

Carbon Emission Reductions and Offsets: Consumer Perceptions of Firm Environmental Sustainability

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This paper studies how carbon emission reductions and offsets influence consumer perceptions of firm environmental sustainability. We hypothesize that consumers perceive firms that reduce (vs. offset) internally (vs. in the supply chain) as more sustainable, since these options are perceived to take more effort, used as a heuristic for altruism and sustainability. We also hypothesize that knowledge about climate change and offsets reduce the reliance on effort. The results from three experiments show that firms that reduce are perceived as more sustainable than firms that offset emissions, and that this effect is mediated through perceived effort and altruism. Reducing or offsetting internally (vs. in the supply chain) does not influence perceived sustainability, and knowledge about climate change or offsets does not reduce the effect of reduction (vs offsets). Employee participation in the offsetting does not increase perceived effort and sustainability.

Keywords: *Carbon offsets, firm sustainability, carbon emissions, effort, altruism*

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1. Introduction

How do different types of carbon emission reduction initiatives influence consumers' perceptions of how environmentally sustainable a firm is? Due to concerns about climate change, stricter regulations, and pressure from stakeholders, firms work to manage and reduce their greenhouse gas emissions (Cadez et al., 2019). To reduce their net emissions, firms reduce emissions in their own internal operations, work to reduce emissions downstream and upstream in the supply chain, and use carbon offsets (Dahlman et al., 2019). Apple, for instance, reduces CO₂ emissions from their own direct activities, works to reduce emissions in their supply chain, and invests in CO₂ offsets (Apple Inc 2022). Carbon offsets compensate for carbon emissions from the company's activities by reducing or removing carbon emissions elsewhere, unconnected to the company activities. Offsets can be made through investments in renewable energy replacing emissions-heavy energy, carbon capture and storage, or through tree-planting (Dahlstrom, 2022; Warburg et al., 2021).

Firms' climate initiatives are frequently communicated in webpages, sustainability reports and advertising (de Grosbois and Fennell, 2022; Zheng et al., 2023), but little is known about how the different initiatives influence consumers' perceptions of firm environmental sustainability. This is important, since previous research has shown that sustainable firms achieve higher brand loyalty, higher willingness to pay, and better perceived quality (Sen et al., 2016). Consumers typically have limited knowledge about carbon emissions and find it difficult to make good environmental choices (Wynes et al., 2020) but realise that carbon emissions are an important part of environmental sustainability (Hans and Böhm, 2012).

This paper therefore studies how the different carbon emission reduction strategies influence the perceived environmental sustainability of the firm. We hypothesize that firms that reduce their emissions, especially internally, are perceived as more sustainable than those who offset. Our theoretical predictions are based on perceived effort as a heuristic for altruism and sustainability. Perceived effort has been found to influence judgements of quality and morals (Kruger et al., 2004; Celniker et al., 2023), and we suggest that consumers also evaluate the sustainability of firms' carbon emissions strategies partly based on perceived effort. We expect a company that is seen to put a lot of effort into a sustainability activity to be perceived as more altruistic and, hence, also more environmentally sustainable, compared to another equally effective action taking less effort.

We test our hypotheses using online experiments, a suitable method in sustainability research when researchers want to control the intervention to secure high internal validity (Caniglia et al., 2017) and achieve high response quality (Douglas et al., 2023). In three pre-registered experiments, we manipulate information about how the firm manages carbon emissions (reductions and/or offsets, studies 1-3), whether this takes place in-house or in the supply chain (Study 1), whether the respondents are given knowledge about offsets (Study 2), and whether employees are actively involved in the offsetting or not (Study 3).

The current research offers the first test of how carbon emissions reductions strategies influence perceived sustainability, and it contributes to the growing theory on the role of effort in evaluations of firm strategies (e.g. Garcia-Rada et al. 2022). The findings hold crucial implications for practical application. They suggest that directly reducing emissions yields stronger perceptions of sustainability compared to relying on offsets. The location of these emission reductions or offsets, whether internal or within the supply chain, does not significantly impact the perception of sustainability.

In the following, we discuss the theoretical rationale for our predictions. We then report the results of the three studies and conclude with a discussion of the results and their implications.

2. Theoretical background

2.1. Consumers, carbon emissions and perceptions of corporate sustainability

Being perceived as a sustainable or responsible brand or firm has positive consequences (Sen et al., 2016). Engaging in socially responsible behavior can benefit consumers' overall brand attitudes (Sen and Bhattacharya, 2001), protect against accidents or crises (Klein and Dawar, 2004), improve perceived product quality (Chernev and Blair, 2015), and increase willingness to pay (Tully and Winer, 2014).

Consumers are increasingly concerned with climate change (Bergquist and Warshaw, 2019) and see carbon emissions as a part of corporate environmental sustainability (Hans and Böhm, 2012). However, they often have limited knowledge about climate emissions and find it difficult to evaluate different behaviors and options (Wynes et al., 2020, Grinstein et al., 2018). Therefore, consumers often rely on cues and heuristics to make consumer choices or evaluate options or firms. For instance, consumers most often mention buying organic or local as strategies to reduce emissions from food products, while few mention more efficient

strategies such as avoiding meat, dairy and air-transported products (Kause et al., 2019). Products from local and small firms are typically seen as more environmentally friendly, even if this is not necessarily the case (Larranaga and Valor, 2022).

When it comes to carbon offsets, consumers also generally have limited knowledge, are skeptical of firm's motives for using offsets, and have little trust in the offsetting sector (Haug and Hassinggard, 2023, Karhunma et al., 2023). Partly as a result, very few consumers are willing to pay to offset their CO2 emissions. In a sample of bookings at a European airline, 4% of customers bought an offset, and the mean willingness to pay was very low (Berger et al., 2022).

2.2. Corporate effort and sustainability

Our general theory is that when consumers find the effects of sustainability initiatives difficult to judge, they rely to some degree on the effort done by the company. In a series of experiments, Kruger et al. (2004) established the “effort heuristic”. Effort is the amount of energy or force put into a behaviour (Mohr and Bitner, 1995). A heuristic is “a strategy that ignores part of the information, with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods” (Gigerenzer and Gaissmaier, 2011, p. 454). According to the effort heuristic, effort is used as a heuristic for quality when quality is difficult to assess. Kruger et al. (2004) find that the same poem is better liked when told that it took more time for the poet to write it, that a painting is evaluated more positively when respondents were told that it took more time to paint, and that a set of arms and armour is rated as being of better quality when told that it took more time to make it for the blacksmith (Kruger et al., 2004).

