The Covid-19 Pandemic:Impact on Consumers' Environmental Consciousness and Food Choices in California

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Abstract

This study investigates empirically whether consumers are willing to pay for more sustainable food choices within the context of COVID-19. I implemented an online survey choice experiment for food products containing two choices where one has lower GHG emission in its description to elicit consumer valuation for both characteristics via revealed choices. I estimate a model of consumer choice where a product is defined as a bundle of attributes: price and sustainability. Varying the attribute space presented to consumers in the experimental choice design gives us the data variation to estimate a discrete choice model as mixed Logit specifications. The result shows that consumers have a significant positive marginal utility towards sustainability and estimate a significant average implied willingness to pay (WTP) of about 40 cents per pound. I find that there is heterogeneity in the WTP along respondents' education, race, and also with respect to stated environmental concern. This study has policy implications in that they suggest market based potential to stimulate certain consumer segments who want to decrease their environmental footprint by revealing information in the form labeling and awareness raising activities among consumers.

Keywords: Choice experiments, Discrete choice model, Willingness to pay, Labels, Information, Sustainability, Food production, COVID-19.

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1 Introduction

Understanding consumer preferences is a key component of studying the affect of consumer behavior on the environment and supply chain participants, such as firms, essential workers, local communities, and the consumers themselves. It is also important to recognize that preferences may change due to awareness towards climate change and characteristics of alternatives towards sustainability. The rise of eco-labels has created a market for sustainable options, however, currently "sustainable" labels are not available to provide sufficient information for consumers to make educated food choice. Changing consumers' dietary habits may have a significant impact on the production process, if consumers choose to purchase more sustainable options. Springmann M (2018) suggests the environmental (and health) impact of the reduction in meat consumption could decrease greenhouse gas (GHG) emission by over a million tonnes.This paper empirically assesses whether consumers respond to information on the sustainability of the food they choose.

One of the many side effects of the COVID-19 pandemic has been an increase in discussions about the environment. When shelter-in-place orders shut down economies, traffic levels plummeted. News reports and social media were suddenly full of discussions of improved air quality citing EPA data. Liu et al. (2020) revealed an 8.8% decrease in global CO2 emissions in the first half of 2020 compared to the corresponding period in 2019, larger than during the economic downturn that followed the 2008 financial crisis or World War II. In the meantime, the pandemic forced people to change their shopping and eating habits. Due to panic buying in line with guidance about creating a 'healthy pandemic pantry' - beans, dry pasta, canned vegetables and fruit, alternative milks (basically a lot of plant-based products), many of these plant-based products subsequently disappeared from store shelves, while meat and dairy were more attainable. Until there was a meat shortage, which brought national attention to the business ethics in current meat production. Moreover, industry evidence suggested that sales of plant based meat increased during this period. It appeared conversations around environmental issues and food supply chains have become more active.

It seemed that people had started considering environmentally friendly alternatives to how things used to be during the "new normal."

My research question is whether consumer preferences have changed towards considering environmentally friendly alternatives since the pandemic. Specifically, an online survey choice experiment for food products containing two choices where one has lower GHG emission in its description. I design two separate surveys to collect California residents' data to test whether there are significant shifts in consumer values around sustainability through their food choice.

I estimate a model of consumer choices where a product is defined as a bundle of attributes: price and sustainability at the point of choice. Varying the attribute space presented to consumers in the experimental choice design, and collecting data on consumer characteristics, gives us the data variation to estimate a Logit discrete choice model specification assuming consumers choose the option that maximizes their utility. The estimated model parameters consist of estimated marginal utilities for price and marginal utilities for other product characteristics for marginal utilities.

Relating marginal utility for the sustainability attributes to the marginal utility of price allows me to estimate average willingness to pay for said characteristics. Additionally, I empirically test whether consumer demographic characteristics affect the willingness to pay. Moreover, by revealing information on the benefits of choosing a sustainable diet, we are able to assess whether the information treatment significantly affects the willingness to pay for sustainability in the product set.

The contribution of this paper is twofold: (1) to estimate stated preferences and corresponding willingness to pay (WTP) for sustainability in the production of food products, and (2) to investigate whether consumers respond to information about environmental consequences of their food choice. The availability of information about a product's attribute, that is GHG emission level, does not necessarily mean consumers will incorporate it into their decisions and alter their behavior. It also does not necessarily result in a change in the

WTP. This study provides a distribution of WTP estimates for attributes of food options during COVID-19 and an empirical test of whether consumers directly incorporate available information. In so doing, I equip resource managers with important information on the efficacy of potential labels pertaining to sustainability as well as a barometer reading on consumer stated preferences.

