Online purchasing creates opportunities to lower the life cycle carbon footprints of consumer products

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A major barrier to transitions to environmental sustainability is that consumers lack information about the full environmental footprints of their purchases. Sellers' incentives do not support reducing the footprints unless customers have such information and are willing to act on it. We explore the potential of modern information technology to lower this barrier by enabling firms to inform customers of products' environmental footprints at the point of purchase and easily offset consumers' contributions through bundled purchases of carbon offsets. Using online stated choice experiments, we evaluated the effectiveness of several inexpensive features that firms in four industries could implement with existing online user interfaces for consumers. These examples illustrate the potential for firms to lower their overall carbon footprints while improving customer satisfaction by lowering the "soft costs" to consumers of proenvironmental choices. Opportunities such as these likely exist wherever firms possess environmentally relevant data not accessible to consumers or when transaction costs make proenvironmental action difficult.

carbon footprint | online experiments | carbon offset | ecolabels

In the United States, indirect CO_2 emissions from the supply chains leading to consumer purchases are double the direct emissions from home energy use and personal travel (1). Reducing these emissions is therefore a major target for environmental policy, but a hard one to hit because of the difficulty for consumers of gathering information on indirect emissions and the disconnects between consumers who might want to use that information and the other entities whose decisions shape indirect environmental impact (2, 3). A common example of the disconnects is the landlord–tenant relationship: Landlords may install energy-efficient equipment but cannot control tenants' use, and tenants motivated to lower energy costs cannot readily inform themselves before renting about a landlord's prior choice of equipment (4). Similar relationships of split incentives and divided information exist generally in consumers' relationships with firms that supply goods and services. Consumers may want their purchases to have a lower environmental "footprint," but producers' choices largely determine that footprint and consumer access to trustworthy information about the footprints of available products is absent or prohibitively difficult to obtain. Even a small reduction in these indirect emissions would lead to significant environmental benefits.

Efforts to reduce emissions generally rely on direct government intervention in the form of regulations or taxes or private sector governance strategies (5) such as corporate carbon disclosure projects (6) or supply chain contracting requirements (7). Strategies that address entire supply chains, such as carbon taxes, have so far proved impossible to implement in many countries; the other strategies focus mainly on firms. Additional strategies that focus on the ultimate consumers and combine appropriate incentives with simple processes for adoption, targeted information from credible sources, and quality assurance show significant potential for reducing direct energy consumption, using known techniques (8, 9). We explore ways to reduce indirect energy consumption by lowering the soft costs, mainly involving time and effort, of choosing goods and services with low footprints or purchasing offsets for them.

Modern information technology can reduce those soft costs by providing consumers with pertinent, timely data on the carbon footprints of products and by bundling contributions of carbon offsets. Producer firms can provide such data, and some may find competitive advantage in building reputations for enabling customers to better express their environmental preferences. Consumer-facing firms often possess data that individuals could use to make more environmentally friendly choices, and firms possess economies of scale that allow them to act on behalf of large groups of individuals rather than requiring consumers to act in isolation. Advances in information technology are making such opportunities increasingly common and inexpensive.

We examine opportunities for firms to offer purchasers options to reduce the carbon footprints of their purchases in four industries: online retailing, ridesharing service provision, video streaming, and online lodging. We present these opportunities in two forms: (*i*) One involves providing information to consumers on the carbon footprints of various purchase options. There is a long history of "ecolabeling" to provide consumers with environmental information about products at point of purchase, with mixed success influencing consumer purchases (10). Labeling goods and services with their carbon footprints presents particular challenges because of the difficulty in estimating these footprints accurately for many types of products (11). We examined labeling of streaming video rentals and online lodging: two items for which carbon footprint information can be provided with sufficient accuracy to support

Significance

A major barrier to reducing greenhouse emissions from economic consumption involves information about product supply chains. Consumers who wish to reduce or offset the emissions embodied in goods and services they buy have no economical way to inform such choices. Vendors often can, but rarely do, gather embodied carbon information at little cost and offer it to consumers. They can also bundle carbon offsets for customers, thus facilitating choices. We report on a series of experiments using online interfaces to offer carbon footprint information and offset bundling in four sectors: online retailing, ride sharing, video streaming, and short-term lodging. Results indicate that firms can reduce their supply chains' carbon footprints while improving customer satisfaction by facilitating consumers' proenvironmental choices.

