Should Carbon Footprint Labeling be Mandatory for all Food Products?  
RCT Shows no Benefit beyond Labeling the Top Third

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Carbon footprint labels have been shown to lead consumers to choose food products with lower CO\textsubscript{2} emissions, but an unresolved issue is what proportion of food products must be labeled for labeling to be effective. We asked 1,081 American consumers to shop in an experimental online grocery store and choose one frozen meal among the full assortment of a major American grocer in a control (no label), 33% labeled (the third of products with the lowest carbon footprint were labeled), 67% labeled (the top two thirds were labeled) and all labeled condition. A 16.5% reduction in emissions was achieved by labeling the top third of products, with no statistically significant improvement gained by further increasing the proportion of labeled products. Mandating all products, including the least virtuous, to be labeled may therefore not be necessary to promote sustainable diets if the most virtuous products self-select into labeling.

Key Words: Ecolabels; Carbon Label; Consumer Behavior; Sustainable Consumption; Online Experimental Supermarket

Given that food systems are responsible for a third of global anthropogenic greenhouse gas emissions\(^1\), promoting the choice of food products with a lower carbon footprint is a priority. To achieve this goal, many governments and nongovernmental organizations have been studying and promoting environmental labels, and particularly carbon footprint labels which inform consumers about the amount of CO\(_2\) equivalent emissions generated by the product. Studies have shown that environmental labels in general, and carbon footprint labels in particular, lead to more sustainable food choices\(^2,3,4,5,6,7,8,9\). An important unresolved issue is what proportion of food products need to be labeled for carbon footprint to be effective.

Existing studies cannot answer this question because they have only examined the impact of labeling all products or none. Yet, there is no reason to expect that all food producers, especially those that would receive a low rating, would adopt carbon labeling voluntarily. First, because current US and EU regulations preclude forcing food manufacturers to adopt environmental labels. Second, because carbon labeling is costly and not demanded by all consumers\(^10,11\). A comparison with the diffusion of other food labels, such as nutrition ones, suggests that carbon footprint labels will be first used by the best-rated products before gradually progressing to lower-rated products as the label becomes more established, without necessarily reaching all products. For example, despite widespread consumer support for the Nutri-Score label, only 50% of the food sold in France carries the label three years after its governmental endorsement\(^12\). At first, only national brands with a good Nutri-Score were displaying it, although it is slowly being used by products with a lower rating\(^13,14\).

To address the above question, we conducted a randomized controlled trial in an experimental online grocery shop. Unlike existing studies that used small and ad-hoc product assortments, we asked American shoppers to choose from the full assortment of frozen meals sold by an existing American retailer. And unlike most experimental studies of environmental labeling, which measured preferences over label designs or relied on self-reported willingness to pay, we designed an incentive-compatible choice experiment. Consumers were assigned to one of four between-subject conditions, which simulated the gradual labeling in the market, and their purchasing choices were recorded and analyzed. This design allowed to explore the effectiveness of carbon footprint labeling as the number of labeled products progresses from the best to all the products in the category.

**Method**

The research project was preregistered on AsPredicted (https://aspredicted.org/MKG_T3H) a preregistration platform created by the University of Pennsylvania’s Wharton Credibility Lab. Note that pre-registration includes additional research questions (on consumers’ inferences about unlabeled products and their information search) that are beyond the scope of this project. The study was approved by the ethical review committee of the author’s institution (Protocol ID 2022-79), and informed consent was obtained from all participants through the study’s online questionnaire on Qualtrics. The data that support the plots and tables within this paper are available at https://osf.io/afjt4/?view_only=0ca05cac547a4ed1991ae655a22de018.
**Participants**

To determine the sample size, we computed using Fischer’s inequality test the required sample size that would mimic the proportions of individuals’ sustainable choices in a study like ours using the G*Power statistical software. In the first study conducted, 63% of participants chose a sustainable food option compared to 49% in the control group. With a 95% power and a two-sided $\alpha = 0.05$, the sample size would be 340. In the second study in the same paper, 13.8% of participants chose a vegetarian meal under a multi-icon label, compared to 4.9% in the control group. With a 95% power and a two-sided $\alpha = 0.05$, the sample size would be 284 to replicate that study’s proportions. We opted for averaging out the two sample sizes (340 and 284) and added a 5% attrition rate to get a sample size of 330 per group. The total target recruitment for the research study was therefore $330 \times 4 = 1,320$ participants to achieve a 95% power with a two-sided $\alpha = 0.05$.