In a recent replication study, Ziano et al. (2023) find support for this heuristic in two out of three experiments, although the effect seems weaker and more context-specific than previously thought. Effort also impacts concepts closely related to quality, such as satisfaction. Consumers evaluate a donation offer by a firm more positively when more effort is used (Ellen et al. 2000). Söderlund and Sagfossen (2017) find that company effort in services increase consumer satisfaction, and Morales (2005) finds that effort increases willingness to pay and agent ratings.

The influence of effort extends to evaluations of morals. Across cultural contexts, workers who exert more effort are seen as more moral and deserving of more compensation (Celniker

et al., 2023). For instance, a runner that use more effort to achieve a result was perceived to be more moral and preferred for a later trust-based task, and respondents were more likely to donate to a fundraiser where the runner had run a marathon than when the runner had run a 5k, partly because he was seen as more moral (Celniker et al., 2023). A person and company giving time rather than money was seen as more caring, moral, socially responsible, and heartfelt (Reed II et al., 2007).

If effort is a heuristic, it should be particularly relevant when quality, in our case sustainability performance, is difficult to assess. Kruger et al. (2004) found that effort was more important under conditions of high ambiguity (in their experiment, when an image was blurred). Hence, it may be that consumers with less knowledge rely more on heuristics. However, Kruger et al. (2004) did not find a moderating effect of expertise on the effect of effort on liking of a painting.

We argue that effort will lead to higher levels of perceived altruism, which is highly related to morals. Altruism in this context is corporate actions that enhance the welfare of society even at the expense of the company's own benefits (Rim et al., 2016). Effort and altruism have been linked before, consumers feel like better caregivers when they put more effort into the caregiving, since effort is a sign of love (Garcia-Rada et al., 2022). Previous research has found that the perceived motivation of the firm as altruistic is important for the consequences of sustainability. Only when the firm motivation was perceived as benevolent (vs. self-interested) did consumers perceive product quality as higher in Chernev and Blair (2015). Habel et al. (2016) found that only consumers who attributed the sustainability activities to intrinsic firm motivation perceived higher prices due to the sustainability activities as fairer.

2.3. Reductions, offsets and perceived sustainability

Regarding reductions versus offsets, we theorize that consumers will perceive carbon reductions to take more effort than carbon offsets. Market-based solutions are generally seen as taking less effort. For instance, donating products instead of money is perceived to take more effort for a firm (Ellen et al., 2000). Donations of time is perceived to take more effort than donations of money (Langan and Kumar, 2019). This effect is partly explained by time-based donations being perceived as more costly (even when the cost is equal), since time is more related to the self (Johnson and Park, 2021). We extend this to purchasing offsets versus doing the work of reducing carbon emissions, where buying offsets should be seen as less effortful. Offsets are a simple market transaction, requiring money but no true effort.

Reducing emissions, on the other hand, will be perceived as effortful by consumers, requiring money but also company efforts to change processes and technology. As a result, the reducing firm will be seen as more effortful, altruistic, and finally more sustainable. This is supported by related research, Roemer et al. (2023) find that consumers have preferences for and willingness to pay for reductions (versus offsets). H1 is therefore as follows:

H1: Firms that reduce (vs. offset) carbon emissions are perceived by consumers as more sustainable.

We expect that the same logic will apply to the choice between reducing or offsetting internally (done by the firm) vs. externally (in the supply chain, upstream or downstream). We expect consumers to perceive internal measures to take more effort than external efforts, since external efforts will be implemented by others, requiring little effort from the focal firm, even if this is not necessarily the case. The internal reductions will be perceived by consumers to involve true efforts to change processes and technology inside the firm. Again, the effortful firm will be seen as more altruistic, and therefore more sustainable. This has been supported by related research which has found that internal responsibility practices have more impact on consumer attitudes and behavior than external responsibility practices (Buell and Kalkanici, 2021). H2 is therefore:

H2: Firms that reduce or offset carbon emissions internally (vs. in the supply chain) are perceived by consumers as more sustainable.

As explained above, our theoretical explanation for H1 and H2 is the effect of reduction (vs offsets) and internal (vs external) initiatives through effort and altruism, which will finally influence perceived sustainability. In H3, we test the mediating effect through effort and altruism:

H3: The effects of reducing (vs. offset) and internal (vs. supply chain) on perceived sustainability and brand attitude are mediated through perceived effort and altruism

If effort is used as a heuristic to evaluate firm sustainability, more knowledge about climate change and carbon offsets should reduce the effect of reducing vs. offsetting and implementing the changes internally vs. in the supply chain. Heuristics are used when other methods are demanding including when performance is difficult to assess (Kruger et al. 2004). A consumer with more knowledge about climate change and CO2 offsets should rely

less on effort as a simple heuristic and more on evaluating the actual results of the initiatives, regardless of the chosen technology and whether the measures were taken internally or externally. H4 is therefore:

H4: Knowledge about climate change and CO2 offsets reduces the effects of reduce (vs. offset) and internal (vs. supply chain) on perceived sustainability


3. Study 1

We conducted a pre-registered 2 (Reduction vs. Offset) × 2 (Internal vs. Supply chain) experiment. The data was collected on Prolific’s online panel with UK-based respondents (n = 807, balanced 50-50 men and women). The pre-registration, materials, data, and analysis code are available online².

3.1. Procedure

We first measured respondents’ knowledge about climate change using twelve items from Shi et al. (2016) and knowledge about carbon offsets using six items from Polonsky et al. (2012). Respondents then read a press release from Indigo Jeans (fictitious) (Table 1). The text was designed to manipulate whether the company reduced or offset CO2 emissions, and whether this action happened internally or in the supply chain. Respondents were randomly assigned to the experimental conditions.