Exploring associated literature demonstrates consumer knowledge and market mechanisms to compel consumers toward sustainable food products. Regarding consumer knowledge, Macdiarmid (2012) finds that fewer than 20% of surveyed people believe they would know how to make the necessary changes to create a sustainable diet. Smith (2008) also discusses how consumers often lack the knowledge or ability to discriminate between what is sustainable and what is not. However, Tait et al. (2011) finds, when evaluating consumer attitudes toward sustainability attributes, water efficiency is among the most important attributes of a food item, behind price and carbon footprint. Regarding market mechanisms, numerous studies have shown that providing consumers with information about product sustainability through "eco-labels" impacts consumer choices, such as the USDA organic seal Kiesel and Villas-Boas (2007), sustainable seafood advisories Hallstein and Villas-Boas (2013), dolphin-free tuna labels Teisl et al. (2002), and environmentally certified wood products Aguilar and Vlosky (2007). Therefore, given consumers' stated knowledge gap on the sustainability of their diets and the effectiveness of eco-labels in other settings, this paper contributes to relevant discourse by estimating how much consumers would value sustainability in the midst of a pandemic and economic shutdowns.

This paper follows and expands the existing revealed and stated preference literature, which uses a variety of reduced form and structural approaches to infer the value consumers place on product attributes that are not observable or taste-able by consumers at the point of purchase (such as organic, vitamin fortified, dolphin-safe, free-range, rBGH-free). In the reduced form context, hedonic price model approaches have been used to estimate relative values for food product attributes Asche and Guillen (2012); Roheim et al. (2007, 2011);

Jaffry et al. (2004); McConnell and Strand (2000). Structurally, demand system approaches are estimated to place a willingness to pay for product attributes Alfnes et al. (2006); Teisl et al. (2002). My work is more closely related to this second literature stream and is the first to use these methods to place a value on sustainability. This paper asks whether consumers might be willing to pay for reduced environmental impact.

My results are as follows. I find a positive average WTP for more sustainable options. I find consumers have a significant positive marginal utility towards sustainability and estimate an average implied willingness to pay (WTP) of approximately 40 cents per pound when they are informed, in the experimental treatment arm, of the impact food has on overall greenhouse gas emissions. I find that the heterogeneity of the WTP estimates positively correlate with respondents' income and education. A respondent's age positively increases the WTP for sustainability. We also find that there is significant heterogeneity in the WTP in line with respondents' gender, race, and also with respect to stated environmental concern, and or being infected (or a loved one being infected) with COVID-19.

The rest of the paper proceeds as follows. Section 2 describes the empirical setting, the research design and data summary. Section 3 outlines the model used to estimate consumer choices and willingness to pay for product attributes. Section 4 presents the results of the choice model, and section 5 discusses the findings in terms of the average and distribution of WTP in the sample. Finally, section 6 concludes and presents avenues for future research.

2 Empirical Setting, Survey Design, and Data

This study uses discrete choice surveys to evaluate consumer preferences for sustainable food production.[1] Discrete choice experiments are among the most common methods for gathering stated preference, and are rooted in Random Utility Models Lu et al. (2013). The first step is to define a product as being made up of a set of attributes. Respondents are then asked to choose a single option from among alternatives, simulating the context that

[1]See the Appendix for the the full survey instruments.

consumers are normally presented with in the marketplace Tait et al. (2011). In this section I describe the survey implementation and design, and report data summary statistics showing initial evidence on consumer choices among greener and more sustainable alternatives.

2.1 Survey

Through an online survey by the online platform, Qualtrics.com, survey participants were asked questions in four main categories: 1)demographic information, 2)psychological values towards the environment and COVID-19 pandemic, 3)food choice, 4) hypothetical tax on food products based on GHG footprints.

Demographic information includes age, income, educational level and zipcode. The next set of questions is aimed at quantifying respondent's attitudes towards the environment and assessing pandemic concerns. Each question asks respondents to select one from a range of five choices: from 'strongly disagree' worth 1 point to 'strongly agree' worth 5 points. Each question is categorized either "Environmental", "COVID-19" and "Pandemic" and individual points are summed per category and become ***scores***. In so doing we are able to get data to empirically research whether the pandemic has shaped and changed respondents' awareness of animal agriculture and its contribution to climate change.

