotional associations and positive perceptions towards the advertised product (Florack & Scarabis, 2006).

Similarly, ample research shows social-norm communication can be used to influence people's choices (McDonald & Crandall, 2015). For instance, social norms have been proposed an effective way to nudge certain pro-environmental behaviors by conveying information regarding what others do or think, in turn influencing people's environmental attitudes and behaviors (Byerly et al., 2018; Ölander & Thøgersen, 2014; Schultz et al., 2008). Both information instruments, i.e. advertising and social norms, can make use of social media. In fact, most advertising takes place today on such media. It is unclear which of these information mechanisms is more effective at influencing consumer behavior, and moreover, whether they interact, i.e., whether the presence of one influences the effectiveness of the other in influencing behavior. Here we examine their individual effectiveness on shifting consumption behavior towards low-carbon products, and whether

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nudging with norms for low-carbon consumption is an effective strategy in the presence of advertising.

To this end, we undertook an incentivized experiment presenting a choice between a high- and a low-carbon product. Our aim was to mimic a real-life scenario to test if consumer choice between low-and high-carbon products can be affected by information provision. We assess the separate and combined effects of product advertising and social-norm communication on choice. In particular, we test for potential interaction effects between the two information mechanisms, namely, through two scenarios: one in which advertising and the norm work in the same direction (i.e., both favor a low-carbon option); and another where they work in opposite directions (i.e., advertising for a high-carbon option and a social norm for low-carbon consumption). Finally, we undertake a structural-equation-model analysis, which identifies the channels through which the two types of information (advertising and social norm) affect behavior.

2. Background and present study

2.1. The influence of advertising

Psychologists have long established that repeated exposure to advertising leads to a stronger preference for a product (Becknell Jr et al., 1963; Krugman, 1968; Zajonc, 1968). This exposure phenomenon has been explained through the advertised products creating a sense of familiarity that reduces the level of risk in choices, and exempts consumers from evaluating too much information, thus avoiding overly complex decision making (Hansen & Wänke, 2009). Neurological evidence on this familiarity effect shows that exposure to known-brand logos activates emotional neural responses in consumers (McClure et al., 2004; Plassmann et al., 2012). Advertising typically combines product information with pleasant cues, such as colors, music, or images, which elicit affective processing based on induced emotions (Bagozzi et al., 2017). Highly advertised products are perceived as better than non-advertised ones (Rossiter & Percy, 1980; Staats & Staats, 1958), particularly in terms of having higher quality (Moorthy & Hawkins, 2005; Moorthy & Zhao, 2000) and as being more popular (Kim & Min, 2014). Both of these perceptions serve as predictors of purchase intention. In this context it is difficult for new brands to enter the market, which is the case for many low-carbon options.

In the last decades, green advertising has emerged as a successful marketing strategy to promote product or services with relatively little environmental impact (Henion & Kinnear, 1976). Consumption of low-carbon products is often encouraged by advertisements making environmental claims or using green color, labels or nature images, in order to signal reduced environmental impact. Given the rapid rise of environmental concern among the population, the association of products with environmental benefits presents a topical opportunity for marketing firms (Pickett-Baker & Ozaki, 2008). It has been found that consumers can be more strongly persuaded by advertisements which emphasize green rather than non-green product attributes (Ku et al., 2012), and that such advertisements induce more positive attitudes towards brands (D'Souza & Taghian, 2005; Thorson et al., 1995). These positive attitudes generated through green advertising can further predict consumer purchase intention (Leonidou et al., 2011; Purohit, 2012).

Moreover, green advertising not only generates more positive attitudes towards a product through consumer perception of reduced environmental impact, but also improves other consumer attitudes. For example, some studies find that people rate an eco-labelled product as having a better taste or performance than an identical non-labeled product, which has been suggested to be the result of a green-halo effect (Sörqvist et al., 2015). Such effects on consumer attitudes are typically achieved using green cues. Not only do consumers associate green color with a reduced environmental impact of products (Lim et al., 2020), but also research shows that images of nature in advertising have higher positive effects on brand attitude than textual information about environmental benefits (Hartmann, Ibáñez & Sainz, 2005).

Naturally, the extent to which consumer perceptions of products are influenced by cues and claims of green advertising is moderated by other dimensions, such as the consumers' involvement with environmental issues (Matthes et al., 2014; Petty & Cacioppo, 1979). Overall, the reviewed evidence suggests that advertising strengthens consumer attitudes towards a product by using a combination of green claims and cues to create favorable perceptions of attributes such as quality or popularity, and in the case of green advertising, reduced environmental impact.

2.2. The influence of social norms

Within information policy research, social norm management has been praised as being particularly effective at encouraging pro-environmental behaviors, such as reducing home energy use and recycling (Allcott & Kessler, 2019; Nyborg et al., 2016). The effectiveness of communicating a social norm depends on whether it can generate peer pressure through social information, or activate personal norms related to a moral behavior (Farrow et al., 2017). Norms can relate to the perceived appropriateness or moral nature of a particular behavior (injunctive norms), or to observations of what most people do independent of the appropriateness of the behavior (descriptive norms). The percentage of people that follow a norm (i.e., how many people engage in the respective behavior) determines whether the norm is weak or strong, that is, followed by the minority or the majority (de Groot & Schuitema, 2012).

Social norms only followed by a minority may fail to influence others' behaviors or even backfire (Cialdini, 2003). Nonetheless, recent studies suggest that when accompanied by normative information, weak norms can influence others' behaviors either by conveying that a behavior is desired, or even perceived as trending (Mortensen et al., 2019). For these reasons, it is not surprising that effective norm-based interventions in the environmental domain have often combined both descriptive and injunctive information (Schultz et al., 2007). Examples include people reducing their energy use by 2% on average if they learn that *most* of their neighbors consume less than they do (Allcott, 2011), re-using towels in hotel rooms if they are told that *most* other guests do so (Goldstein et al., 2008), or increasing recycling by 25% after being exposed to recycling campaigns transmitted via TV and radio stations, communicating that most local residents recycle (Cialdini, 2003). These types of norm-based interventions, apart from describing others' actions, display to individuals that their behavior is relevant from an environmental perspective, which activates any latent pro-environmental preferences (Schultz et al., 2008).