Table 1: Manipulations (Study 1)

Introduction (all respondents)		
Press release: Indigo Jeans commits to reduce net CO2 emissions by 70%		
<p>About Indigo Jeans: One of the world’s fastest growing producers of jeans, Indigo Jeans is known for style and value for money. With a strong legacy dating back to 1990, the brand holds a clear position in the sphere of low-cost but trendy jeans. Indigo Jeans is headquartered in the UK and has sales all over the world. Manufacturing takes place in the UK and several European and Asian countries.</p>		
<p>London, UK – Leading jeans brand Indigo Jeans today revealed its plans to reduce net CO2 emissions by 70% before 2030. “Businesses have a profound opportunity to help build a more sustainable future,” says Tim Henwood, Indigo Jeans CEO.</p>		
	Reduction	Offset
Internal	<p>Net reduction in own production The net CO2 reductions will mainly result from reduced carbon emissions from its own production facilities. All energy used in production will come from renewable</p>	<p>Planting trees in own forest gives net reduction The net CO2 reductions will mainly result from Indigo Jeans removing CO2 from the atmosphere by planting large amounts of trees. Trees capture CO2 from the atmosphere and store the carbon in</p>

² <https://researchbox.org/1010>

	sources, including solar panels that will be installed in factories. Trucks will be replaced with non-polluting alternatives using electricity or hydrogen. All production processes will be reengineered to eliminate emissions	their leaves, stems, and roots, eventually increasing the carbon stored in soil. Every year, Indigo will plant 100 000s of trees on its own suitable land.
Supply chain	Suppliers behind net reduction The net CO2 reductions will mainly result from reduced carbon emissions in suppliers' production facilities. All energy used in production will come from renewable sources, including solar panels that will be installed in supplier's factories. Trucks used by transport providers will be replaced with non-polluting alternatives using electricity or hydrogen. All suppliers will reengineer their production processes to eliminate emissions.	Paying for tree-planting gives net reduction The net CO2 reductions will mainly result from Indigo Jeans removing CO2 from the atmosphere by paying for the planting of large amounts of trees. Trees capture CO ₂ from the atmosphere and store the carbon in their leaves, stems, and roots, eventually increasing the carbon stored in soil. To plant the trees, Indigo Jeans has reached agreements with several partners. Every year, Indigo Jeans will pay for the planting of several hundred thousand trees on suitable land.
<p><u>Conclusion (all respondents)</u> Independent environmental organizations have approved the plans and there is full certainty that the net emissions goals will be reached according to plans by 2030.</p> <p>For Indigo Jeans the commitment will mean tens of millions of pounds in investments, but the company is confident that it will pay off. "Above all, the climate and our common future depend on it", says Henwood.</p>		

Respondents answered manipulation checks, a question about whether the respondents trusted that the initiative would reduce net carbon emissions (trust in the results), and questions measuring the perceived sustainability, effort and altruism. The manipulation check was the questions "How does Indigo Jeans plan to reduce its net emissions going forward?" (Reduce Co2 emissions from the production process or compensate for CO2 emissions by other activities) and "Who will mainly implement the actual changes to reduce net emissions?" (Indigo by itself or Indigo's suppliers/partners). Trust in the result was measured as the response to the question "To which extent do you trust that Indigo jeans will reduce their net emissions as promised? » (1: a little extent, 7: a large extent). Perceived sustainability was measured as the average of eight items taken from Habel et al. (2016) and Alvarado-Herrera et al. (2017): "[the company]: values ecological sustainability; acts in a responsible way regarding the environment; is a company that acts socially responsible; cares for the wellbeing of society; holds high ethical standards; carries out programmes to reduce pollution; protects the environment; uses only the necessary natural resources" (1: fully disagree, 7: fully agree). Effort was measured using the average of six items from Langan and Kumar (2019) and Söderlund and Sagfossen (2017) "Please rate how much effort/energy/extent [the company] put toward managing their carbon emissions": (1 little – 7 a lot/large, for [the company], managing their carbon emissions will be... 1 not effortful/easy/require little work...7 effortful/difficult/require a lot of work). Altruism was

measured using the average of five items taken from Langan and Kumar (2019): “How would you describe [the company]’s motive for becoming climate neutral?” (impure-pure, self-serving-society-serving, selfish-unselfish, reactive-proactive, uninvolved-involved, uncaring-caring, all on 1-7 scales)³.

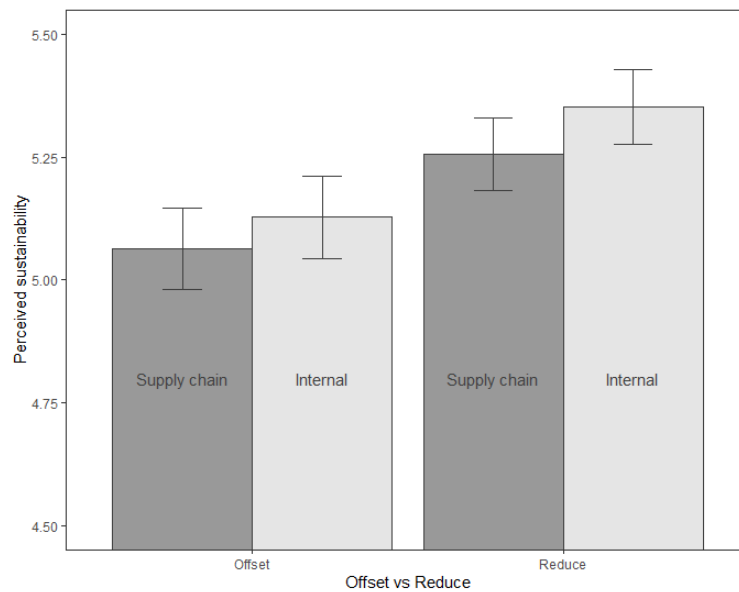
3.2. Results

22 respondents that spent less than 10 seconds on the text about Indigo Jeans were removed from the analysis, as pre-registered (final $n = 785$, mean age = 41.8, 50% female). Chi-square tests showed a significant relationship between the manipulation and perceived reduction/offset ($X^2(1, N = 785) = 422.6, p < .0001$), and between the manipulation and perceived internal/supply chain change ($X^2(1, N = 785) = 161.4, p < .0001$). A confirmatory factor analysis showed that the measurement model had acceptable fit after removing five items ($\chi^2(df) = 565.13(129), p < .0001$, RMSEA = .067, CFI = .971). Final factor loadings ranged from .70 to .97.