**Table 1. Characteristics of the respondents**

<table>
<thead>
<tr>
<th></th>
<th>No label</th>
<th>33% labeled</th>
<th>67% labeled</th>
<th>All labeled</th>
<th>Statistical difference tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>278</td>
<td>264</td>
<td>274</td>
<td>265</td>
<td></td>
</tr>
<tr>
<td>Age (mean, 95% CI)</td>
<td>42 (41,44)</td>
<td>41 (39,43)</td>
<td>42 (41,44)</td>
<td>41 (39,42)</td>
<td>$F_{(3,1077)} = 1.11$ p=0.34</td>
</tr>
<tr>
<td>Gender, (% women)</td>
<td>46.4%</td>
<td>53.0%</td>
<td>49.3%</td>
<td>44.5%</td>
<td>$\chi^2_{(3)} = 4.38$ p=0.22</td>
</tr>
<tr>
<td>Ethnicity, (% white)</td>
<td>79.5%</td>
<td>78.4%</td>
<td>78.1%</td>
<td>76.9%</td>
<td>$\chi^2_{(3)} = 0.51$ p=0.916</td>
</tr>
<tr>
<td>Student, (% students)</td>
<td>7.9%</td>
<td>9.1%</td>
<td>11.7%</td>
<td>10.2%</td>
<td>$\chi^2_{(3)} = 2.42$ p=0.49</td>
</tr>
<tr>
<td>Employment, (% employed full time)</td>
<td>53.9%</td>
<td>53.0%</td>
<td>52.6%</td>
<td>52.8%</td>
<td>$\chi^2_{(3)} = 0.12$ p=0.99</td>
</tr>
<tr>
<td>Political affiliation, (% Democrat)</td>
<td>47.9%</td>
<td>49.2%</td>
<td>46.3%</td>
<td>49.1%</td>
<td>$\chi^2_{(3)} = 0.61$ p=0.89</td>
</tr>
<tr>
<td>BEP Score (mean, 95% CI)</td>
<td>4.15 (4.05, 4.26)</td>
<td>4.19 (4.09, 4.28)</td>
<td>4.23 (4.13, 4.33)</td>
<td>4.26 (4.15, 4.33)</td>
<td>$F_{(3,1077)} = 0.66$ p=0.58</td>
</tr>
</tbody>
</table>

The participants were recruited on Prolific (www.prolific.co), an online research platform, and were paid 1.3 GBP per completed survey. As preregistered, we only surveyed adults currently residing in the United States and excluded participants who had never bought frozen meals; who reported being vegan or vegetarian (as several products in our experiment were meat-based); or
who attempted to participate in the study via a mobile phone or a tablet (which degraded the shopping experience). Also following the preregistration, we excluded one participant who completed the survey twice (2 observations); 36 participants who did not provide the correct code after the shopping task (showing that they had not completed it); 195 participants who shopped in another food category in the online store than the one indicated, and 6 participants who selected more than one product despite our instructions. Following the preregistered exclusion criteria, the total number of respondents was \( N = 1,081 \).

Demographic data on the 1,081 respondents was obtained through the Prolific interface, which includes information on the participating users. As shown in Table 1, participants were on average 42 years old (SD = 13.2), 48.3% were females, 78.3% were white, 9.7% were students, 53.1% were employed, and 48% identified themselves as Democrats (18.2% as Republicans, and 27.8% as Independent). The characteristics of the respondents were not statistically different across the four conditions (all \( p \)'s > 0.20, see Table 1), indicating that the randomization was successful.