The activation of personal norms relevant to moral behaviors requires that an individual (a) becomes aware of the consequences of their behavior on others' welfare; (b) holds personal norms regarding these consequences; and (c) feels some capability to control the outcomes of their behavior (Schwartz, 1973). Translated to environmentally-relevant behaviors, norm activation will be mediated by the concern a person has for the environment, the extent to which they feel responsible, and their perception of an action's effectiveness in having an environmental impact (De Groot & Steg, 2009). These psychological constructs can help explain when norm activation takes place for many environmentally-relevant behaviors (Oreg & Katz-Gerro, 2006). For example, research has shown that social norms influence environmental behaviors only if individuals perceive that the particular behavior (e.g., recycling) has a significant impact on reducing emissions (Doherty & Webler, 2016).

Social norms can induce behavioral change beyond the realm they focus on. For example, it has been found that communicating social norms regarding car-sharing can encourage recycling (Evans & Stanovich, 2013). This is relevant to policy and raises the question whether one should focus on explicit, concrete, social norms, such as "the majority of consumers buy organic apples"; or implicit, general, social

norms. In the case of a social norm aimed at nudging consumption towards low-carbon products, an implicit norm seems more practical for two reasons: (a) it will affect the majority of products in the market; and (b) it avoids the influence of conformity and reactance along the lines of "someone is trying to manipulate my choices". So far, available experimental evidence for social norms promoting a shift to lower-carbon options in consumption deals predominantly with explicit norm communication. The findings of this research are, however, inconclusive. While three studies report shifts to 'greener' options when individuals become aware that most others consume green goods (Demarque et al., 2015; Kim, Lee & Hur, 2012; Sparkman & Walton, 2017), other studies report null results (DellaValle & Zubaryeva, 2019) and even "boomerang effect" from norm presentation, shifting consumption in the opposite direction (Richter et al., 2018). That is, when consumers were presented with a social norm nudging eco-labelled seafood in a supermarket (i.e., a message saying most consumers buy labelled seafood), they overall bought more seafood; both labelled and unlabeled. Additionally, explicit norm communication in the way it is applied in most studies so far is relatively unrealistic. In real life, it will rarely be allowed for a policy to campaign for a given product since there are countless products in the market and this could eventually go against market regulation rules. Finally, the research to date lacks an important dimension of consumption, namely its extensive interaction with commercial advertisement.

2.3. The present study

In this study we investigate whether social norms nudging towards low-carbon consumption alongside green advertising can be effective at shifting consumption from strongly advertised, carbon-intensive products towards less advertised, low-carbon options. We consider various questions such as: Do social norms and advertising, both representing cases of information provision, affect consumption decisions in a similar way? Which is more effective, and why? And particularly relevant from a policy-making perspective are their interactions; for example, are social norms for low-carbon consumption effective in the presence of advertising for high-carbon alternatives?

To address these questions, we run a controlled experiment in which we manipulate the strength of "low-carbon social norms", by suggesting that a majority or minority of people consume low-carbon products, and through the type of advertising, namely for either a low-carbon product (green advertising) or a high-carbon product (non-green advertising). In order to create a realistic setting where both stimuli could be presented, the experiment employs a simulated Facebook homepage where posts with green and non-green product advertising are presented. The social norm takes the form of a Facebook poll showing most/few people consume low-carbon products nudging towards low-carbon consumption. After being presented with the Facebook imitation page, participants make an incentivized choice between a high-and a low-carbon product. By including both green and non-green product adverts and a weak or strong social norm, we can assess the separate and combined effects of the two types of information on consumer choice.

Furthermore, we explore the underlying mechanisms behind the observed effects from the social norms and advertising by undertaking a structural-equation-model analysis for low-carbon choice, using subjects' responses of a post-experimental survey. This allows the assessment of the distinct decision channels suggested in the literature. In particular, we test whether green and non-green advertising effects on choice are mediated by product perceptions (e.g., quality, popularity and environmental impact), and investigate if there are variations between the two types of advertising. For social norms we test whether its effects on low-carbon choice are mediated through norm activation (environmental concern, responsibility and self-efficacy) or only through peer effects. Finally, we compare the decision channels used by social norms and advertising to interpret experimental results.

3. The experiment

3.1. Experimental design and procedure

A 3 × 3 between-subjects survey experiment was designed by manipulating product advertising (*no advertising* vs. *green advertising* vs. *non-green advertising)* and the low-carbon social norm (*no social norm* vs. *strong social norm* vs. *weak social norm*) in an imitation Facebook homepage (see Fig. 1). A total of 2728 US participants (51% women, mean age=38.7) were recruited via Amazon Mechanical Turk to participate in an incentivized "observation task" and were randomly assigned to one of the nine treatments (approximately $N = 300$ by treatment, see Fig. 1). The participation fee was set at 1 dollar for a seven-minutes task. In addition, participants could receive $0.20 for each correct answer on five questions following the Facebook Homepage, that served as an attention test (SM10). The size of the sample per treatment was set at 300, well above that of studies with similar designs (see for example Sparkman & Walton, 2017), assuring sufficient