Testing hypotheses 1 and 2, a two-way ANOVA showed that respondents in the reduce condition perceived the firm to be more sustainable than the respondents in the offset condition ($M_{REDUCE} = 5.30, SD = 1.17$. vs. $M_{OFFSET} = 5.1, SD = 1.17; F(1, 781) = 6.9, p < .001, \eta_p^2 < .01$). There was no difference between respondents in the internal vs. supply chain condition ($M_{INTERNAL} = 5.24, SD = 1.13$ vs. $M_{SUPPLYCHAIN} = 5.16, SD = 1.11; F(1, 781) = 1.01, p = .31$). Hence, the results provide support for hypothesis 1 but not for hypothesis 2. There was no interaction between reduce/offset and internal/supply chain ($F(1, 781) = .04, p = .84$). Means and standard errors are plotted in Figure 1.

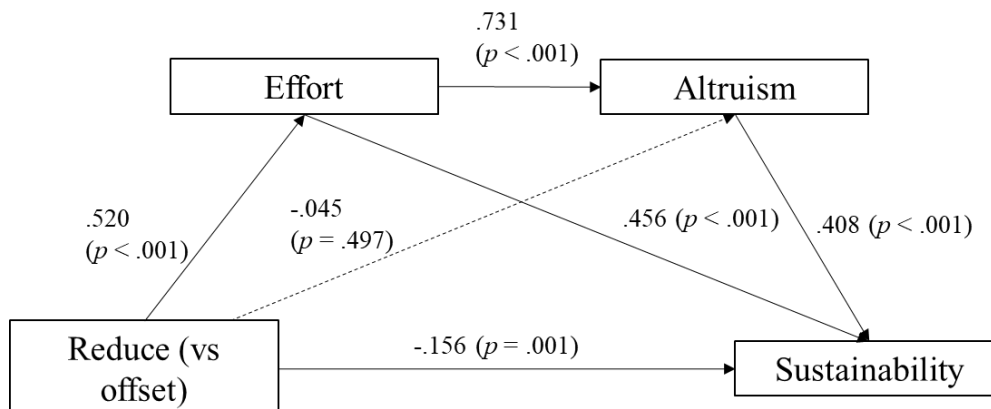
³ In the preregistration, we predicted similar results for brand attitude and greenwashing as for perceived sustainability. We report the results with brand attitude and greenwashing as dependent variable in the web appendix available at <https://researchbox.org/1010>

Figure 1: Means and standard errors (Study 1)



Testing hypothesis 3, a serial mediation analysis using Lavaan (Rosseel, 2012) revealed a significant indirect relationship between reduce (vs. offset) and perceived sustainability through effort and altruism ($b = .155, p < .001$). Also, there was a significant indirect relationship between reduce (vs. offset) and perceived sustainability through effort ($b = .237, p < .001$). Figure 2 plots the results. These effects were still present and significant when including trust in the results as a control variable (indirect relationship through effort and altruism $b = .081, p < .001$, through effort $b = .147, p < .001$). The results provide support for hypothesis 3.

Figure 2: Mediation through effort and altruism (Study 1)



Indirect effects:

Reduce → Effort → Sustainability: $b = .237 (p < .001)$

Reduce → Effort → Altruism → Sustainability: $b = .155 (p < .001)$

A serial mediation analysis revealed a significant indirect relationship between internal (vs. supply chain) and perceived sustainability through effort and altruism ($b = .067, p < .001$). Also, there was a significant indirect relationship between internal (vs. supply chain) and perceived sustainability through effort ($b = .099, p < .001$).

To test hypothesis 4, we estimated regression models with perceived sustainability as the dependent variable and reduce (vs. offset), internal (vs. supply chain), knowledge about climate change and carbon offsets and their interactions as independent variables. Table 2 shows the results.

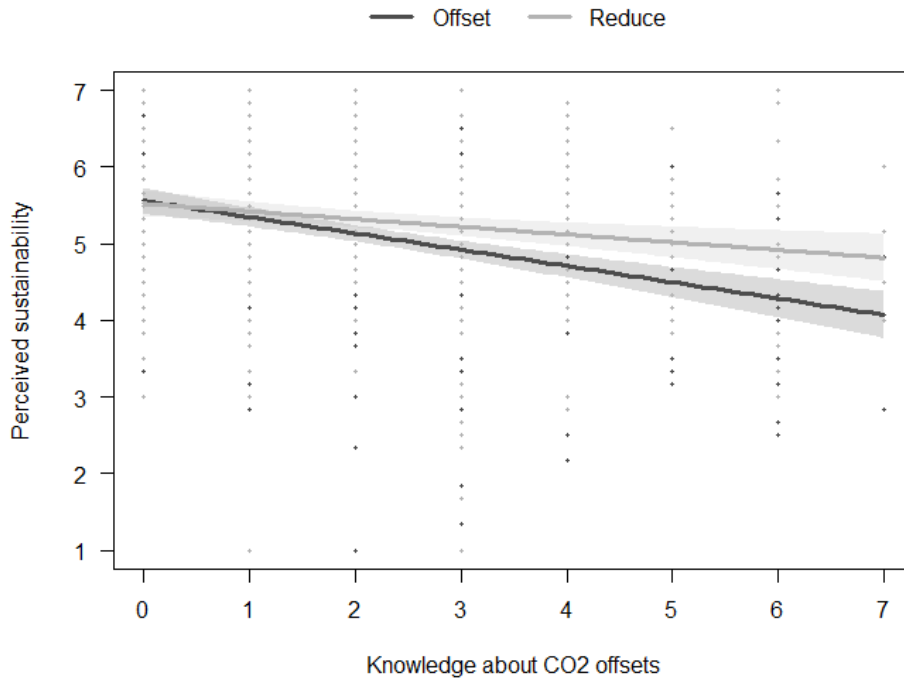
Table 2: Regression results, perceived sustainability (Study 1)