**Stimuli**

The study was pre-conducted using the newly developed Open Science Online Grocery (OSOG) platform ([https://openscience-onlinegrocery.com/](https://openscience-onlinegrocery.com/)), a research tool that mirrors large online grocery stores and is populated with hundreds of real products that are sold by an anonymous major US retail chain. We focused on one grocery category, frozen prepared meals and included all the 33 national brands sold by the retailer. We chose this category because frozen meals are a full dish and have a large variance in CO2 emissions.

The carbon emissions and associated labels for each product were obtained by using an open-access carbon footprint calculator made available by My Emissions ([https://myemissions.green/food-carbon-footprint-calculator/](https://myemissions.green/food-carbon-footprint-calculator/)). The calculations are ‘cradle-to-grave’ carbon dioxide equivalents, using a life cycle assessment approach to the emissions created by farming, processing, packaging, and transportation. The emissions database currently covers about 3,000 products, sourced from life cycle assessments published in peer-reviewed journals and global scientific emission calculation databases.

We calculated the carbon emissions in grams of CO2e (carbon dioxide equivalents) per 100g of product for the 33 products in the experiment by entering the ingredients in each frozen meal in the My Emissions calculator. The ingredients were evaluated based on the information provided by the manufacturer, augmented by recipes to estimate their weights. The values of CO2e emissions obtained were benchmarked against other peer-reviewed published emissions databases to ensure their validity. All the calculated emissions were within a valid range of other published estimates using a similar life cycle methodology.

We used the MyEmission front-of-pack carbon footprint label, a traffic-light label used by food producers and restaurants in Europe. The carbon label is color-coded and rates the product from A (Very Low) to E (Very High), based on the ‘per 100g’ carbon footprint of the food (Fig. 1).
Procedure

Following the power analyses and preregistered exclusions, 1,081 frozen meal consumers participated in the study. They were randomly assigned to one of four between-subject conditions, which simulated the gradual labeling in the market: control condition (no products are labeled), 33% labeled condition (the top third of the products with the lowest carbon footprint are labeled), 67% labeled condition (the top two third of the products with the lowest carbon footprint are labeled) and all-labeled condition (all products are labeled). As shown in Figure 1, the 33% labeled condition only had A or B labels; the 67% labeled condition included labels A, B, C and D; and the all-labeled condition featured all A-E labels.

Consumers answered questions about their frozen food purchasing habits and viewed video instructions on how to shop in the online grocery store. As can be seen in Figure 2, the online store displayed the brand name, product name, price, weight, a pack shot of the product and, depending on the condition, its carbon footprint label. Clicking on the packaging revealed detailed information about the nutritional values and composition of the product. Consumers could choose a product by placing it in the cart, where they could view detailed information again and change their choice before finalizing their purchase. The full range of the labels available in each condition could be seen in the landing page without having to scroll down and the products were not ordered by price, weight, or brand.
Fig. 2. Screenshot of the landing page across experimental conditions

‘No label’ condition

33% labeled’ condition

‘67% labeled’ condition

‘All labeled’ condition
To avoid socially desirable responses, consumers were told that the goal of the study was to test their user experience on the online grocery shop. To make the experiment incentive compatible, they were told that 15 of them would be randomly chosen to receive the value of their selected product in the form of a monetary voucher. Since the products in the experiment have similar prices, and these prices do not vary across conditions, incentive compatibility is not affected by price variability. After completing their online purchase, consumers were directed back to the survey which measured their attitudes toward labeled products and their environmental beliefs.

Measures

To measure environmental preferences, we adapted the 5-item questionnaire from the Brief Ecological Paradigm (BEP) scale\textsuperscript{18}. Participants were asked to rate on a scale of 1 to 5 [1-Strongly disagree; 5-Strongly agree] how far they agreed or disagreed with 5 statements about the relationship between humans and the environment (such as: “If things continue on their present course, we will soon experience a major ecological catastrophe”). We averaged the 5 ratings to get the BEP score for each participant. The BEP Score averaged 4.2 across the participants (SD = 0.82).