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choices among alternatives. (*ii*) The other opportunity involves facilitating consumers' purchases of carbon offsets—a calculation that would impose large transaction costs and time burdens for any single individual (12, 13), but for which firms have economies of scale. We report experiments with online retailing and ridesharing service provision. In all four cases, we reproduced the online interfaces of actual firms to make the choices realistic to research participants. All participants were informed that the research was in no way associated with or endorsed by the firms under study. The illustrative experiments demonstrate that the potential exists for using current information technology to breach informational and split-incentive barriers between producers and consumers in a variety of consumer-facing industries.

Online Retailing

Amazon is a major online retailer in the United States and offers Amazon Prime as a program that includes free two-day shipping and other services. Because Prime customers do not pay the extra cost of the faster shipping, there is little incentive to choose the no-rush shipping option. Realizing this, Amazon offers Prime customers a $1 credit (or other credit incentive) toward their next book or e-book purchase when they choose free no-rush shipping.

We conducted two experiments to explore ways Amazon could reduce environmental footprints. In one, we compared the $1 credit incentive to informing customers that Amazon would buy carbon offsets for their shipping only if they chose the no-rush option. The second experiment involved allowing individuals to add the cost of carbon offsets for shipping to their bills.

The carbon emissions associated with shipping were calculated using the results of Facanha and Horvath (14) and found to be very low. A tablet computer weighing 450 g shipped by rail halfway across the United States results in CO_2 emissions of about 40 g, which at $50 per ton equals $0.002. More details can be found in *Supporting Information*.

Experiment 1: Carbon Neutral No-Rush Shipping. If offering carbon neutral no-rush shipping induces Prime members to abandon free two-day shipping, then Amazon may save money because the offsets are likely less expensive than the $1 credit. To the extent that carbon neutral no-rush shipping is less popular than the $1 credit, Amazon would fail to achieve these savings.

A total of 609 individuals completed the experiment. Four different products were tested. Survey participants were instructed to assume they were Prime members. Participants were randomly assigned to the control group, which saw the $1 credit incentive, a treatment group that saw the carbon neutral no-rush shipping incentive, or a treatment group that got the $1 credit and was given the option to donate part of that to make their shipping carbon neutral. Each participant made shipping choices for four products: a book, a tablet computer, emergency water supplies, and a lawn mower. "FREE Two-Day Shipping" was the default option, as on the actual Amazon website. These goods were chosen to provide a mix of expensive items (the lawn mower and tablet) and items likely to be desired right away (the tablet and book). Figs. S1–S7 in the *Supporting Information* contain sample images of each experiment as seen by the participants.

As Fig. 1 shows, green shipping was roughly as popular as Amazon's $1 credit, with the notable exception of the lawnmower, for which green shipping was statistically more popular than the $1 credit. In a free-response area of the online experiment, many survey takers noted that they chose the green shipping option for this product because they realized heavier items would result in more CO_2 emissions. Counterintuitively, the choice option was never more effective than the green shipping option, and it was statistically less so for the book and tablet. This was despite it being a dominant option in financial terms, as it provides both carbon neutral shipping as in the green shipping option and additional monetary compensation. The added complexity of this choice may have led some participants to choose the default option of two-day shipping because of the added cognitive effort required to consider the alternative. This finding comports with the design principle of keeping interventions simple for greater effect (15, 16). However, it is not intuitively obvious that such a small increase in complexity would have this effect. Thus, the finding points to the importance of pretesting environmental interventions.