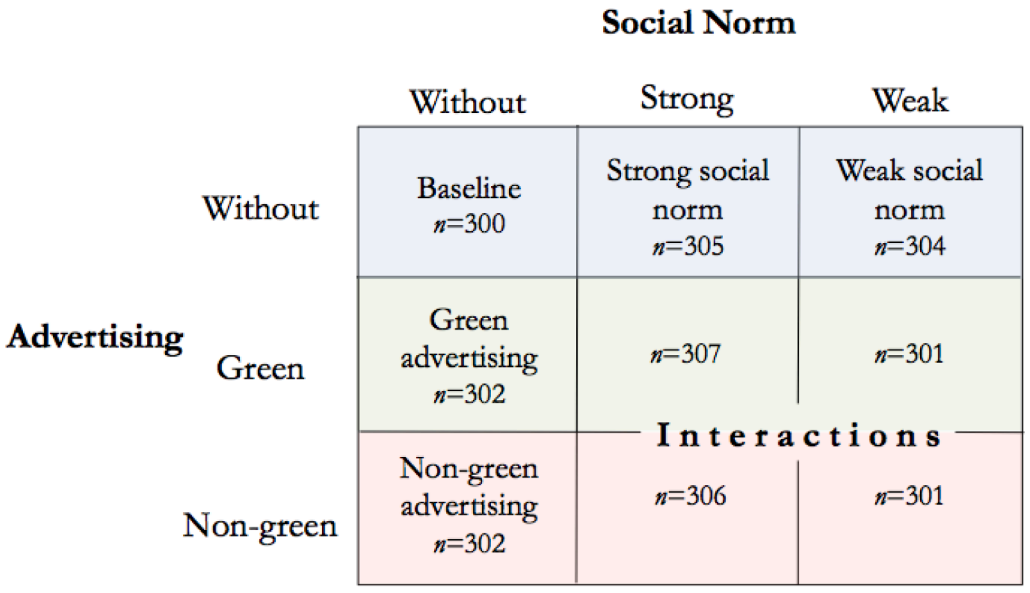

Fig. 1. Experimental treatments.

statistical power to detect smaller effects and their magnitude.

The experimental sequence was as follows. Once participants agreed to participate in the "observation task", they were instructed to look over an "image", about which they would later answer some questions. The image presented was the imitation Facebook homepage with different posts created for the purpose of the experiment. The questions that followed were regarding the content of the posts (attention test). After answering these questions, participants were asked to choose between a low- and high-carbon tablet. The choice was presented in a screen containing a picture of both tablets accompanied by explicit descriptions of their technical characteristics (RAM memory, processor, etc.). In the description of the product, the low-carbon tablet had one important additional characteristic, namely a certified eco-label.

The choice was incentivized, in the sense that one randomly chosen participant would win a $200 discount coupon for the tablet s/he had previously chosen. The likelihood of winning, approximately one over 3000, was the same for every participant as it was independent of the choice. Finally, participants were asked about their perceptions of the high- and low-carbon products, their beliefs relating to climate change, and their basic socio-demographic information (for more details on the experimental procedures, see section S1, and for the full questionnaire and instructions see sections S10–12 of the Supplementary Material (SM)).

3.2. Choice of product

Tablets were chosen as the product in our experimental setup for several reasons: (a) They are relevant to a large number of participants, (b) they are likely to be advertised in Facebook, (c) their production is associated to considerable carbon emissions, and (d) they represent a non-trivial purchase decision given their high price. In the experiment the "low/high-carbon" product categorization refers to the extent of carbon emissions during lifecycle, particularly in production. As the aim of the study was to test the efficacy of advertising and social norms in shifting consumption towards lower-carbon products in the presence of a highly advertised brand, we used a well-known brand associated with relatively high-carbon emissions, namely Samsung (Cook & Jardim, 2017). The low-carbon alternative (i.e., the Iameco tablet) was chosen as its lifecycle emissions are 70% less, has a certified eco-label, and is expected to be less familiar to the participants.

While the two tablets (Iameco and Samsung) have similar functional characteristics and approximately the same market price, they differ with respect to lifecycle emissions. In addition, they might differ in other relevant dimensions (such as perceived quality, attractiveness, and familiarity, which we elicit in a post-experimental questionnaire). Such differences do, however, not affect the interpretation of the results, since they remain the same across treatments. We decided against using the same brand for the alternative options, such as *Samsung* vs. *green Samsung*, since there is evidence that information about the environmental attributes of the same brand makes the "green" version always more desirable (see Hartmann & Apaolaza-Ibáñez, 2015). With the chosen setup of two brands, we are able to assess the real-word case of shifting choice from a well-known, carbon-intensive brand to a new and less-known, low-carbon alternative. Crucially, all the important features that affect the subjects' choice are present across all treatments. Therefore, any difference between treatments is attributable only to treatment effects and not to the specific differences of the two tablets. For more details on the choice of the products please see S10–12 from the SM.

3.3. Manipulation of advertising and the social norm

In the baseline condition, the Facebook simulated page contained five neutral posts. In the treatment conditions, the Facebook image was identical except for one or two posts that differed depending on the treatment. In treatments involving advertising, the post was a green or non-green advert for Iameco or Samsung respectively, displaying a picture of the advertised tablet and the brand logo below. The slogans used in the simulated ads were taken from actual advertisements of both brands. The Iameco advert had an environmental claim regarding the tablet's carbon emissions which read that "The Iameco touch screen computer has a carbon footprint that is 70% less than the average PC", whereas the advert for Samsung did not use any environmental claims.

In the social norm treatment, the post displayed a Facebook poll where compliance with a low-carbon consumption behavior was either a majority (strong social norm) or minority (weak social norm) of respondents. The social norm used a low-carbon behavior correlated with the one we want to influence (see Kallgren et al., 2000) for a similar norm manipulation). The norm was framed as a poll asking, "Do you use energy-saving light bulbs?" with two possible answers of "yes" or "no". The number of respondents for each option was also displayed. This behavior was taken from a pre-survey ($N = 87$) that explored which low-carbon behaviors correlated with the one we examine, that is, buying low-carbon electronic appliances (see pre-survey results in S9 of the SM). In treatments involving both advertising and a social norm, both types of posts appeared in the Facebook simulated page presented to participants.

In previous studies, social norms have been manipulated by directly stating to subjects that a certain percentage of people undertake a certain behavior (Rhodes et al., 2020). However, such norm manipulation is prone to strong experimenter demand effects (Zizzo, 2010). In particular, when subjects are explicitly told that 'most others chose option x' right before they make their decision, they are more likely to choose x over the alternative(s) for reasons other than the induced social norm. For example, participants might try to adapt their behavior to what they believe to be the experimenter's hypothesis. Moreover, such an approach is difficult to implement in a realistic Facebook setting. Instead, we use an innovative design that introduces the norm using a poll feature that already exists in Facebook, thus allowing for a natural induction of the norm.

The image Fig. 2 shows the Facebook posts used for advertising and social norm manipulations. In combined-effects treatments, both a post with advertising and a post with a social norm were added to the baseline Facebook homepage.