The purchasing data obtained from the online grocery store were matched to the individual participants’ responses to the survey questionnaire in Qualtrics, using the individual identifier and a matching code respondents had to enter on OSOG.

We used linear regression analysis to explore the determinants of the variability in the selected products’ CO\textsubscript{2} emissions, by regressing these emissions on participant characteristics and dummy variables indicating the experimental condition. The statistical analysis was conducted in STATA (Stata Statistical Software: Release 16. College Station, TX: StataCorp LP).

Results

Impact of labeling on CO\textsubscript{2} emissions

For each condition, we computed the average CO\textsubscript{2} emissions of the purchased products. The average CO\textsubscript{2} emissions in the control group was 689.1g CO\textsubscript{2} eq. per 100g (95%CIs: 599.6, 778.6). As shown in Figure 3, it dropped significantly as the proportion of labeled products increased.

Compared to the control condition, the mean CO\textsubscript{2} emissions were 16.5% lower ($M=575.8$, 95%CIs: 494.4, 657.3) in the 33% labeled group, 19.8% lower in the 67% labeled group ($M=552.6$, 95%CIs: 472.6, 632.5), and 20.4% lower in the ‘all labeled’ group ($M=548.4$, 95%CIs: 462.0, 634.7).
We further investigated these findings by regressing CO₂ emissions on the individual characteristics of respondents (demographic information and environmental preferences), in addition to dummy variables associated with each condition. Since the distribution of CO₂ emissions of our products was skewed (see Fig. 1), we used the natural logarithm of emissions as the dependent variable.

The regression results (Table 2) show that having strong environmental preferences (measured through the Brief Ecological Paradigm (BEP) score – see Methods) and gender (identifying as a woman) have a strong and statistically significant negative impact on carbon emissions, in line with the previous literature. No significant effect was detected for the other demographic variables (age, ethnicity, student status, employment) or for political affiliation.

Controlling for the above variables, the main independent variables of interest in the regression are the conditions’ dummy variables. The coefficients associated with these conditions are all negative and statistically significant, which confirms our findings reported in Figure 3.
We further tested the parameters associated with these conditions by conducting two tests: the first was whether all these parameters are equal to 0, which would indicate that carbon labels had no impact on CO$_2$ emissions ($H_1$). The second was whether the parameters associated with the conditions other than the control were equal ($H_2$), indicating that the proportion of products labeled had no impact on CO$_2$ emissions, as long as the top 33% of the products were labeled.

The above tests are standard linear restrictions Wald tests which we obtained through STATA 16 (Judge, 1985). For $H_1$, the F statistic was $F(3,1064) = 6.41$, with a significance level yielding: Prob>F=0.0003. We therefore rejected $H_1$ at the 1% level. For $H_2$, the F statistic was $F(2,1064)=1.56$, with a significance level yielding: Prob>F=0.211. We failed to reject $H_2$ at the 10% level.

Table 2. Regression estimates of the CO$_2$ emissions of the chosen product

<table>
<thead>
<tr>
<th></th>
<th>Natural log of CO$_2$ emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Belief Score</td>
<td>-0.086***</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
</tr>
<tr>
<td>Age</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
</tr>
<tr>
<td>Gender (Female=1)</td>
<td>-0.190***</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
</tr>
<tr>
<td>Ethnicity (While=1)</td>
<td>-0.098</td>
</tr>
<tr>
<td></td>
<td>(0.064)</td>
</tr>
<tr>
<td>Student</td>
<td>0.131</td>
</tr>
<tr>
<td></td>
<td>(0.091)</td>
</tr>
<tr>
<td>Employed</td>
<td>-0.053</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
</tr>
<tr>
<td>Political affiliation (Democrat=1)</td>
<td>-0.027</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
</tr>
<tr>
<td>Conditions:</td>
<td></td>
</tr>
<tr>
<td>33% labeled</td>
<td>-0.170**</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
</tr>
<tr>
<td>67% labeled</td>
<td>-0.241***</td>
</tr>
<tr>
<td></td>
<td>(0.072)</td>
</tr>
<tr>
<td>All labeled</td>
<td>-0.300***</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
</tr>
<tr>
<td>Constant</td>
<td>6.578***</td>
</tr>
<tr>
<td></td>
<td>(0.182)</td>
</tr>
<tr>
<td>Observations</td>
<td>1075</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.10$
The results of these statistical tests showed that mean CO$_2$ emissions were statistically significantly different between each label condition and the control (no labels) condition, but not significantly different among the three labeling treatments. This finding confirmed that the bulk of reductions in emissions are already achieved when only the top third of the products were labeled.