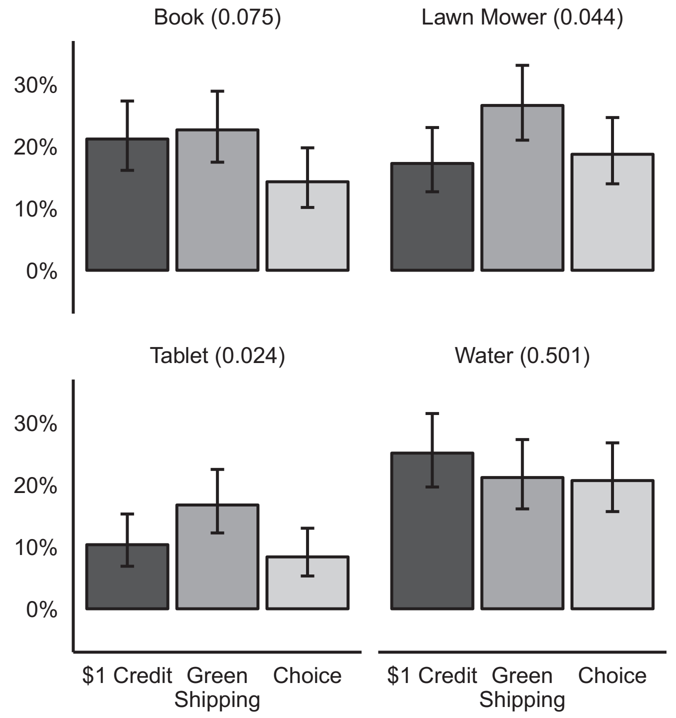

Fig. 1. Percentage of respondents choosing the carbon neutral no-rush shipping option for each product. Error bars denote the 95% Wilson interval. The *P* value for the equality of all three proportions is shown in parentheses.

Because of the popularity of the green shipping option, Amazon could likely save substantially by purchasing offsets, which typically cost just pennies. However, we cannot estimate the total potential savings without data on the distribution of product weights shipped by Amazon.

We explored participants' reactions to the green shipping option by asking all survey takers how their opinion of Amazon would change if they offered to make the no-rush shipping method carbon neutral. A total of 33% of respondents would think slightly better or much better of Amazon, 2.5% would think slightly less or much less, and the rest would have an unchanged opinion. These results suggest that this new shipping option could help Amazon improve its environmental image as well as reducing costs.

Experiment 2: Carbon Offset Purchases. This experiment explored the efficacy of adding the cost of shipping-related carbon offsets to customer bills by modifying the choice architecture (17) of Amazon's shipping selection user interface.

In this experiment, the shipping confirmation page included a checkable box that participants could use to add carbon offsets to their total bills. The cost of the carbon offset varied with the shipping option selected and the product. Facanha and Horvath's (14) methodology was used to calculate the carbon emissions due to shipping, with rail travel assumed for no-rush shipping and air travel assumed for next day shipping. Values for standard shipping and two-day shipping were interpolated based on the total travel time.

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Table 1. Percentage of respondents choosing to purchase carbon offsets for the four different products

Item	Carbon offset cost		Unchecked, %	Checked, %
	No rush	Next day		
Water	$0.01	$0.18	39.0	89.3
Lawn mower	$0.17	$4.55	25.3	80.6
Book	$0.01	$0.04	47.4	91.7
Tablet	$0.01	$0.05	47.4	91.3

Checked vs. unchecked refers to the initial status of the carbon-neutral shipping checkbox. All differences are significant at the 1% level.

For this experiment, the default state of the carbon offset checkbox proved important as it has in other studies of consumer choice (18). Table 1 shows the proportion of participants who added carbon offsets to their bills for the four different products. When the default was not to add offsets to the bill, the percentage of participants choosing to select it was much lower than when it was checked by default. For a further breakdown by shipping method, see Table S1 in the *Supporting Information*.

Comparing across all products, 40.0% of participants chose to add offsets to their bills when the offset option was unchecked by default, compared with 88.2% when it was checked by default.

From a business perspective, offering carbon offsets (vs. credit for future purchases) does not result in more frequent choice of no-rush shipping (details in *Supporting Information*), so Amazon would not save as much money as by following the practice in experiment 1, but it could produce a larger reduction in overall greenhouse gas (GHG) emissions and improved customer satisfaction. Further, whereas Amazon may not make the addition of carbon offsets the default option, as some users might accidently purchase offsets they do not desire, even when the purchase of offsets is initially unchecked, 40% of respondents chose to add carbon offsets to their purchases. If a similar proportion of Amazon customers would appreciate the option of choosing offsets, this represents a substantial opportunity for Amazon to cater to a currently unfilled customer demand and decrease its corporate carbon footprint.

Ridesharing Services

Uber is a ridesharing service based in San Francisco that operates much like a digitally enhanced taxi company. Customers use the Uber mobile app to contact a nearby driver from one of several classes of vehicles and request a pickup, pay the fare via Uber (no cash exchange), and provide customer ratings of drivers. At the end of 2014, Uber had over 150,000 active drivers in the United States alone (19).