3.4. Hypotheses

To answer our research objectives, we formulate four hypotheses based on the reviewed literature. First, we hypothesize that green and non-green product advertising will shift average consumer choice towards the advertised product relative to the baseline condition. Since the experiment is framed as a choice between a high- and low-carbon brand and the high-carbon brand is well-known by participants, we expect choice in the baseline group to be concentrated in the non-green Samsung brand. Thus, we anticipate more low-carbon choice for participants assigned to the green advertising treatment compared to baseline, and less low-carbon choices if they were assigned to non-green advertising.

A second hypothesis is that low-carbon choice will be higher among participants assigned to the social norm treatments, relative to the baseline condition. Given that the norm aligns what people do (descriptive norm) with what people typically approve of, and in line with the literature (Schultz et al., 2007), we do not foresee the weak social norm to backfire. We do, however, expect the weak norm to have a smaller positive effect than the strong norm.

Third, we hypothesize that the effects of advertising and social norms on participants' choice change when the two instruments are presented together, that is, they interact. We expect participants presented with social norms and green advertising to make more low-carbon choices than those in the baseline since they both induce low-carbon choice. Specifically, we expect that their joint effect (green advertising + social norm) is larger than the sum of their single effects. Conversely, we

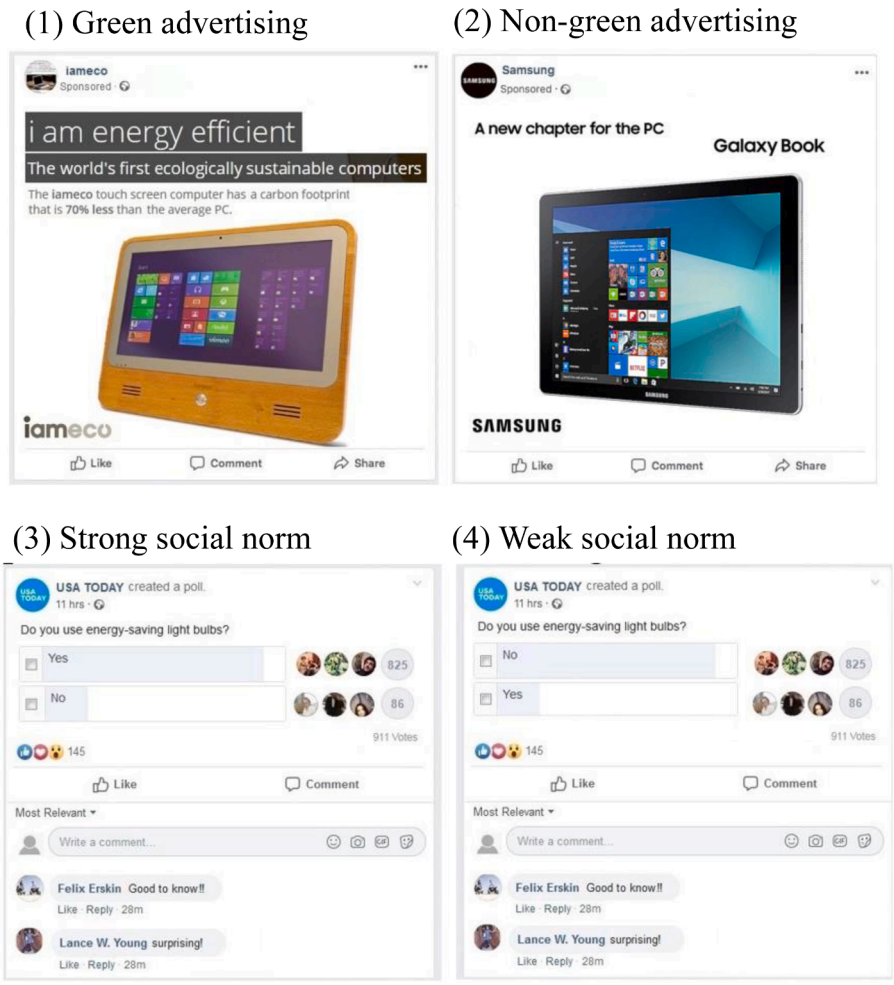

Fig. 2. Experimental stimuli.

expect a negative interaction effect between a social norm and non-green advertising as they enhance opposite choices. That is, we hypothesize that low-carbon choice will be higher than in the case participants are presented with non-green advertising alone, but lower than when presented with social norms alone.

Finally, our fourth hypothesis is about the mechanisms and mediating channels of advertising and social norms to affect behavior. Consistent with previous research, we predict that the mediating variables underlying the influence of advertising and social norms on behavior are different. In particular, we expect advertising to influence behavior mainly by affecting consumers' perceptions of the product advertised, while social norms to influence behavior by activating personal norms.

4. Experimental results

4.1. Treatment effects

Across treatments, most participants chose the well-known carbon-intensive tablet (Samsung), while only 15.6% (419 out of 2728) opted for the low-carbon tablet (Iameco). This is not surprising given that 99.9% of participants reported previous knowledge of the Samsung brand, while only 8% reported previous knowledge of the Iameco brand (further details on sample and demographics are provided in S2 from the SM). We first look at results for advertising-only and social-norm-only treatments. Fig. 3 shows the difference in mean choices of the low-carbon product (Iameco) between treatment and baseline, indicating their effectiveness at shifting choice towards the low-carbon option. Results show that green advertising and strong social norm treatments significantly affect low-carbon choice after controlling for socio-demographic factors (see results of logistic regression in SM S3). In the baseline condition 7.6% participants chose the low-carbon option, showing this represents a non-trivial decision where the vast majority prefer the non-green tablet from the familiar brand Samsung. However, in the treatment with the strong social norm, the low-carbon choice (Iameco tablet) is almost twice that of the baseline (13.1%, $p = 0.016$), while the weak social norm has a smaller, yet still (marginally) significant effect (11.5%, $p = 0.055$). Nevertheless, the effects between strong and weak social norms are statistically indistinguishable ($z = 0.601$; $p = 0.5479$, Mann Whitney (MW) test), suggesting that behavioral effects may be present merely due to norm exposure, regardless of its strength. To our knowledge, this is novel evidence for the effect of implicit social norms regarding low-carbon consumption on other consumption choices.

Bars show the proportion of participants that chose the low-carbon option in baseline, alongside conditions with only the social norm (weak/strong) or only advertising (green/non-green). Error bars indicate 95% confidence intervals.