The third series of questions ask respondents to reveal their preferences between two choices where one option has a larger GHG emission scale than the other. The survey has five different choice scenarios, varying the products and prices displayed in each binary choice situation. Each respondent is asked to repeat the process in the five different pair-wise choice scenarios varying the products paired in each one. These products were featured in the survey because they vary in GHG footprint in supply chain.[2]

Finally I asked an additional choice question aimed at assessing whether consumers would be amenable to meat products' prices including a carbon tax addendum inspired by recent consideration of taxation on food products along its GHG footprint in the supply chain.

[2]See the Appendix for the the full survey instruments.

Springmann M (2018) suggests taxing along the threshold of GHG emission in production, and naturally, by extension, animal products would incur taxation. The answer to this question classifies consumers into two groups, one willing to pay for higher priced meat products instead of a plant based alternative, and the other choosing the plant based alternative given the meat carbon taxes displayed.

While all participants are asked the exact same questions mentioned above, they are randomly assigned into two groups; treatment and control. As a randomized experimental treatment, the treatment group was given information on environmental impact by (1) food supply chain per food category and (2) GHG emission level impacted by the COVID-19 pandemic, before they are asked to make food choices in the survey, and the control groups is not given such information prior to making choices, as can be seen in Figure 1. The Treatment consists of showing respondents a page containing the amount of GHG emissions in the production of several agricultural food products in two images displayed[3] just before respondents are to make the food choices.

Both the treated and the control group performed the choice experiment for the five different products. At the bottom of Figure 1 we see one such choice situation. The respondent is given two options, where she sees the price of each of the two alternatives but also that the meat alternative produces 10 times more GHG than the plant-based meat alternative.[4]

Comparing average responses in the treatment and control groups allows me to test the role of information treatment exposure on food choices and on the estimates of Willingness to pay (WTP) for sustainability, inferred via a specification and estimation of a behavioral structural choice model. This is done under the assumption that the control group is a good counterfactual to the treatment group. The next subsection analyzes the balance of

[3]See Figure 6 and Figure 7 in the Appendix.

[4]A New York Times article, 'Plant-Based 'Meats' Catch On,' is an example of the growing awareness and popularity of this trend (NY Times, May 22nd 2020). Plant-based meat producers are reporting record sales increases and rolling out partnerships with franchises; for instance Burger King and, most recently, Starbucks are serving Impossible Food products (CNBC June 23, 2020). As of April 2021, Impossible Burgers are available at five additional retailers, increasing from a single retailer in 2020. The market is clearly expanding. Although availability, price, flavor, quality, accessibility, and other variables could be factors, the pandemic may have changed the playing field for plant based meat options.

treatment and control groups along the demographics reported in the top of the survey in Figure 1, and presents the summary statistics of the data used in the analysis. It also presents summary statistics on a set of additional questions on the pandemic and environmental attitudes of respondents. Table 5 contains the summary statistics of the response to a choice question of meat product or a plant-based alternative, under a hypothetical carbon tax pricing of meat products.

2.1.1 Data Summary Statistics Survey

The survey instrument was sent to a total of 420 respondents, California residents who are 18 years and older, by Qualtrics via an email link. The sample size was determined by financial constraints. Summary statistics of my data set are presented in Table 1. It is summarized by the demographic makeup of survey respondents in the treatment and control groups. It is compared to the total California population. I chose to send the survey to potential respondents in California as I hypothesized that the population in California is very diverse in terms of socioeconomic characteristics that could potentially explain consumer choices.

The gender breakdown is approximately half-and-half, both in the survey and in California's general population. Ages "18 to 24" and the next two age intervals in the survey sample are over-represented compared to the California population. Furthermore, the "45-54" and "55-64" are under-represented, while"65 or older" age groups are over-represented in the survey sample, suggesting the sample data are skewed towards both older and younger populations at the expense of the middle age ranges. Whites are vastly over-represented at the expense of all other race categories. Income levels in the sample overall are fairly representative of the California population, as is race and gender. Finally, education attainment levels of "Less than some college" is under-represented in the survey sample as is "Graduate degree or more." When comparing the treatment and control groups to each other, we have balance across all the demographic variables, with the makeup of the control and treatment

groups similar for all rows in Panel A.[5]