Data collected and used by Uber, including the characteristics of all vehicles in its network, as well as exactly how far each one drove and estimates of the traffic conditions, could be used by customers to reduce their environmental footprints. For example, the GHG emissions of each trip could be accurately calculated and provided to customers. Further, Uber could purchase carbon offsets, pooling them across individuals, with minimal modification to its user interface or business processes.

We examined the willingness of individuals to purchase carbon offsets by modifying the Uber payment screen to offer the option of adding the cost of carbon offsets to a customer's bills. The cost of the carbon offset was varied between $0.02 and $0.20 per trip based on estimated costs of carbon of $6/ton of CO_2 (tCO_2) and $50/$tCO_2$ and assuming a 10-mile trip and the 2012 average fuel economy for light duty vehicles in the United States of 23.3 miles per gallon (20). Clicking on a "Go Green!" button updated the total cost of the ride and changed the button to "Go Back," which would remove the fee.

After this choice was made, participants answered some survey questions, one of which was, "If Uber gave you the option of automatically adding the cost of carbon offsets to your bill for every ride, would you choose to do so? (If you took a 10-mile trip every weekday for a year this would increase your total cost by x)," where x was either $49.58 or $5.95, depending on the carbon price. A total of 401 individuals completed this experiment. As Table 2 shows, the percentage of respondents willing to pay for carbon offsets for a single trip is a large majority at either carbon price.

Furthermore, when the cost is very low, about as many people indicate willingness to offset the emissions associated with all their Uber trips as do so for a single trip. Even when the cost is higher, half of all participants indicated a willingness to purchase offsets for all their Uber trips. These findings suggest that Uber has a considerable opportunity to provide a desired service to its customers and improve its position on environmental sustainability. This is an easily implemented opt-in scenario, and the results suggest that a very large portion of Uber's users would take advantage of such an eco-oriented service.

As with Amazon, we asked participants about brand perceptions. When asked, "How would your opinion of Uber change if it offered to let you easily purchase carbon offset credits to offset the carbon associated with your Uber trips?", 40% of respondents replied that they would think slightly or much better of Uber, whereas 4% said they would think slightly or much less. We also asked individuals who had never taken an Uber trip if such a feature would make them more or less likely to try Uber in the future. A total of 37% said they would be slightly or much more likely to try Uber whereas 2.5% said they would be slightly or much less likely to try Uber.

Online Video Streaming

Online video streaming has increased substantially since its introduction. Netflix, YouTube, Amazon Video, and Hulu account for just over half (51%) of downstream fixed-access internet traffic during peak periods in North America (21). Of these, Netflix is the largest distributor of online media with 34.2% of downstream traffic.

Netflix uses a subscription-based model in which individuals pay a flat monthly rate and receive unlimited streaming of movies and television shows. The basic plan includes unlimited standard definition (SD) content, the standard plan adds unlimited high definition (HD) content, and the premium plan adds unlimited ultrahigh definition (UHD) content.

Delivering higher-definition content has an added environmental impact that many subscribers may not be aware of, so these options may be chosen more frequently than an individual subscriber with environmental preferences would wish. In this experiment, we modified the standard Netflix user interface to include information on the carbon footprints of the three streaming resolutions and compared user choices to the interface without the carbon footprint information. Each participant was asked to select a preferred streaming resolution for 8 different videos, chosen randomly from a set of 32 videos. These videos were equally divided into old vs. new and full-length movies vs. television shows.

Before choosing streaming resolutions, each participant was shown the same test video in SD, HD, and UHD format to experience the difference in quality. Because UHD monitors are not common, the actual resolutions used were adjusted based on the screen size of the participant.