**Impact of labeling on the carbon label category of the chosen product**

To examine whether the reduction in average emissions was driven by increases in the purchases of products with low emissions or by reductions in the purchases of products with high emissions, we computed the distribution of (latent or actual) carbon labels among the purchased products in each condition. Because of the low number of products with A or D labels, we categorized the products into three approximately equal groups: 11 products with an A or B label; 8 products with a C label, and 14 products with a D or E label.

**Fig. 4. Distribution of carbon labels of chosen products across experimental conditions**

As shown in Figure 4, the share of the 11 products with the lowest emissions (A or B labels) increased from 32.7% in the no labels condition to 52.1% in the ‘all labeled’ condition, a change by 19.4 percentage points. In contrast, the share of the 14 products with the worst emissions (D or E labels) exhibited a smaller drop as the number of labeled products increased (from 36.0% to 24.9%, or 11.1 percentage points). Finally, the share of the 8 products with a C label showed the least variation, decreasing by only 8.3 percentage points between the no labels and all labeled conditions. Figure 4 also shows that most of the changes took place between the no labels and the 33% label condition. Specifically, 13.1 of the 19.4 percentage points increase in the share of A &
B products and 7.6 of the 11.1 percentage points reduction in the market share of D & E products were due to labeling the A & B products (i.e., the change from the no labels to the 33% labeled condition). Conversely, compared to labeling the top two thirds of products (67% labeled condition), further labeling the bottom third of products (which all had a D or E label) only reduced the market share of A & B products by 4.3 percentage points while, remarkably, increasing the market share of D & E products by 1.5 percentage point.

Table 3. Multinomial regression estimates of the carbon label group choice

<table>
<thead>
<tr>
<th></th>
<th>Products with low emissions labels (A &amp; B)</th>
<th>Products with high emissions labels (D &amp; E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Belief Score</td>
<td>0.354*** (0.098)</td>
<td>0.131 (0.102)</td>
</tr>
<tr>
<td>Age</td>
<td>0.0124** (0.006)</td>
<td>0.0159** (0.007)</td>
</tr>
<tr>
<td>Gender (Female=1)</td>
<td>-0.0006 (0.155)</td>
<td>-0.416** (0.172)</td>
</tr>
<tr>
<td>Ethnicity (White=1)</td>
<td>0.0357 (0.190)</td>
<td>-0.195 (0.204)</td>
</tr>
<tr>
<td>Student (Yes=1)</td>
<td>-0.144 (0.266)</td>
<td>0.206 (0.281)</td>
</tr>
<tr>
<td>Employed (Yes=1)</td>
<td>0.030 (0.154)</td>
<td>-0.048 (0.169)</td>
</tr>
<tr>
<td>Political affiliation</td>
<td>0.097 (0.162)</td>
<td>-0.052 (0.179)</td>
</tr>
</tbody>
</table>

**Conditions:**

<table>
<thead>
<tr>
<th></th>
<th>Products with low emissions labels (A &amp; B)</th>
<th>Products with high emissions labels (D &amp; E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33% labeled</td>
<td>0.550** (0.216)</td>
<td>-0.004 (0.225)</td>
</tr>
<tr>
<td>67% labeled</td>
<td>0.450** (0.210)</td>
<td>-0.381* (0.226)</td>
</tr>
<tr>
<td>All labeled</td>
<td>0.786*** (0.218)</td>
<td>-0.078 (0.233)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.041*** (0.544)</td>
<td>-0.699 (0.561)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,075</td>
<td>1,075</td>
</tr>
<tr>
<td>Prob&gt;chi2</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. Medium emissions labels considered as base outcome.