DV: Perceived sustainability	(a)	(b)	(c)	(d)
(Intercept)	5.882*** (.215)	5.562*** (.086)	5.840*** (.227)	5.473*** (.089)
Reduce (vs. Offset)	-.227 (.304)	-.038 (.121)		
Climate change knowledge	-.100*** (.027)		-.084** (.027)	
Reduce × Climate change knowledge	.056 (.037)			
Offset knowledge		-.213*** (.030)		-.142*** (.032)
Reduce × Offset knowledge		.112** (.043)		
Internal (vs. Supply chain)			-.162 (.307)	.137 (.122)
Internal × Climate change knowledge			.027 (.038)	
Internal × Offset knowledge				-.029 (.043)
N	785	785	785	785
R2	.030	.080	.019	.065

* $p < .05$, ** $p < .01$, *** $p < .001$

The interaction between reduce (vs. offset) and climate change knowledge was not significant (Model a). Respondents with more knowledge about offsets perceived firms using offsets as even less sustainable compared to firms reducing (Model b) ($b = .112, p < .001$, standardized coefficient = .18). These results are plotted in Figure 3. This is the opposite of our prediction in hypothesis 4. The interactions between internal (vs. supply chain) and climate change knowledge (Model c) and offset knowledge (Model d) were not significant.

Figure 3: The interaction between reduce/offset and offset knowledge (Study 1)



3.3. Discussion

Study 1 shows that consumers perceive firms that reduce their carbon emissions to be more sustainable than firms that buy carbon offsets. This effect is mediated through effort and altruism. We find no effect of whether the firm implements the carbon emissions initiatives internally or in the supply chain. Contrary to hypothesized, firms that offset are seen as less sustainable among respondents with more knowledge about carbon offsets. We speculate that this is a result of more knowledgeable consumers being more critical of firm sustainability efforts and in particular offsets, which have been criticized frequently in media, also in the UK (e.g., Greenfield, 2021) where we collected the data

A limitation in the study is the focus on extreme options. In practice, many firms use combinations of reductions and offsets. In addition, the study used measured knowledge about carbon offsets, making it difficult to draw causal conclusions. We designed Study 2 to take these limitations into account by using different combinations of reductions/offsets and by manipulating knowledge about carbon offsets.

4. Study 2

We conducted a pre-registered 3 (100% reduction vs. 75% reduction and 25% offset vs. 50% reduction and 50% offset) \times 2 (Information about offsets vs. Control) experiment. The data

was collected on Prolific’s online panel with UK-based respondents (n = 649, balanced 50-50 men and women). The preregistration, materials, data, and analysis code are available online⁴.

4.1. Procedure

Respondents read a press release about Rebel Burgers (fictitious) designed to manipulate the experimental conditions (Table 3). The reduction vs. offset conditions were manipulated by the description of Rebel Burges net zero plan, either reducing 100 %, 75 % or 50 % of emissions and offsetting the remaining. Knowledge about offsets was manipulated by including (vs. not including) a short text explaining carbon offsets. Respondents were randomly assigned to the experimental conditions.

Table 3: Manipulations (Study 2)

<u>Introduction (all respondents):</u>		
<p>Rebel Burgers commits to net zero by 2030 <i>About Rebel Burgers:</i> Rebel Burgers serves street food with inspiration from New York and ingredients from local farms. Founded by a group of London friends in 2015, the chain now has more than 100 restaurants in several countries.</p> <p>London, UK - Burger chain Rebel Burgers today announced its plan to reduce net CO2 emissions to zero before 2030. “Businesses have a profound opportunity to help build a more sustainable future,” says Annabel Clarke, Rebel Burgers CEO.</p>		
	Reduction/offset	Offset info (control: no info)
100% reduction	<p>100% reduction, 0% covered by offsets The plan involves reducing CO2 emissions by 100%. All energy used in restaurants will come from renewable sources. Ingredients will be sourced sustainably, and recipes adjusted to provide equally tasty but not CO2 emitting meals. Rebel will collaborate with farmers and suppliers to eliminate CO2 emissions in the supply chain. This means that there will be no need for purchasing CO2 offsets.</p>	<p>A carbon offset is a removal of carbon emissions made to compensate for emissions made elsewhere.</p>
75% reduction, 25% offset	<p>75% reduction, 25% covered by offsets The plan involves reducing CO2 emissions by 75%. All energy used in restaurants will come from renewable sources. Ingredients will be sourced sustainably, and recipes adjusted to provide equally tasty but less CO2 emitting meals. Rebel will collaborate with farmers and suppliers to reduce CO2 emissions in the supply chain. The remaining 25% of emissions that are hard to avoid will be compensated for by purchasing CO2 offsets from projects capturing and storing CO2 in soils and forests, including tree-planting. Every year, Rebel will pay for the planting of large amounts of trees in the UK and elsewhere.</p>	<p>Companies can voluntarily buy such offsets to compensate for the climate emissions.</p> <p>Carbon offsets are typically bought from projects that provide renewable energy, improve energy efficiency, or store carbon in soils or forests.</p>
50% reduction, 50% offset	<p>50% reduction, 50% covered by offsets The plan involves reducing CO2 emissions by 50%. All energy used in restaurants will come from renewable sources. Ingredients will be sourced sustainably, and recipes adjusted to provide equally tasty but less CO2 emitting meals. Rebel</p>	<p>Offsets are criticized for often not delivering as promised but are</p>

⁴ <https://researchbox.org/1010>

	will collaborate with farmers and suppliers to reduce CO2 emissions in the supply chain. The remaining 50% of emissions that are hard to avoid will be compensated for by purchasing CO2 offsets. Every year, Rebel will pay for the planting of large amounts of trees in the UK and elsewhere	still seen as relevant for emissions that are hard to avoid. Source: Carbon Offset Guide
<p><u>Conclusion (all respondents)</u> For Rebel Burgers the commitment will mean substantial investments, but the company is confident that it will pay off. "Above all, the climate and our common future depend on it", says Clarke.</p>		

Respondents then answered manipulation checks, and questions measuring perceived sustainability, perceived greenwashing, effort, altruism and brand attitude⁵. Our manipulation check was “How does Rebel burgers plan to reduce its net emissions going forward?” (Reduce emissions 100%, offset 0%, reduce emissions 75%, offset 25%, reduce emissions 50%, offset 50%). The other measures were the same as in Study 1.