Green advertising, however, almost quadruples low-carbon choice compared to the baseline (27.8%, $p < 0.001$). Importantly, this increase is more than double that of the strong social norm treatment ($z = 4.488$; $p < 0.001$, MW test), revealing its high effectiveness at influencing choice. Lastly, non-green advertising had virtually no effect (7.9%; $p = 0.833$), something to be expected given the already very high percentage of participants choosing the high-carbon option (See the complete matrix with MW tests in SM S4).

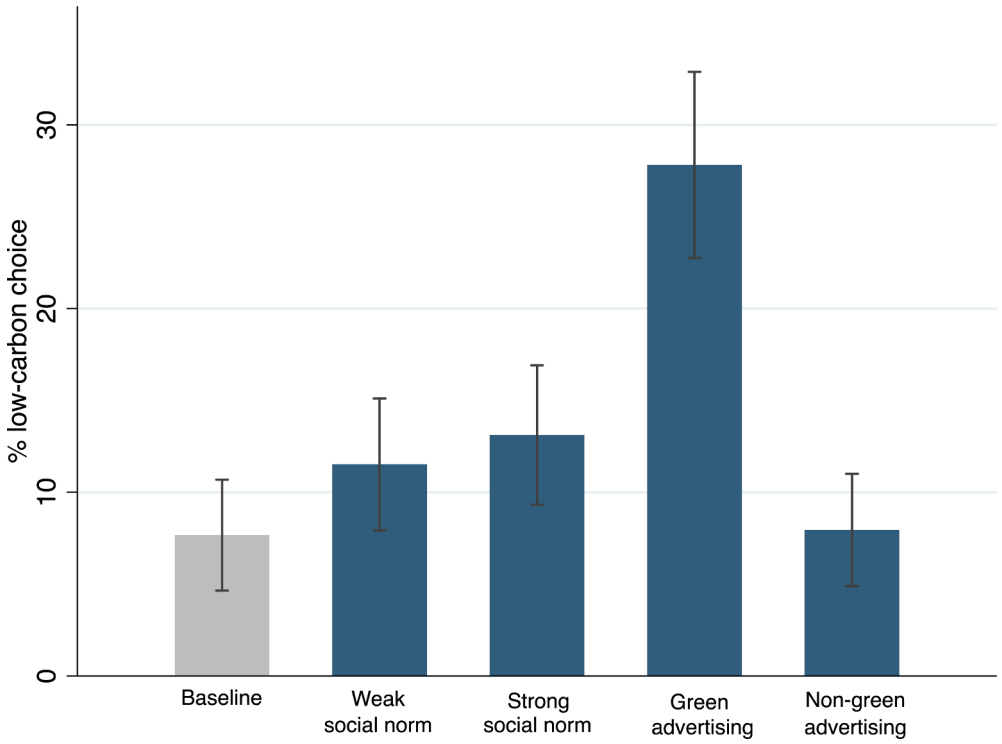

Fig. 3. Isolated effects of advertising and social norm on low-carbon choice.

When analyzing treatments combining social norms and advertising, the dominant role of advertising is further revealed. Fig. 4 shows the percentages of participants choosing the low-carbon product across all nine treatments. Treatments involving green and non-green advertising are depicted in green and red respectively, while treatments without any advertising are depicted in blue. The green- and red-shaded areas depict the 95% confidence intervals of the green and non-green advertisement treatment, respectively, without any social norm manipulation. The figure reveals that there are no interaction effects between advertising and social norms. When they are combined, shares of low-carbon choice are almost exclusively determined by advertising. Combining green advertising with a strong social norm does not significantly increase the

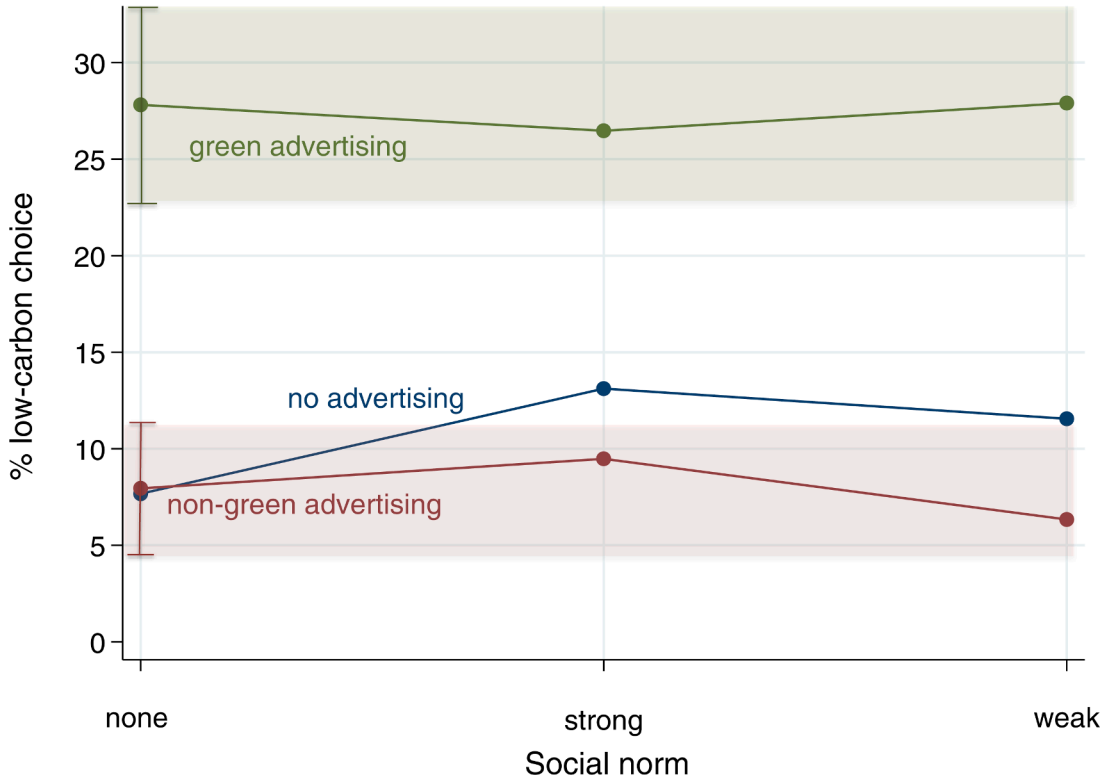

Fig. 4. Combined effects: Green and non-green advertising counteract social-norms.

share of the low-carbon choice compared with the green advertising-only treatment. In fact, mean Iameco choice slightly decreases from 27.8% to 26.4% ($z = 0.397$; $p = 0.692$, MW test) and the same occurs when green advertisement is combined with a weak social norm ($z = -0.025$; $p = 0.980$, MW test).