*** p<0.01, ** p<0.05, * p<0.10

To compare the magnitude of the changes in the distribution of carbon label groups, we estimated a multinomial logistic regression of the choice among the three groups of products (those with an
A or B label, with a C label, and with a D or E label) using the same set of independent variables as previously. The group of products with a C label was used as the default.

The estimation results (Table 3) showed that the parameters associated with the conditions were positive, statistically significant, and increased with labeling for products with low emissions (A & B) labels. Increasing the number of products labeled led to a 0.55 (33% labels), 0.45 (67% labels) and 0.78 (full label) increase in the relative log odds of selecting products with a low emissions label (A & B) compared to products with a medium emissions label (C).

Regarding the group of products with high emissions labels (D & E), the coefficients associated with conditions are not statistically significant except for the 67% condition (-0.381). Table 3 also shows that ecological beliefs predict the choice of A & B products (relative to C products) but not the choice of D & E products (also relative to C products). This suggests that people who care about the environment view A & B products as significantly better than C, D, or E products, which are all perceived as equally bad in terms of environmental impact.

To estimate the effects of labeling on the choice share of the three groups of products while controlling for the other factors, we calculated the predicted probability of choosing each group of products in each condition, holding all other variables in the model at the mean. The average marginal effects (Table 4) showed that the predicted probabilities of choosing the A & B products increased from 12.8% to 19.4% as labeling increased, whereas the predicted changes for the C products were not statistically significant, except for an 8.1% decrease when comparing the ‘all labeled’ condition to the low label condition. The predicted probabilities for the D & E products were all statistically significant but did not decrease linearly. In particular, the predicted probability of selecting D & E products was not lower in the ‘all labeled’ conditions than in the 67% labeled condition (when only the 3 D products with the lowest emissions were labeled). In addition, the magnitude of the change was highest for A & B products and lowest for C products.

Table 4. Average marginal effects dy/dx for the impact of conditions on labels group choice

<table>
<thead>
<tr>
<th>Conditions:</th>
<th>Products with low emissions labels (A &amp; B)</th>
<th>Products with medium emissions label (C)</th>
<th>Products with high emissions labels (D &amp; E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33% labeled</td>
<td>0.128*** (0.041)</td>
<td>-0.059 (0.038)</td>
<td>-0.069* (0.040)</td>
</tr>
<tr>
<td>67% labeled</td>
<td>0.148*** (0.041)</td>
<td>-0.020 (0.039)</td>
<td>-0.128*** (0.038)</td>
</tr>
<tr>
<td>All labeled</td>
<td>0.194*** (0.041)</td>
<td>-0.081** (0.038)</td>
<td>-0.113*** (0.039)</td>
</tr>
</tbody>
</table>

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1
Overall, these analyses show that the reduction in average emissions came from the increased probability of choosing A & B products at the expense of D & E products. These analyses also demonstrate that most of the benefits of carbon labeling accrued by labeling A & B products.

**Discussion**

Like other recently published studies, our findings confirmed that traffic-light front-of-pack ecolabels were effective in altering consumers’ behavior. Relative to the control condition where no labels were included, having all products labeled decreased the average greenhouse gas emissions of the products tested in our study by 20.4%. Yet the main goal of the study was to examine a more realistic setting where not all products are labeled.

Our key finding was that most of the benefits of ecolabeling were already achieved by labeling only the top third of products. Adding A or B labels alone reduced the average greenhouse gas emissions of the products tested in our study by 16.5%. Once the products with the lowest carbon footprints could be easily identified, further labeling had almost negligible impact. This occurred because labeling primarily influenced the purchasing of A or B products. Strikingly, when A, B, and C products were already labeled, further labeling D or E products did not decrease their market share. In other words, low emission products were helped by green labels, but high emissions products were not hurt by further adding orange or red labels. These results echo earlier findings that simplified graphic nutrition labels increase the sales of food products with the best nutritional quality in their category but do not hurt those with medium or low nutritional quality. A simple explanation for these results is that ecolabels primarily influence consumers who care about the environment and these consumers can already identify those products with the worst carbon emissions (e.g., beef-based products). Identifying A & B products is enough to change the choices of consumers who care about the environment and further distinguishing between C, D, and E products does not add much since these consumers are unlikely to select these high emission products anyway. Conversely, environmental impact is evidently not a primary motivator of consumers who choose food products with the worst carbon footprint. Consequently, consumers who prefer D or E products do not change their choices once these products receive a D or E label.