4.2. Results

12 respondents that spent less than 10 seconds on the text about Rebel Burgers were removed from the analysis, as pre-registered (final n = 637, mean age = 41.4, 50% female). The manipulations worked as planned. A chi-square test showed that there was a significant relationship between the manipulation and perceived reduction/offset ($X^2(4, N = 637) = 1146.3, p < .0001$). A Wilcoxon rank sum test showed a significant effect of the information manipulation and knowledge about offsets ($W = 44716, p < .01$) for the two items that were directly manipulated in the text.

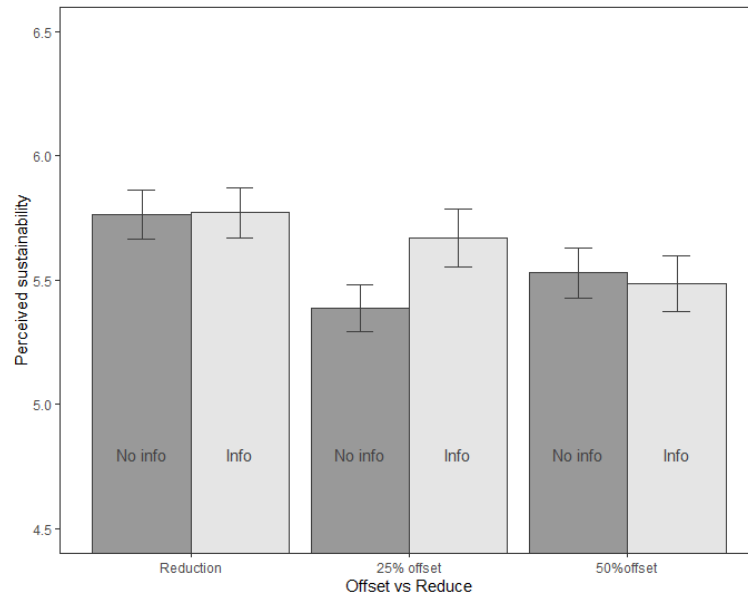
A confirmatory factor analysis showed that the variables had acceptable fit after removing five items ($(\chi^2(df) = 657.98(220), p < .0001, RMSEA = .056, CFI = .972)$). Final factor loadings ranged from .70 to .97.

Testing hypothesis 1, a one-way ANOVA showed that the reduction/offset balance had a significant effect on perceived sustainability ($M_{100\% \text{ REDUCE}} = 5.77, SD = 1.02$. vs. $M_{75\% \text{ REDUCE}/25\% \text{ OFFSET}} = 5.52, SD = 1.10$ vs. $M_{50\% \text{ REDUCE}/50\% \text{ OFFSET}} = 5.51, SD = 1.10; F(2, 633) = 3.899, p < .03, \eta_p^2 = .01$). Contrast analyses showed that respondents in the 100% reduce condition perceived the firm to be more sustainable than the respondents in the 75% reduction/25% offset condition ($p < .02$) and in the 50% reduction/50% offset condition ($p <$

⁵ In the preregistration, we predicted similar results for brand attitude and greenwashing as for perceived sustainability. We report the results for brand attitude and greenwashing in the web appendix available at <https://researchbox.org/1010>

.03), but that there was no difference between the 75% reduction/25% offset and the 50% reduction/50% offset conditions ($p < .85$). Means and standard errors are plotted in Figure 4. The results provide additional support for hypothesis 1.

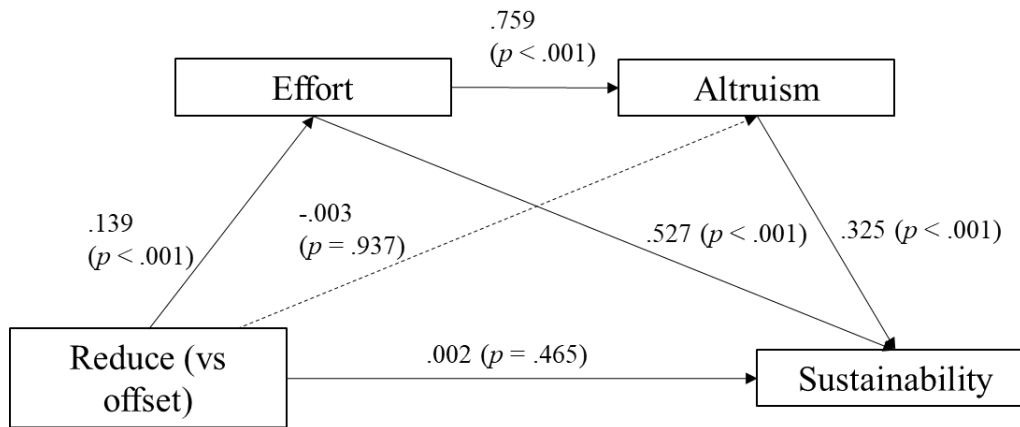
Figure 4: Means and standard errors (Study 2)



There was no effect of information vs. no information about CO₂ offsets on perceived sustainability ($M_{\text{INFO}} = 5.64, SD = 1.13$. vs. $M_{\text{NO INFO}} = 5.56, SD = 1.02$; $F(1, 633) = .980, p = .32$). The interaction between reduce/offset and information was not significant ($F(2, 631) = 1.449, p = .24$).

A serial mediation analysis using Lavaan (Rosseel, 2012) revealed a significant indirect relationship between reduce (vs. offset) and perceived sustainability through effort and altruism ($b = .034, p < .02$). Also, there was a significant indirect relationship between reduce (vs. offset) and perceived sustainability through effort ($b = .073, p < .02$). These results provide support for hypothesis 3 and are illustrated in Figure 5.

Figure 5: Mediation through effort and altruism (Study 2)



Indirect effects:

Reduce -> Effort -> Sustainability: $b = .073$ ($p < .02$)

Reduce -> Effort -> Altruism -> Sustainability: $b = .034$ ($p < .02$)

In a regression analysis with perceived sustainability as the dependent variable and reduction/offset balance, offset knowledge (measured, similar to Study 1) and their interactions as independent variables, the interaction between 50% reduction and 50% offset and offset knowledge was significant and negative ($b = -.13$, $se = .067$, $p < .05$). This means that offsetting (vs. reducing) is seen as less sustainable for respondents with more knowledge about offsets, similar to the finding in Study 1, and rejecting hypothesis 4. There was no significant interaction between 75% reduction and 25% offset and offset knowledge on perceived sustainability.