Visually, this is depicted by low-carbon choice always remaining within the 95% confidence interval of green advertising only. Similarly, combining non-green advertising with either a strong or a weak social norm does not significantly change low-carbon choice compared with the non-green advertising-only treatment ($z = -0.668$; $p = 0.504$, and $z = 0.779$; $p = 0.436$, MW tests, respectively) and choice remains within the 95% confidence interval of non-green advertising only. It is worth noting, however, that both green and non-green advertising have greater dominance over the weak norm than over the strong norm; whenever combined with the weak norm, advertisement causes larger changes towards what is advertised. To summarize, in the absence of any advertising effects, social norms for low-carbon consumption might appear as effective in shifting choice towards low-carbon products. However, when social norms are communicated in the presence of advertising, their effects are practically nullified.

The dots in the graph display the share of low-carbon choice for advertising and social-norm nudges, and its combinations. Green and red colored dots display treatments presenting green and non-green advertising respectively, while treatments without any advertising (baseline and social norm only) are depicted in blue. The x-axis indicates the presence of a social norm nudging towards low-carbon consumption and its type (weak/strong). Shaded regions depict 95% confidence intervals for green and non-green advertising only treatments.

5. Mechanisms and decision channels

5.1. Recall

To explore the reasons behind the dominance of advertising over the social norms (and especially of green advertising), we first examine whether more subjects observed the product advertisements than the social norms posts. Even though both stimuli were of the same size in the Facebook image, it can still be the case that advertising triggers more attention, for reasons such as the presence of brighter colors or more attractive images, or simply because people are more used to check out ads than posts in Facebook. The dominance of the green advertisement would then be on the grounds of attention.

To test this, we asked subjects whether they remembered having seen the stimuli that they were presented with, i.e., either the post with the social norm or the advertisement. Correct answers were monetarily incentivized. Of respondents, 52% recall having seen the Iameco ad and 76.5% the Samsung ad. The post with the strong social norm was recalled by 55% of the subjects, and with the weak social norm by 42.7%. Therefore, the percentage of subjects aware of the stimuli in the green advertising and the social norm treatments are statistically indistinguishable.

This suggests that, a similar percentage of subjects were "treated" across treatments (which is comforting from an experimental design point of view: a significantly higher percentage of treated subjects might point at an experimental artifact). To explore this further, we compare low-carbon choices between each subgroup within each treatment: those who recall having seen the stimuli (the "treated" subjects) and those who do not (the "untreated" subjects). One should expect the probability of choosing the Iameco tablet to be the same among subjects assigned to the baseline and among those not remembering being presented with the stimuli. Likewise, the probability of choosing the low-carbon tablet should be higher for those who were aware of being presented with the advertisement or social norm. Fig. 5 presents the results: low-carbon choice among participants who do not recall the social norms is not statistically different from the baseline ($z = -0.390$; $p = 0.6966$, MW test). Yet, in the advertising treatment, even theoretically "untreated" subjects (those not recalling the Iameco ad) chose Iameco with higher probability than in the baseline treatment (20% vs 7,6%, $z = -7.280$; $p < 0.001$, MW test). These results suggest that green advertising might be affecting subjects via less conscious channels.

The figure compares low-carbon choice between participants who remember being present with the stimuli in the attention test and those

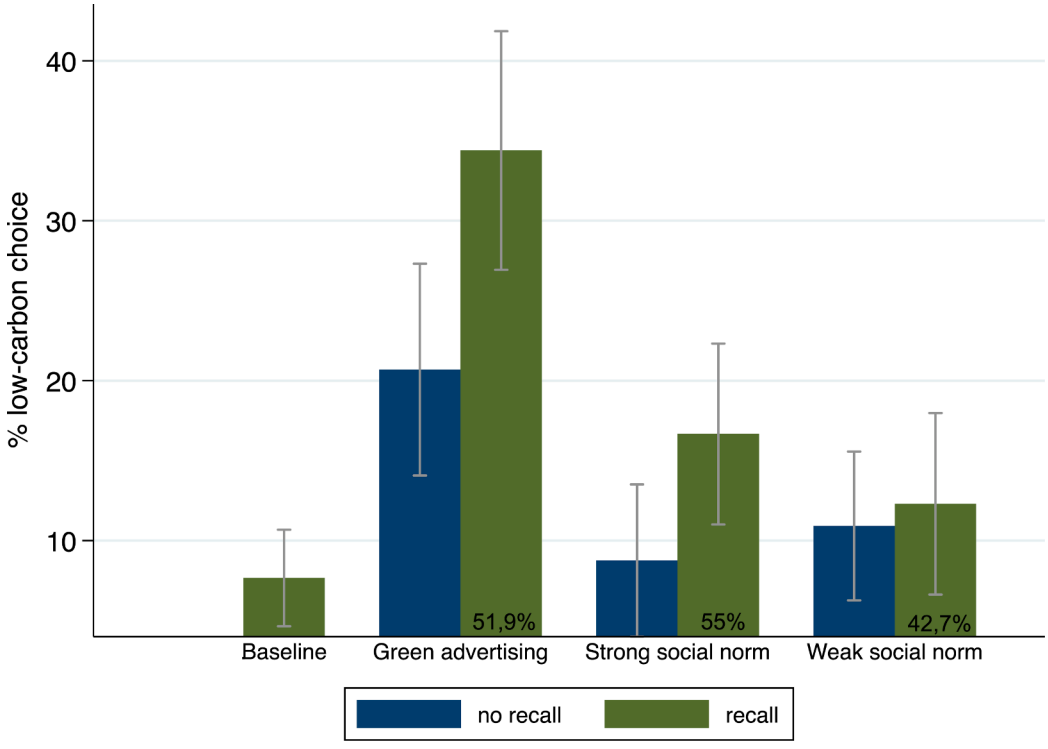

Fig. 5. Low-carbon choice among participants that recall and do not recall the stimuli.

who did not, both relative to the baseline treatment. The percentages in the bars show the total proportion of participants in the treatment that remember being presented with the stimuli.