These results have significant policy implications. Recent opinion polls show a very strong support among consumers for ecolabels. A 2020 nationally representative survey of more than 10,000 adults across France, Germany, Italy, the Netherlands, Spain, Sweden, the UK, and the US showed that two thirds of consumers thought that carbon labelling was a good idea. In the EU, a special Eurobarometer survey of 27,000 people in 27 EU countries conducted in the summer of 2020 found that 88% of respondents agreed that information on food sustainability should be compulsory on food labels. Yet despite consumer support, the legislation of ecolabels is still in its infancy. For example, the European Commission has only recently started exploring a sustainability labeling framework. It is not obvious that national or trans-national standards for environmental sustainability labeling will be agreed upon in the near term. Even if they were adopted, ecolabels would face strong resistance and legal challenges from producers, especially those offering products with a heavy ecological footprint.
Our results indicate that there may be no need to immediately put ecolabels on all products under mandatory schemes, as partial voluntary labeling even of the most sustainable food products could lead to changes in consumer behavior and sizeable reductions in ecological damage. Rather than attempting to find unanimity around a mandatory ecolabel that is unlikely to ever be accepted by some, the focus should be on finding a consensus for a standardized ecolabel among those producers who want to adopt it. This would facilitate the diffusion of ecolabels and allow them to have an impact sooner rather than later.

A limitation of our research is that it only included one product category and future research should expand the purchasing experiment to all the food products typically purchased in grocery stores. Another limitation is that the label only measured carbon equivalent emissions. This was chosen because carbon footprint is relatively easy to understand by consumers and relatively easier to compute across products. Future research should examine more comprehensive ecolabels that include other environmental impacts (such as land use, water, or biodiversity). Further research could also explore the impact of price changes in parallel to introducing ecolabels, to test consumers’ price sensitivity to labeled products for instance. The fact that our experiment was conducted online could also be another limitation and future research should test ecolabels in physical grocery stores. Finally, a comprehensive analysis of the value of mandatory labeling would require estimating its impact not just on the demand for food, as we have attempted to do, but also on the supply of food products since labels are likely to lead some producers to reformulate their products to decrease their carbon footprint11.

References


**Acknowledgments**

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**Author contributions**


**Competing interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
Supplementary Information

Should carbon footprint labeling be mandatory for all food products? RCT shows no benefit beyond labeling the top third

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This file includes:
- Supplementary Note 1: Product composition and gCO2eq estimates
- Supplementary Note 2: Survey instrument
Supplementary Note 2: Survey instrument

This section contains all the questions and measures used in the analyses reported in the paper.

Section 1: Exclusion Criteria

Please confirm that you are using a desktop/laptop to complete this survey. We are not able to use data from a mobile or tablet device for this study.

  I confirm: I am using a desktop/laptop device to complete this study.

  No, I am using a mobile phone or tablet.

You are being asked to take part in a questionnaire conducted by Shemal Doshi, Jad Chaaban & Pierre Chandon. In this survey, you will be asked to choose products in an online grocery store using an interface that we are currently testing. All responses are confidential and we do not ask for personally identifiable information.

You will be compensated £1.3 for your participation in the present survey.

There are no anticipated risks or benefits to participating in this study. Participation is voluntary and you may withdraw from the study at any time. Please note that you must be 18 years of age or older to participate and compensation is only available if you complete the survey. This study will take about 11 minutes to complete. By continuing, you are agreeing that you have read and understood what is being asked of you and are taking part in this study voluntarily (without coercion). If you have additional questions about this survey, you can contact Shemal Doshi at shemal.doshi@insead.edu.