4.3. Discussion

Study 2 again shows that consumers see firms that reduce carbon emissions as more sustainable than firms that buy carbon offsets, and that the effect is mediated through effort and altruism. The results showed no difference between 75% reduction and 25% offsets versus 50% reduction and 50% offsets. This may indicate that consumers see offsetting as a low-effort alternative regardless of the offset/reduction balance. Increased knowledge about carbon offsets did not influence the effects of reduction/offset balance on perceived sustainability. This again questions the role of effort as a heuristic since more knowledge does not reduce the reliance on effort.

If perceived effort increases perceived sustainability, firms may try to increase perceived effort from CO₂ offsets to be perceived as more sustainable. We designed Study 3 to test this option, using employee participation in a carbon offset program through tree planting.

Employee participation in tree planting is used by corporations to improve employee engagement but also potentially to signal real effort in the sustainability initiatives. Examples of firms that involve employees in tree-planting include Nestle and Air Canada (Nestle, 2022; Air Canada, 2022).

5. Study 3

We conducted a pre-registered experiment with 3 groups (100% reduction vs. 50% reduction and 50% offset, normal effort vs. 50% reduction and 50% offset, employee effort). The data was collected on Prolific’s online panel with UK-based respondents (n = 300, balanced 50-50 men and women). The preregistration, materials, data, and analysis code are available online⁶.

5.1. Procedure

Respondents read a short text about Lumier Electronics (fictitious) designed to manipulate the experimental conditions (Table 5). The reduction vs. offset conditions were manipulated by the description of Lumier Electronics’ net zero plan, reducing 100 % or reducing 50 % of emissions and offsetting the remaining emissions through tree-planting. In the employee effort condition, the text stated that the tree-planting was conducted by the firm’s own employees, using considerable effort. Respondents were randomly assigned to the experimental conditions.

Table 4: Manipulations (Study 3)

<u>Introduction (all respondents):</u>	
Lumier Electronics commits to net zero by 2030	
<i>About Lumier Electronics:</i> - Lumier Electronics specializes in the production of smart home lightning solutions and is headquartered in the UK and present in 15 European markets. We have more than 20 years experience with making your home and life brighter.	
London, UK – Lumier Electronics today announced its plan to reduce net CO2 emissions to zero before 2030. “Businesses have a profound opportunity to help build a more sustainable future,” says John Terrent, Lumier Electronics CEO.	
100% reduction	<p>100% reduction</p> <p>The plan involves removing CO2 emissions completely. All energy used will come from renewable sources. Lumier will collaborate with suppliers to eliminate CO2 emissions in the supply chain.</p> <p>This means that there will be no need for purchasing CO2 offsets, frequently used by firms to compensate for their CO2 emissions that cannot easily be avoided.</p>
50% reduction, 50% offset	<p>50% reduction, 50% covered by offsets from tree planting</p> <p>The plan involves reducing CO2 emissions by 50%. All energy used will come from renewable sources. Lumier will collaborate with suppliers to eliminate CO2 emissions in the supply chain.</p>

⁶ <https://researchbox.org/1010>

	The remaining 50% of emissions that are hard to avoid will be compensated for by purchasing CO2 offsets. Every year, Lumier will be behind the planting of thousands of trees, that will absorb and store CO2 from the air as they grow.
50% reduction, 50% offset, employee effort	<p>50% reduction, 50% covered by offsets from tree planting partly done by employees</p> <p>The plan involves reducing CO2 emissions by 50%. All energy used will come from renewable sources. Lumier will collaborate with suppliers to eliminate CO2 emissions in the supply chain.</p> <p>The remaining 50% of emissions that are hard to avoid will be compensated for by purchasing CO2 offsets. Every year, Lumier will be behind the planting of thousands of trees, that absorb and store CO2 from the air as they grow.</p> <p>A large portion of the trees will be planted by Lumier’s own employees in a comprehensive program designed to raise awareness and involvement. All Lumier employees will participate in the program as part of their job, making the program a considerable endeavor for Lumier and its employees.</p>
<u>Conclusion (all respondents)</u>	
For Lumier the commitment will mean substantial investments, but the company is confident that it will pay off. “Above all, the climate and our common future depend on it”, says Terrent.	

Respondents then answered questions measuring perceived sustainability, effort, and altruism. We also measured brand attitude⁷, greenwashing and offset knowledge. Finally, respondents answered our manipulation check: “How does Lumier electronics plan to reduce its net emissions going forward?” (Remove 100% of emissions, reduce emissions 50%, offset 50%, reduce emissions 50%, offset 50%, offset will be done through tree-planting from employees). The other measures were the same as in Study 1 and 2.

5.2. Results

Six respondents that spent less than 10 seconds on the text about Lumier Electronics were removed from the analysis, as pre-registered (final n = 294, mean age = 39.8, 50% female). A chi-square test showed that there was a significant relationship between the manipulation and perceived reduction/offset ($\chi^2(4, N = 296) = 301.25, p < .0001$). A confirmatory factor analysis showed that the measurement model had acceptable fit after removing four items ($\chi^2(df) = 312.24(160), p < .0001, RMSEA = .057, CFI = .976$). Final factor loadings ranged from .77 to .98.

Testing hypothesis 1, a one-way ANOVA showed that the reduction/offset balance had a significant effect on perceived sustainability ($M_{100\% \text{ REDUCE}} = 5.94, SD = .85$. vs. $M_{50\% \text{ REDUCE/NORMAL EFFORT}} = 5.62, SD = 0.93$ vs. $M_{50\% \text{ REDUCE/EMPLOYEE EFFORT}} = 5.64 SD = 1.01$;

⁷ In the preregistration, we predicted similar results for brand attitude and greenwashing as for perceived sustainability. We report the results for brand attitude and greenwashing in the web appendix available at <https://researchbox.org/1010>

$F(2, 291) = 3.664, p < .03, \eta_p^2 = .02$). Contrast analyses showed that respondents in the 100% reduce condition perceived the firm to be more sustainable than the respondents in the 50% reduction and 50% offset condition, normal effort ($p < .02$) and in the 50% reduction and 50% offset, employee effort condition ($p < .02$). The results provide support for hypothesis 1. There was no difference between the two 50% reduction and 50% offset conditions ($p = .89$). This can be a result of the employee effort condition not being perceived as more effortful than the normal effort condition. A one-way ANOVA showed that the reduction/offset balance had a significant effect on perceived effort ($M_{100\% \text{ REDUCE}} = 5.66, SD = 0.92$. vs. $M_{50\% \text{ REDUCE/NORMAL EFFORT}} = 5.15, SD = 0.81$ vs. $M_{50\% \text{ REDUCE/EMPLOYEE EFFORT}} = 5.29, SD = 1.14$; $F(2, 291) = 7.477, p < .001$). However, contrast analyses revealed that there was no significant difference between the 50% reduction and 50% offset normal effort versus employee effort groups ($p = .30$).