Table 2. Percentage of respondents adding the cost of carbon offsets to their Uber bills for the two prices studied (range indicates 95% Wilson interval)

Timespan	$0.02, %	$0.20, %
Single ride	78 (71–84)	67 (59–74)
All future rides	75 (68–81)	49 (41–56)

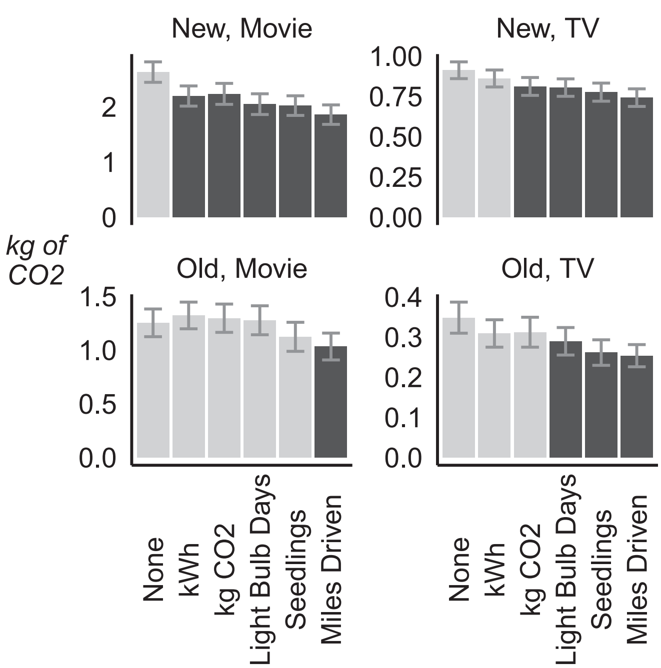

Fig. 2. Average carbon intensity of the chosen resolution for each carbon metric used in the experiment. Solid bars denote display methods that are statistically different from the control display ("None") at the 5% significance level.

After the test video segment of the experiment, each participant was asked to choose a resolution for eight different videos, with two randomly chosen from each combination of old vs. new and full-length movie vs. television shows.

Participants were divided into six groups: a control group that saw no carbon information and five treatment groups that saw carbon footprint information presented as kilograms of CO_2, kilowatt hours of electricity, equivalent number of days leaving a lightbulb on, tree seedlings, and miles driven in a standard US sedan. For each treatment group, an icon and value were displayed and a popup box with help text appeared when the participant hovered the mouse over the icon. Further details can be found in *Supporting Information*.

A total of 799 individuals completed the experiment, each choosing resolutions for eight videos. Fig. 2 compares the average carbon footprints of the selected video streams.

Many of the display methods were effective in prompting participants to change to a lower-resolution stream. Only the miles driven display format was consistently effective. Stating the results in kilograms of CO_2 had a statistically significant effect with only some content and produced a 10% reduction in the average carbon footprint, compared with a 24% reduction when the impact was presented as equivalent miles driven. Miles driven is a much easier concept for the average US person to understand and conceptualize than kilograms of carbon dioxide, and this makes a difference in consumer response.

When asked, "If Netflix gave an option to automatically select the least carbon-intense streaming resolution for specific genres of your choosing (e.g., old TV sitcoms), would you choose to do so?", 42% of respondents said yes. This response could represent an opportunity for Netflix to reduce operating costs, lower its corporate environmental footprint, and improve customer satisfaction with one simple innovation. The cost of implementing such a feature is almost surely very low in comparison with the potential benefits.

Lodging

Airbnb is one of the firms most associated with the sharing economy. It facilitates the renting of lodging among private individuals. "Hosts" can sign up on the website and offer space for rent and individuals browsing the website can book those spaces. The Airbnb website allows visitors to filter lodgings on many attributes, including size, price, location, and various amenities, such as cable TV, indoor fireplace, and air conditioning. However, Airbnb does not include any energy efficiency features in property listings. As a result, individuals with environmental preferences are left with little information to inform their choices.

We conducted a stated preference discrete choice experiment (22) to estimate how popular such environmental information would be to potential Airbnb customers. We presented each participant with four rental options that varied by price ($80–$100), visual attractiveness of the image of the rental (as judged by us and confirmed by participant ratings), and the presence or absence of a leaf icon that denoted an environmentally friendly rental option. *Supporting Information* contains details of the experimental design, the utility estimation procedure, and alternate specifications (see Table S2). Fig. S7 depicts one choice situation encountered by participants. When participants hovered the mouse over the leaf icon, a popup box appeared with the text, "The leaf indicates that the rental has significantly lower environmental impact than other similar homes."