The bottom of table 1 reports summary statistics for the constructed Environment, Pandemic and COVID-19 Scores for each respondent. I use the survey data to construct a measure of environmental concern of each respondent based on the degree of agreement/disagreement (on a scale of 1 to 5, 1 being strong disagreement and 5 strong agreement) with a series of nine statements regarding environmental issues to create an Environmental score for each respondent, as well as seven statements pertaining to the pandemic to create a Pandemic Score (PS). Finally we use answers to four COVID-19 questions to form a COVID-19 Score (CS) for each respondent. Starting with the construction of the ES for each respondent, if she strongly agrees with all nine statements she gets an ES of 35, and otherwise strong disagreement with all statements gets a score of 9. Similarly, the Pandemic Score (PS) ranges from 35 to 7, and the COVID Score (CS) ranges from 4 to 20.[6] The average ES in the treated group is 33.96 out of maximum 45, and is 33.97 in the control group. For the PS, the averages are 25.2 and 24.94 in the treated and control group respectively. The CS in the treated group is on average 17.78 and is 17.4 in the control group. Comparing the average scores by treatment and by control group separately, we find a balance, as the sample averages for each of the three score types are not statistically different between the treated arm and the control arm of respondents, consistent with the random assignment having succeeded along these score classifications.

Finally, besides the demographics and the three scores, we also classify a respondent with an indicator "Chose Taxed Meat" equal to one if she chooses meat products when they are taxed with a hypothetical carbon tax, instead of a plant-based meat alternative. Summary statistics of the proportion of respondents that chose the taxed meat options instead of the plant based one are reported in the last row of Table 1. The proportions are very similar between the treated (60 %) and the control group (63.33%) and we cannot reject the

[5]We cannot reject that the average is similar between control and treated groups for any of the demographic variables.

[6]See in Figure 8 in the Appendix the summary statistics for the average agreement with a representative set of statements

null of equality between the control and treatment groups in the proportion of respondents who chose taxed meat instead of plant-based meat, in the hypothetical carbon tax policy scenario[7].

2.1.2 Average Choices in Sustainability Survey

In Table 2, we present the share of respondents choosing the greener option along demographic segments as well as broken down for the treatment and control group in the bottom of the table. The share of green product chosen is very similar across genders with the greener option being chosen 51% of the time for men and 40% of the time for women respondents. An interesting pattern emerges as we go down the table from younger to older respondents, namely that for those lower aged, the proportion of times the green option is chosen is higher (50% for the youngest segment) than for the older segments, with the exception that ages between "$35-44$" have the highest share of the greener option chosen, 59%. Higher income ranges have a higher share of greener alternative chosen than lower income ranges. We see that the highest education respondents also, on average, have the highest proportion of choosing the greener alternative. Finally, in terms of the information treatment, the treated group has a significantly higher average proportion of choosing the greener alternative (53%) than the control group respondents (47%).

3 Empirical Strategy to Estimate WTP for Sustainability

The survey data—with respondent-specific choice information and demographics—enables us to estimate a specification of heterogeneous preferences in an econometric discrete choice model.

To analyze the impact of information on consumer choice, I define information content as

[7]Please see Table 5 for full result.

an additional or differentiated product attribute. Recognizing that products can be defined as a bundle of perceived attributes provides the framework to compute consumers' preferences and, ultimately, willingness to pay for product attributes in a discrete choice model. Starting from a random utility framework (as in McFadden 1974; McFadden and Train 2000; Train 2003) where both the product attributes as well as the random term are assumed to enter linearly, the utility from consuming a particular product can be described as

$$U_{ji} = X_j\beta_i + \epsilon_{ji}. \tag{1}$$

The matrix X_j indicates the attributes of product j, the vector β_i indicates the marginal utility that individual i places on these attributes, and ϵ_{ji} indicates the error term.

Distributional assumptions about β_i and ϵ_{ij} propel the econometric model decision. If I assume that ϵ_{ij} is independently and identically distributed extreme value (type I), then we have a Logit choice model. If I also specify

$$\beta_i = \beta_0 + \beta_1 D_i, \tag{2}$$

then I have a mixed Logit model, where the marginal utility coefficients vary according to the respondent's observed demographics D_i. This implies different decision-makers may have different preferences.