By selecting "yes" below, you confirm that you are at least 18 years old and that you have read and understood the information provided on this page.

  Yes

  No

Have you ever bought frozen entrées (frozen prepared meals) from the grocery store?

  Yes

  No

Are you Vegan or Vegetarian?

  Yes

  No
**Section 2: Cover Story and Instructions**

We are working for a company that is launching an online grocery store. We are trying to pre-test some parts of the interface out in public for them.

After watching some video instructions, you will test the shopping experience on the online grocery store interface. You will have to make a purchase of a 'single' food item from the 'TEST' subcategory of the online grocery store.

15 randomly chosen participants will receive a coupon allowing them to buy the product they have chosen. Hence, choose the product carefully.

**Section 3: Instructional Video**

Please click on the icon and watch the instructional video below. You can advance once the video is complete.

*Video: [https://www.youtube.com/embed/leOxNyHyAF8](https://www.youtube.com/embed/leOxNyHyAF8)*

----- Page Break ----- 

Now it's your turn: Choose one product from the 'TEST' category.

Remember you have a chance of receiving a coupon allowing you to get the product that you have chosen for **FREE**.

To be eligible, you **MUST** only choose 'one' food item from the 'TEST' category.

**Section 4: Random Assignment into One of the Four Conditions of Shopping Task**

*Condition 1 (No label):*

[Click this link](https://www.youtube.com) to open the grocery store on a new tab.

Enter your Prolific ID ${e://Field/Prolific_PID} on the first page of the online grocery store.

Please **do not** refresh while in the online grocery store.

When you have finished your grocery shopping, please check out. Once you have completed check out, you will be given a checkout code to enter into the box below.

Please enter the CHECKOUT code:

________________________________________________________________________
Condition 2 (33% labeled):

[Click this link](#) to open the grocery store on a new tab.

Enter your Prolific ID $\{e://Field/Prolific_PID\}$ on the first page of the online grocery store.

Please **do not** refresh while in the online grocery store.

When you have finished your grocery shopping, please check out. Once you have completed check out, you will be given a checkout code to enter into the box below.

Please enter the CHECKOUT code:

________________________________________________________________

Condition 3 (67% labeled):

[Click this link](#) to open the grocery store on a new tab.

Enter your Prolific ID $\{e://Field/Prolific_PID\}$ on the first page of the online grocery store.

Please **do not** refresh while in the online grocery store.

When you have finished your grocery shopping, please check out. Once you have completed check out, you will be given a checkout code to enter into the box below.

Please enter the CHECKOUT code:

________________________________________________________________

Condition 4 (All labeled):

[Click this link](#) to open the grocery store on a new tab.

Enter your Prolific ID $\{e://Field/Prolific_PID\}$ on the first page of the online grocery store.

Please **do not** refresh while in the online grocery store.

When you have finished your grocery shopping, please check out. Once you have completed check out, you will be given a checkout code to enter into the box below.

Please enter the CHECKOUT code:

________________________________________________________________
Section 5: Interface Review:
How was the overall shopping experience?
  Ease of use ★ ★ ★ ★ ★
  User interface ★ ★ ★ ★ ★

Section 6: Attention Check:
Which category of product did you shop from during the buying from the online grocery store?
  Frozen entrees (frozen prepared meals)
  Vegetables
  Pizza
  Sodas

Section 7: BEP Measure of Care for Environment
Listed below are statements about the relationship between humans and the environment.

For each one, please indicate whether you Strongly Disagree, Mildly Disagree, are Unsure, Mildly Agree or Strongly Agree with it.
<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Mildly Disagree</th>
<th>Unsure</th>
<th>Mildly Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humans are severely abusing the environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Despite our special abilities humans are still subject to the laws of nature.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The earth is like a spaceship with very limited room and resources.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The balance of nature is very delicate and easily upset.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If things continue on their present course, we will soon experience a major ecological catastrophe.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Section 8: Feedback:**

Thank you very much for your help. If you have any questions or suggestions, please enter them below.

__________________________________________________________________________