A total of 355 individuals completed the experiment. The results are summarized in Table 3. The final column, willingness to pay (WTP), represents the average amount that an individual would pay for the various features relative to a baseline. For the room image, the baseline level ($0 WTP) was a dark, poorly furnished room. The nicest room image yields a premium of around $84, whereas the midlevel images generated premiums of $12 and $35. The leaf icon produced a statistically significant positive premium estimated at $6.68. This result implies that hosts could expect to get this much more on average per booking if Airbnb implemented this feature and their properties qualified for the green leaf icon. Providing such an icon would thus enable hosts to benefit financially from investments in energy efficiency or other green improvements that could earn such a label.

The estimated "leaf" premium represents an 8% increase for an $80 rental, which would yield an additional $1,095 in revenue annually if the property was rented for half the year. This provides an indication of the amount a host might be willing to invest in the property to attain the environmental icon. If getting the green leaf required an energy audit from an accredited provider, this potential revenue could motivate hosts to obtain one.

In a similar manner to the Uber experiment, participants were also given the choice to add carbon offsets to their bills to make their stays carbon neutral. The prices offered were $0.50, $1.50, or $3.00. These values were based on the carbon footprint of a hotel stay ranging from 3 kg to 60 kg of CO_2 (23) and a carbon price of $50/t$CO_2$.

Table 4 shows that the number of people indicating they would purchase the offsets is relatively small and decreases with price. However, the differences were not statistically significant at the

Table 3. Model estimates for Airbnb experiment

Variable	Coefficient	SE	WTP
Price	−0.031	0.004**	—
Best room	2.640	0.120**	$84.31
Average room 1	0.397	0.148*	$12.69
Average room 2	1.100	0.133**	$35.15
Leaf icon	0.209	0.068*	$6.68

* and ** denote significance at the 95% and 99% confidence levels, respectively. The reference level for the room variables is the "worst" image. WTP is the coefficient value normalized by the price coefficient to yield an estimate of the willingness to pay for the attribute.

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Table 4. Percentage of respondents indicating they would purchase carbon offsets by offset price

Price	Purchasing offsets, % (95% Wilson range)	Respondents
\$0.50	12.5 (7.7–19.6)	120
\$1.50	8.6 (4.7–15.1)	116
\$3.00	7.6 (4.0–13.8)	119

5% level. The Airbnb website claims 1.5 million listings worldwide as of August 2015. If one-quarter of these are in the United States and each one is occupied one-quarter of the time on average, and if 5% of guests purchase carbon offsets and the midpoint of the range for carbon emissions applies, the total annual carbon offset from such a program would be nearly 54,000 tCO_2 in the United States alone.

Discussion

These experiments indicate significant untapped potential for firms to reduce the climate impact of their product chains and improve customer satisfaction at very low or even negative cost. When customers have the option to make lower-emissions purchases at little or no additional cost to them, firms can provide the pertinent information so that individuals will be aware of the full impact of their decisions and act accordingly. In such cases, firms could reduce their costs while providing value-added features to their customers. Results consistently showed that individuals would think better of companies that provide such climate-friendly options. For firms that collect large amounts of data on their customers' preferences, it would likely be straightforward to target these features to their more environmentally conscious customers.

We see three causes for concern about the generality of these results. One is that the sampled population is not nationally representative. The research relied on Amazon's Mechanical Turk (AMT) population. If AMT users have stronger personal norms to reduce their environmental footprints than the national average, these findings overestimate the potential of the strategies examined to a degree. This possibility can be examined in research on other populations. See *Methodology* for further details on the AMT system. A second concern is that these results are based entirely on hypothetical choices: Experimental participants did not have to choose a shipping method or a video streaming quality for actual purchases. Research on the "hypothetical bias" suggests that although this problem is real, large errors are most commonly associated with large hypothetical monetary values (24). The examples in this research all relied on small monetary values, which should reduce concerns about hypothetical bias.

A third concern is the possibility of "rebound" effects, in which consumers who have reduced emissions through green choices feel empowered to use the savings in ways that consume fossil fuels, thereby reducing or eliminating the carbon savings. Most research on rebound effects looks at efficiency improvements that lower operating costs and increase net income, leading to direct and indirect rebound effects (i.e., increased use of the more energy-efficient good or service and increased purchases of other items with carbon footprints) (25). The interventions explored here do not lower the price of any good or service and in several cases increase it via the addition of carbon offset purchases. This could result in a sort of rebound effect in which individuals who spend money on carbon offsets feel empowered to increase their carbon footprints in other ways. Whether this phenomenon occurs is an open question that has not yet received extensive research attention.