Assuming that consumers choose one unit of product j among all the possible alternatives N available at a certain time that maximizes their indirect utility, then the probability that good j is chosen is the probability that good j maximizes consumer i's utility

$$\Pr(\text{Choice}_j) = \Pr(U_{ji} > U_{ki}) = \Pr(X_j\beta_i + \epsilon_{ji} > X_k\beta_i + \epsilon_{ki}), \forall k \neq j. \tag{3}$$

Then, the following closed form solution can be derived for the probability that a respondent's

product choice corresponds to product j as

$$Prob_{ji} = \frac{e^{X_j\beta_i + \alpha \text{Price}_j}}{\sum_{k=0}^{N} e^{X_k\beta_i + \alpha \text{Price}_k}}, \tag{4}$$

where $\alpha = \alpha_0$ is the marginal utility with respect to price, that is constant for all respondents, and β_i contains the marginal utilities relative to the remaining attributes X for respondent i. The mean utility of not-choosing is normalized to zero. In other words, the attributes for the outside option are set equal to zero in all the experimental choice cases. This implies that equation (4) becomes

$$Prob_{ji} = \frac{e^{X_j\beta_i + \alpha \text{Price}_j}}{1 + \sum_{k=1}^{N} e^{X_k\beta_i + \alpha \text{Price}_k}}. \tag{5}$$

I have a mixed Logit where respondents have a binary choice of buying a product or not buying the product (i.e., N=1, and the choice is to choose or not).

Finally, given that each respondent makes T choice decisions (for the T different product categories separately), then the probability of individual i making a sequence of choices among the N alternatives and the outside option ($j = 0, ...N$) is given as

$$S_i = \prod_{t=1}^{T} \prod_{j=0}^{N} \left[\frac{e^{X_{ijt}\beta_i + \alpha \text{Price}_{jt}}}{1 + \sum_{k=1}^{N} e^{X_{ikt}\beta_i + \alpha \text{Price}_{kt}}} \right]^{Y_{ijt}}, \tag{6}$$

where $Y_{ijt} = 1$ if the respondent i chooses alternative j for choice situation t and 0 otherwise. Given a total of I respondents, the parameters $(\alpha, \beta_0, \beta_1)$ are estimated by maximizing the log-likelihood function

$$LL = \sum_{i=1}^{I} ln \prod_{t=1}^{T} \prod_{j=0}^{N} \left[\frac{e^{X_{ijt}\beta_i + \alpha \text{Price}_{jt}}}{1 + \sum_{k=1}^{N} e^{X_{ikt}\beta_i + \alpha \text{Price}_{kt}}} \right]^{Y_{ijt}}. \tag{7}$$

Note that for my survey consumers are presented with five different choice decisions, each

time among a sustainable and a non sustainable alternative. That is, $T = 5$ and $N = 2$. This means that we estimate a binomial mixed Logit by Maximum Likelihood to investigate the preferences for sustainability given the responses to the first survey.

The ultimate goal is to estimate average and heterogeneous marginal utility and the resulting willingness to pay (WTP) for the product attributes of interest. We estimate β_i by Maximum Likelihood. The resulting estimates of each respondent's WTP for a particular attribute x_a are obtained as the ratio of β_i and the absolute value of the marginal utility with respect to price α, namely

$$WTP = \frac{\beta_i}{|\alpha|} = \left[\frac{\frac{\partial U_{ijt}}{\partial x_a}}{\frac{\partial U_{ijt}}{\partial Price}} \right] = \frac{\partial Price}{\partial x_a}. \tag{8}$$

This estimate provides, in dollars (as the prices are measured in dollars per pound), what the willingness to pay is for increasing the characteristic x_a by one unit. I can therefore recover not just the average WTP but also the way the WTP in the sample of respondents varies according to respondent's demographics and other stated characteristics including, for instance, being treated.

4 Results

4.1 Mixed Logit Sustainability Choice Estimates

I present the results from the choice estimates originating from a binomial Logit specification, where consumers are asked to chose the sustainable option or not. I investigate whether there is significant average stated marginal utility for sustainability options when consumers are in the treated group, as well as stated heterogeneity in the marginal utility as a function of observable characteristics of the respondents, in terms of demographics and COVID-19 exposure. The coefficients are estimated by maximizing the likelihood of the sample,

and I perform model comparisons using the Akaike information criterion (AIC) among the estimated specifications and discuss the best specification used moving forward.

In Table 3 I present the estimates of the mixed Logit choice model specifications where β_i are given by equation (2). The dependent variable in both the columns is an indicator variable equal to one if an individual chooses the greener alternative and equal to zero otherwise. All specifications include product choice occasion fixed effects.

In column (1), the variables on the right are the price, product dummies, Treatment status of respondents, and respondents' Environment, Pandemic, and COVID-19 scores. From the estimates in column (1) we see that the coefficient on price is negative and significant (-0.54), meaning that a high price decreases the marginal utility of purchasing the greener alternative. The $Treatment$ status of respondents has an average marginal utility of 0.22 which is positive and significant. This means that, on average, respondents have a higher marginal utility choosing the greener alternative than respondents in the control group. The COVID-19 score has no significant marginal utility, controlling for the other covariates, while both higher pandemic and environmental scores have a positive average marginal utility.