5.2. Mediation analysis for advertising and social norms

In this section we investigate the decision channels through which advertising and social norm influence choice, i.e. the extent to which treatment effects are explained by participants' (a) product perceptions and/or (b) psychological constructs triggering norm activation, as suggested in the literature. To analyze this, we use responses to the post-experimental survey, which measured each of these dimensions. We perform an estimation using a Structural Equation Model (SEM) rather than simple regression techniques, in order to properly establish whether there are mediation effects (see Frazier et al., 2004). Can, for example, an increased perception of the quality of the Iameco tablet, generated through green advertising, significantly predict participant choice? Using a SEM estimation enables us to test simultaneously this effect and other relationships between the proposed variables.

We construct a behavioral model to identify the specific channels through which advertising and the social norm affect low-carbon choice in the experiment Fig. 6. According to the literature, advertising affects choice via improved perceptions and attitudes towards the products (Zajonc, 1968). Thus, we include product perceptions such as quality, popularity and environmental impact as potential mediators of advertising effects on low-carbon choice. Furthermore, social norm effects are attributed to peer effects and the activation of personal norms. While the previous analysis shows that peer effects are significant, there are no differential effects between the strong and weak social norm in terms of a majority versus minority of people complying with the norm. Here we focus here on norm activation as the mechanism of influence. The relevant psychological constructs for norm activation (Schwartz, 1973) in the case of low-carbon consumption are: (a) environmental concern (here specifically "climate concern"); (b) feeling of responsibility regarding the environmental impact of one's consumption emissions ("climate responsibility"); and (c) the belief that consumption decisions are significant for the environment ("self-efficacy"). We measured these variables through a post-experimental survey and used them to assess all of the potential relationships they might have with the observed treatment effects of advertising and social norms (see SM S5).

Our measurement model for low-carbon choice uses $N = 1488$ observations from baseline, advertising and social norm treatments. Treatments combining both instruments (norm and advertising) were excluded due to the impossibility of disentangling their separate effects on choice. Overall, the structural model estimates: (a) effects of advertising and the social norm on participants' product perceptions and norm activation variables, (b) effects of product perceptions and norm activation variables on low-carbon choice, and (c) direct effects of social norms and advertising on choice. The results show that the model has a good fit (χ^2 =34.934 [df =9]***; RMSEA=0.044; SMRM=0.025; CFI=0.985), explaining 22% of the variance in choice (see SM S6–8 for measurement details). Fig. 6 shows the estimated relationship between treatments, mediators and choice in the form of a path diagram. The lines in the diagram in Fig. 6 indicate significant estimates ($p < 0.05$) and show the corresponding coefficients.

The results from the SEM estimation help identifying the channels through which each treatment affects behavior. Non-green advertising has no direct effect on low-carbon choice but, surprisingly, it negatively influences the quality perception of the low-carbon product (β=−0.18; $p = 0.023$), which among all mediators is the largest predictor of choice (β=0.073; $p<0.001$). As for green advertising, it shows both direct (β=0.12; $p<0.001$) and indirect effects on choice through increasing perceptions of all product characteristics as expected from the literature (quality β=0.30, popularity β=0.35 and environmental impact β=0.70;

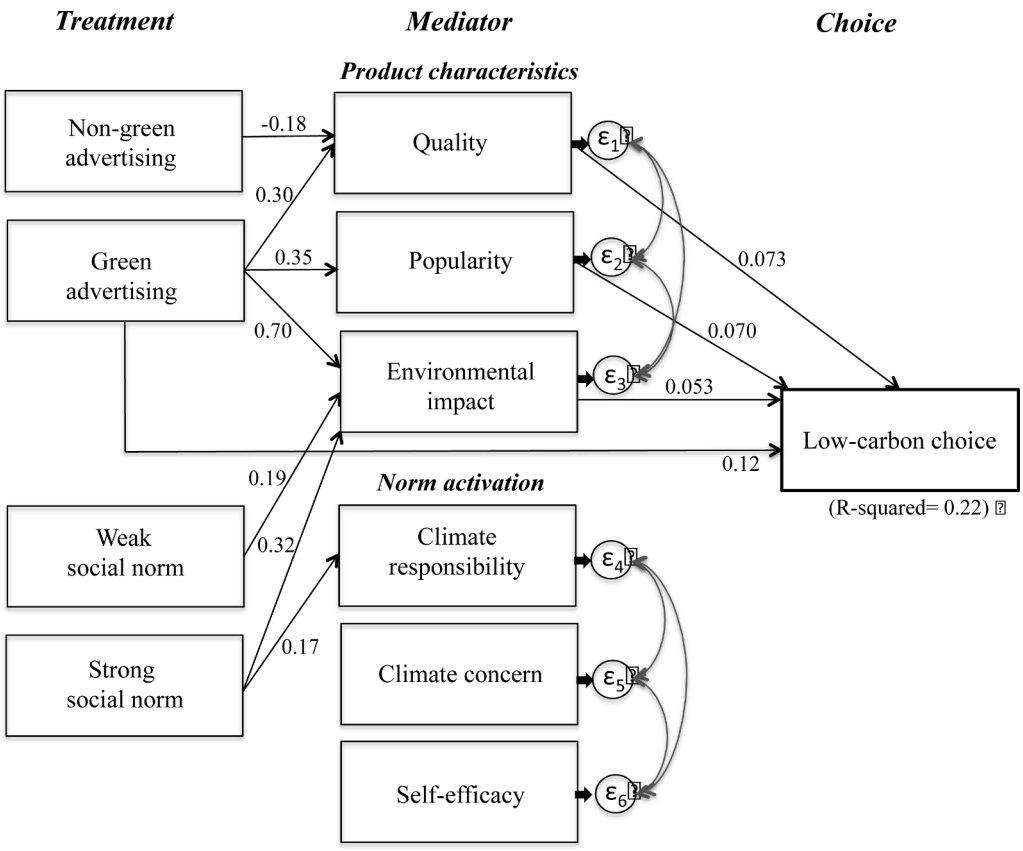

Fig. 6. Direct and Indirect Effects of Advertising and the Social Norm on Low-Carbon Choice.