The first two causes for concern can be tested empirically by firms experimentally offering their customers online opportunities to reduce the carbon footprints of their purchases. Many firms routinely engage in controlled-offering tests wherein a subset of customers is exposed to a modified user interface or new feature before it is more broadly deployed (26). Replicating this research with actual firms and subsets of their customers could yield important insights about the general potential of different interventions and produce results that are truly representative of consumer populations and allow for quantification of the potential of these interventions with specific products.

We note that these experiments demonstrated the potential for real time informed choice that would align with GHG emissions reductions in only some parts of the operations of the firms whose online offerings were simulated. The overall potential for GHG emissions reduction as a percentage of total emissions from firms' supply chains is difficult to estimate quantitatively. However, some of these experiments, such as with Uber and Airbnb, showed significant promise in the major emitting sectors of personal transport and short-term rental housing. These experiments indicated the need for further experimentation to expand the potential of real time informed choice in the provision of carbon footprint information to address the difficult challenges of split information and split incentives in other supply chains.

These experiments strongly exemplify two of the key design principles for carbon emissions reduction programs that have been identified in the research literature on reducing fossil fuel consumption resulting from household activities: (*i*) the need to provide credible and targeted information at the point of decision and (*ii*) to "keep it simple," that is, to minimize the level of cognitive effort required of consumers to reduce the emissions associated with their choices (15, 16).

Nearly any company with large amounts of data on the environmental footprints of its products can help its customers better express their environmental preferences. Firms that want to be "eco-enabling" can identify opportunities by asking themselves two questions: (*i*) "What data do we have that relates to environmental footprints?" and (*ii*) "How can we make these data readily available to assist customer choice?".

Despite the lack of good carbon footprint information for many types of consumer goods (11), nearly all companies will be able to find some products for which they have such information, as nearly all goods and services have energy inputs. In addition, many firms track their own direct emissions as well as those associated with purchases of electricity, heat, and steam—referred to as scope 1 and 2 carbon emissions (27). Understanding how to use this information to the benefit of the firm and to accommodate individual choice preferences remains a significant challenge. This research explores the potential for providing climate impact information to support consumer choice and identifies opportunities that, in aggregate, may have large climate impacts. Improved supply chain management technologies may make more such calculations feasible over time. Finally, it demonstrates for several products and services that it is critically important to provide credible and targeted carbon footprint information at the point of decision and to simplify consumer action (15, 16). Allowing individuals to set environmentally responsible defaults is an especially promising approach because it can apply the cognitive effort involved in making one choice to a series of choices.

This research demonstrates several ways that firms in four industries can, at very low cost, enable their customers to mitigate climate change by providing, at the point of purchase, user-friendly information about the carbon emissions associated with their purchases and ways to reduce emissions. It also indicates that such actions create customer good will. Such opportunities certainly exist in other industries as well.

Methodology

This research makes extensive use of AMT. This platform provides a large pool of individuals willing to take part in online academic experiments at low cost.

The use of crowdsourced online surveys in academic work has increased significantly since its inception in 2006 (28) and has been used for energy- and environment-related research (29). Whereas the subject pool is not representative of the United States, it is more representative than the subject pool used for much academic research, which consists of university students. The AMT population on average is younger, more educated but with lower incomes, and more female than the overall adult population (30). Paolacci et al. (31) have replicated many traditional findings, using AMT.

For all our experiments, the subject pool was restricted to US workers not using tablet or mobile devices, who were paid the federal minimum wage of $7.25/h, assuming average survey completion times. The study procedures were approved by the MRIGlobal Institutional Review Board for Human Studies and informed consent was obtained from all participants before conducting experiments. We relied on an open source package called PsiTurk created by researchers at New York University (32) to conduct the experiments. The source code necessary to reproduce all experiments is available from the authors upon request.

A 95% confidence level was used for all significance tests. For proportions, the Wilson method (33) was used to compute confidence intervals. For testing differences between proportions, the Yates continuity correction was applied. Data analysis was done using R (34) and the binom package (35) in particular.

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