In column (2) I further add respondents' demographics and their interactions with treatment status. On average a person's treatment status does not deferentially affect marginal utility in line with respondents demographics or the three score measures, given that none of the interactions in the bottom of the table are statistically significant. There is therefore no significant heterogeneous effects of treatment on the probability of choosing the greener alternative. The environmental score has a positive and significant marginal utility (point estimate of 0.04), the price a marginal utility (point estimate of -0.59) as before, and also consumers who have chosen the carbon tax meat options have a lower marginal utility of choosing the greener alternative, controlling for other factors in the regression.

For the remainder of the analysis of estimating the implied willingness to pay for the greener alternative, we use the specification in column (2) given its lower Akaike information criterion relative to the specification in column (1).

5 Willingness to Pay (WTP)

Dividing the marginal utilities of product attributes on average and interacted with respondents characteristics and treatment status by the absolute value of the marginal utility of price yields a data set of estimated willingness to pay for each of the respondents in the data sets. The next subsections discuss the WTP estimates and how they relate to observable characteristics of respondents. Next, I construct a series of graphical correlations, and estimate a multivariate linear regression model where the dependent variable is the respondent j WTP_j and the explanatory variables are the characteristics of the respondents given by the equation.

$$WTP_j = \mu_0 + X_j\mu_1 + v_j, \tag{9}$$

where X_j is a matrix of characteristics of respondent j, μ_1 is a vector of parameters, and v_j are unobserved factors contributing to j's WTP.

5.1 WTP for Sustainability in the Form of the Greener Alternative for the Treated Group Relative to the Control Group

Each respondent's WTP for the sustainable option when treated is obtained as the ratio between the marginal utility estimate of β_i for the treatment and the marginal utility of price α. I therefore obtain the estimated change in WTP for the treated respondents relative to the control respondents by using the choice model estimates in Table 3 column (2). Those are depicted in the Appendix in Figure 5. Dividing the Treatment marginal utility parameter 0.22 in Table 3 column (1) by the absolute value of the price (measured in US Dollars) marginal utility parameter 0.54 yields an average willingness to pay for the Greener alternative of the treated group relative to the control of $0.22/0.54 = 0.40$. This means that the treated group is willing to, on average pay 40 cents more than the control group for the greener alternative. Looking at the histogram and overlapped kernel density of the

estimated WTP, though, in the Figure 5 we find there to be considerable heterogeneity in the estimates of the differential WTP across treated and control groups. As we see in the Figure the estimates range from a negative WTP of -2.3 dollars to a WTP of over 2 dollars.

The variation in estimated individual departures from the average changes in WTP between treated and control group, can be due to the fact that respondents have different demographic characteristics. Figures 2 and 3 show the marginal correlations between the differential WTP between Treated and Control Groups against a series of respondents' characteristics. The first Figure 2 focuses on demographics and the second Figure 3 shows correlations among environmental score, pandemic score, COVID-19 score, and whether respondents choose carbon tax options over plant based alternatives.

The top left panel of Figure 2 depicts a scatter plot of the differential Treatment WTP and the income categories of respondents. It shows a positive relationship between the differential Treatment WTP and respondents' income (as shown in the fitted line added to the scatter top left panel). The top right panel repeats the scatter plot and fitted values of WTP and an indicator of whether the respondent has at least a college education. The average differential treatment willingness to pay for College educated respondents is significantly higher than for those with less than a college education. In the bottom left panel we find that there appears to be no significant correlation between the differential treatment WTP and age categories of respondents. Finally, the bottom right panel shows that the white respondents on average have a significantly lower differential treatment WTP than the non white respondents.

Figure 3 in the top left panel contains the scatter plot of the average estimated differential treatment WTP and respondents' Environmental Scores (ES) and the fitted values show a positive relationship. The top right panel shows that the higher the Pandemic Score (PS) the higher the estimated WTP for the greener alternative. The bottom left panel also shows that the COVID-19 Score (CS) is positively correlated with the estimated WTP for the greener alternative. Finally, in the bottom right panel I break up the average differential WTP among respondents who chose the carbon taxed and higher price meat options against

a plant-based alternative (=1), and those that did not (=0). The WTP is significantly higher for respondents choosing the carbon taxed options.