$p < 0.001$). Weak and strong social norms have no direct effects on choice, while both significantly increase the perceived environmental impact of the product (β=0.19; $p = 0.014$ and β=0.32; $p<0.001$, respectively). Although environmental impact predicts choice (β=0.053; $p<0.001$), it does so to a lesser degree than the other product characteristics that are influenced by advertising. Weak norm effects are limited to influencing environmental impact, whereas the strong social norm also has a positive effect on climate responsibility (β=0.17; $p = 0.031$). Nonetheless, this does not translate into increased low-carbon choice since none of the variables for norm activation have a significant effect on low-carbon choice.

Lines indicate significant relations ($p<0.05$) between treatments, mediators and choice. Covariances between-error terms (ε_i) included to account for omitted-variable bias.

Overall, the SEM analysis reveals the underlying reasons behind the observed treatment effects. Particularly, it shows that advertising involves the strongest channels for influencing behavior. While product attitudes are the strongest predictors of choice and are affected by advertising, norm activation is not fully achieved by the social norm, and thus cannot explain low-carbon choice. In fact, the effect achieved by norm communication in this case is through affecting a product attitude, namely the perceived environmental impact, which is the same as by advertising. Nevertheless, the influence of green advertising on the environmental perception of the Iameco tablet is larger than that of the social norm. This can explain the dominance of advertising over norm communication and highlights a new channel, different to norm activation and peer-influence, through which a social norm for low-carbon consumption can affect low-carbon choice.

6. Discussion

The experiment provides evidence on the effectiveness of advertising and social norm communication in shifting choice from a highly-advertised carbon-intensive product to a low-carbon alternative. The results reveal that both green advertising and low-carbon social norms presented through an imitation Facebook homepage were effective in shifting choice towards lower carbon alternative. In isolation, green advertising is twice as effective at shifting consumption towards low-carbon product as the social norm for low-carbon consumption. No evidence of positive interactions between advertising and social norms was found. When combined, we observed a dominance of advertising in discouraging (non-green adverts) or incentivizing (green adverts) low-carbon choice. This suggests that in the presence of advertising for highly known carbon-intensive brands, communicating a social norm is insufficient to induce relevant behavioral changes towards low-carbon consumption. Similarly, in the presence of green advertising, communicating a social norm adds little. These results provide novel evidence on social norms nudging low-carbon consumption in a more realistic setting and in presence of advertising, which contributes to broader research on how social norms perform under different contextual factors (Bergquist et al., 2019).

The reasons underlying the dominance of advertising over social norms were explored by performing an analysis of the mechanisms and decisions channels used by both stimuli to influence choice. Results show green advertising is able to influence choice even if participants do not recall the ad, suggesting an unconscious mechanism. Moreover, the SEM analysis employed shows that, in line with theory, commercial advertising affects attitudes towards products. However, we discover additional limitations to shifting choice from highly-advertised brands towards low-carbon ones. Participants exposed to Samsung's advertising not only perceived this brand better, but importantly, considering quality was the largest predictor of choice among product characteristics, also perceived a lower quality of the low-carbon alternative (Iameco).

Communicating a social norm through a Facebook poll, on the other hand, did not achieve the expected influence on choice strictly by norm activation or by peer effects. Instead, it influenced choice through improving environmental perceptions of the product. To our knowledge, this is a novel result about how norms can affect consumption choices through influencing perceptions of product attributes. The finding that both green advertising and social-norm communication influence behavior through changing participants' perceptions of the products` associated environmental impact might explain the lack of positive interactions when they are combined.

It must be considered when interpreting results that green advertising was specific to a product ("buy Iameco"), while the social norm nudging low-carbon consumption (buying energy saving lightbulbs), addressed a consumption behavior that was correlated but not specific to the target product. Using distinct behaviors was done to avoid demand effects. This can partly explain the smaller effect of the social norm compared to advertising. Moreover, we present a novel norm manipulation that shows how a Facebook post can be used to increase conformity with low-carbon consumption. It should be noted, though, that different representations of a norm in a Facebook homepage might affect the strength of its effects. Further research could test whether communicating a more explicit or specific norm results in stronger effects on choice. Yet, for policy-making to communicate social norms separately for every product, or even brand, would be extremely costly and thus practically impossible. It might also cause negative reactions from consumers feeling manipulated. Indeed, the social norm used here was implicit enough to expect norms related to low-carbon consumption to have similar or even stronger effects on choice.

A complementary explanation for the dominant effect of advertising over norms derives from the notion of cognitive effort. This can be explained by short messages and graphic cues contained in advertising requiring relatively little mental processing in comparison with social norms (Garbarino & Edell, 1997; Zajonc, 2001). This may also explain the non-conscious effects achieved by advertising, i.e. it was able to influence choice even when participants were not aware of having seen the ad. Nudge-like policies aimed at discouraging high-carbon consumption with social norms could also follow the principles of good advertising (Burchell et al., 2013). Copying advertising strategies such as use of images, repetition and framing will make messages in norm-communication capable of rapidly becoming familiar to people and effectively influencing their choices. This is in line with research showing that consumers can reduce their carbon footprint when information is simple (Camilleri et al., 2019; Kanay et al., 2021) and when choices involve low cognitive effort (Isley et al., 2016),

Finally, while the obtained results could be interpreted as a supporting the belief that commercial green advertising by firms is an effective way to encourage the consumption of low-carbon alternatives, the risk of misinformation and false green claims remains a reason for skepticism (Schmuck et al., 2018). It is known that consumers tend to perceive any product that claims to be "green" in some dimension as being less environmentally harmful in general (Gershoff & Frels, 2015; Magnier et al., 2016). Even people that are well informed or have pro-environmental inclinations may be sensitive to such confusion. Therefore, governments should, in the interest of welfare and environment, regulate what can and may be advertised as low-carbon or green.

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Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socec.2022.101956.

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