A serial mediation analysis using Lavaan (Rosseel, 2012) revealed a significant indirect relationship between reduce (vs. offset) and perceived sustainability through effort and altruism ($b = .111, p < .001$). Also, there was a significant indirect relationship between reduce (vs. offset) and perceived sustainability through effort ($b = .206, p < .001$). These results provide additional support for hypothesis 3.

In additional analysis, a regression analysis with perceived sustainability as the dependent variable and reduction/offset balance (the two 50% offset conditions collapsed), offset knowledge (measured, similar to Study 1) and their interactions as independent variables showed a non-significant interaction ($b = -.09, se = .064, p = .14$). The direction and magnitude are relatively like the results in studies 1 and 2.

5.3. Discussion

Like the previous studies, Study 3 finds that consumers perceive firms that reduce their carbon emissions to be more sustainable than firms that buy carbon offsets. This effect is mediated through effort and altruism. The results showed no difference between the conditions with 50% offsets, as involving employees in the offsetting project did not increase perceived effort or sustainability.

6. Conclusion and discussion

In three experiments, we have found that respondents perceive companies that reduce (vs. offset) their carbon emissions to be more sustainable, supporting hypothesis 1. This effect is

mediated by effort and altruism, supporting hypothesis 3. We found no effect of implementing the emission reductions and offsets internally, compared to in the supply chain, rejecting hypothesis 2. Knowledge about offsets was correlated with lower perceived sustainability of offsets in Study 1 and 2 (but not Study 3), and manipulation of knowledge had no effect (Study 2), thus rejecting hypothesis 4.

6.1. Theoretical and managerial implications

The current research holds significant theoretical implications. Our findings underscore the link between perceived effort and judgments concerning altruism and sustainability. Consumers gauge a firm's climate initiatives partly on their perceived level of effort, which influences perceptions of sustainability both directly and indirectly through perceived altruism. Effort has previously been related to morals in judgements of people (Celniker et al., 2023). This study shows that effort also influences perceived altruism and sustainability at the organizational level. Further, it shows that different types of sustainability initiatives influence perceived effort in differentiated ways.

Similar to Kruger et al. (2004), we find that knowledge does not reduce the use of effort as a heuristic. On the contrary, in studies 1 and 2 we find that respondents with more knowledge about offsets perceived firms using offsets as even less sustainable compared to firms reducing emissions. We speculate that this is a result of knowledgeable consumers having doubts regarding the effects of carbon offsets, which have been criticized for being a tool of greenwashing and postponing true emissions reductions by firms (Dhanda and Murphy, 2011). The role of effort as a heuristic used mainly under low levels of knowledge therefore needs more research.

Letting employees be behind the tree-planting in Study 3 did not increase perceived effort. It may be that the initiative described was not effortful enough, and that firms that want to increase the perceived effort of offsets may need to use and communicate even more effort than what we attempted. Based on our results it is still an open question whether increasing perceived effort of offsets will lead to increased perceptions of sustainability.

For managers, the findings show that reducing emissions gives stronger perceptions of sustainability than relying on offsets. We note that there was no significant difference between 75% and 50% reductions on perceived sustainability in Study 2, perhaps indicating that using offsets is seen as less sustainable, regardless of the exact amount. Based on Study

1, it does not matter whether the reductions/offsets take place internally in the company or in the supply chain. This is encouraging, given that most emissions happen in the supply chain for many firms (Tidy et al., 2016). Hence, managers can start and communicate initiatives in the supply chain knowing that the company will benefit equally from improved sustainability perceptions.

Regarding the environment, the results are somewhat encouraging. Most current types of offsets carry doubt about their quality and effectiveness in reducing emissions (Hodgson and Nauman, 2021). Thus, it is promising to note that consumers perceive firms utilizing such offsets as less sustainable. This perception can motivate firms to decrease their reliance on offsets and prioritize direct emission reductions. If a market for high-quality and guaranteed offsets should develop, this could be unfortunate since well-functioning emission markets can reduce emissions very effectively (Bayer and Aklin, 2020). However, we would then expect customers to update their beliefs about the offsets over time.

Nevertheless, the effect of reducing versus offsetting is small. In Study 1 the difference between the groups were 0.2 in a 7-point scale, translating to a formal effect size η_p^2 of $<.01$. Since buying carbon offsets can be cheap - the true “cost of carbon” may be 100 times more than the price of the voluntary offset (World Bank, 2023), - it may be that offsetting is still more profitable given the small impact on perceived sustainability. This may change in the future if the prices of offsets or negative associations from consumers increase.

6.2. Limitations

Perceptions of environmental sustainability are likely influenced by many factors, including firm efforts in many other areas than climate. Future research may want to study the joint impact of climate emission initiatives and other types of sustainability measures and use existing brands. The use of fictional brands means that the respondents did not have any pre-existing attitudes or associations and based their evaluation only on the information in the experiment. This may come at the expense of external validity, for existing brands the effect of the carbon emission reduction initiatives may be weaker. A limitation is the use of UK-based respondents, it is not clear that the findings generalize to other markets. Idiosyncratic factors such as varying degree of media coverage of firm carbon reduction initiatives and in particular carbon offsets may have influenced the results, and future research could replicate our findings in other markets. We note that Roemer et al. (2023) found similar results in a related study in Germany. A final limitation is the use of tree-planting/soil-based offsets in all

three studies, since the offset source may influence the results (Roehmer et al., 2023). Future research may therefore want to vary the source of the CO₂ offsets.

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