Beyond the depicted marginal correlation in both Figures above, the variation in the differential WTP between Treated and control groups for the Greener Alternative is explored by relating the estimated WTP_j for respondent j to their characteristics in a multivariate linear regression model given by equation (9).

The results are in Table 4. Being in a higher income category is significantly correlated with a higher WTP, ceteris paribus, given the point estimated 0.179 for "Respondent's Income Category. Being in a higher age category is also positively correlated with a higher WTP, with a coefficient of 0.023. White respondents have a significantly lower WTP than non white respondents holding all else equal (point estimate -0.816). A respondent who has either a higher environmental score or has chosen the carbon taxed meat options over plant-based meat also has higher estimated WTP than those with lower ES and not having chosen the carbon taxed option, in the hypothetical survey scenario.

6 Conclusion

This paper investigates stated survey evidence on the California population's willingness to pay for more environmentally friendly food options. It also uses two experimental treatments at the time of the survey implementation to estimate how willingness to pay is affected by information on how food choices impact our environment, and if COVID-19 affected consumer stated preferences are impacted by the COVID-19 pandemic. More specifically, this study empirically determines if consumers would pay more for food if the increase in price helped to protect the environment.

I implement an online choice survey for several food products with more environmentally sustainable alternative products to identify consumer valuation for those attributes via revealed choices. I estimate a model of consumer demand where a product is defined as two

attributes: price and sustainability. Varying the attribute space presented to consumers in the experimental choice design gives us the data variation to estimate discrete choice models allowing for respondents' heterogeneity. In so doing, this paper provides researchers and policymakers with the first estimates of the distribution of WTP for attributes pertaining to sustainability and worker safety in the production of food options, within the context of the COVID-19 pandemic.

There is an implied positive willingness to pay for sustainability. Moreover, when informing consumers about sustainability in the survey treatment design, this increases respondents' estimated WTP for the sustainable options significantly by about 40 cents per pound of meat. Having additional information of consumer demographic characteristics, we find that there is heterogeneity: holding all else equal, income and age are both, each in turn, positively correlated with a higher WTP. Stated concerns for the environment and favoring carbon taxed meat options also significantly increase respondents' estimated WTP. Finally, we also find significant heterogeneity with respect to education and race.

This paper offers valuable insights into the effectiveness of revealing information in the form of a label. While a label informs consumers and enables the ability to make educated choices, Wellesley et al. (2015) emphasize soft policy approaches that raise awareness of the importance of dietary change. Labels and awareness campaigns are likely to be the the most successful and accepted pathways. My findings indeed encourage us to explore such pathways, however,there are three potential weaknesses: (1) I captured consumers' stated preferences and not actual behaviors, (2) the small sample size, and (3) the non-representativeness of the sample for the California population. Following field studies and methodologies implemented in previous work Hilger et al. (2011), and given that there can be disparities between consumers' stated preferences and their actual purchases Hensher and Bradley (1993); Batte et al. (2007), future work should extend the experimental approach into a retail-level consumer field study—using actual choices rather than survey choices and based on a larger and more representative sample. Furthermore, future work should repeat

the survey during non-pandemic times, given that the WTP estimates may be different if the analysis is performed in years where environmental concerns are less salient.

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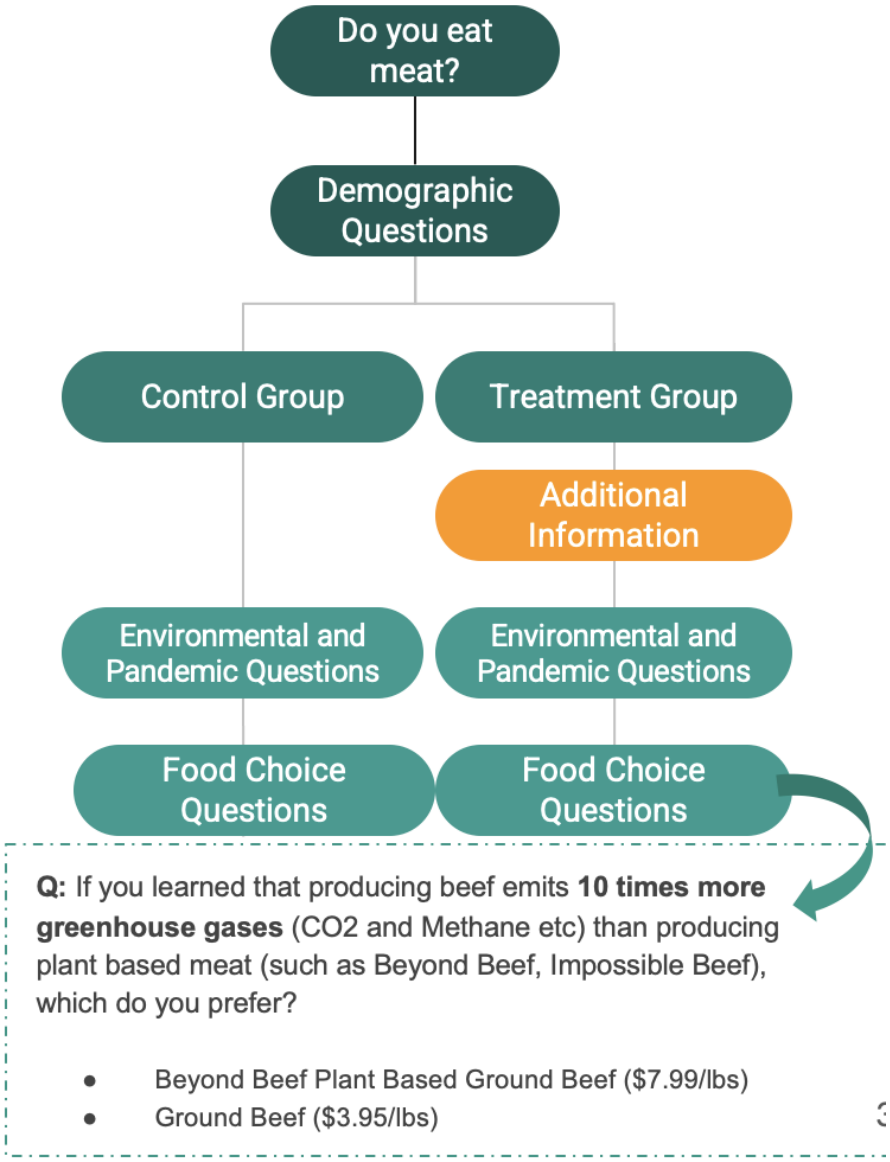
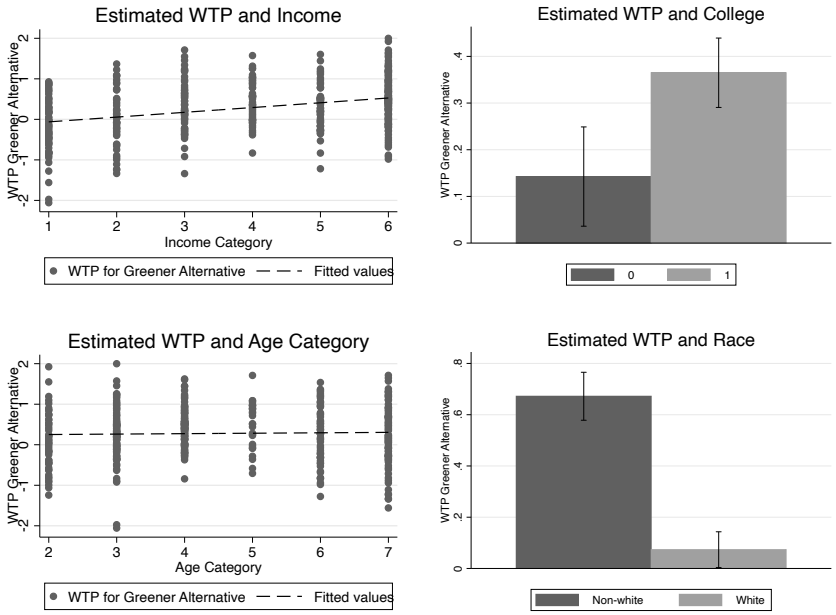
Figure 1: Survey Treatment Arms and Illustration of a Choice Situation



Note: This Figure depicts the survey flow and treatment and Control Design. Qualtrics implemented in the Winter of 2021.

Figure 2: Estimated Willingness to Pay Estimates (WTP) for the Greener Alternative of the Treated Group relative to the Control Group and Respondents' Characteristics: Part 1/2



Note: This Figure depicts the Relationship between the differential WTP between the Treated and Control Groups for the Greener alternative and Respondents' income (top left), college (top right), age (bottom left) and race (bottom right) . Based on the Mixed Logit estimates in Table 3 column (2).

Characteristics of Respondents and CA residents

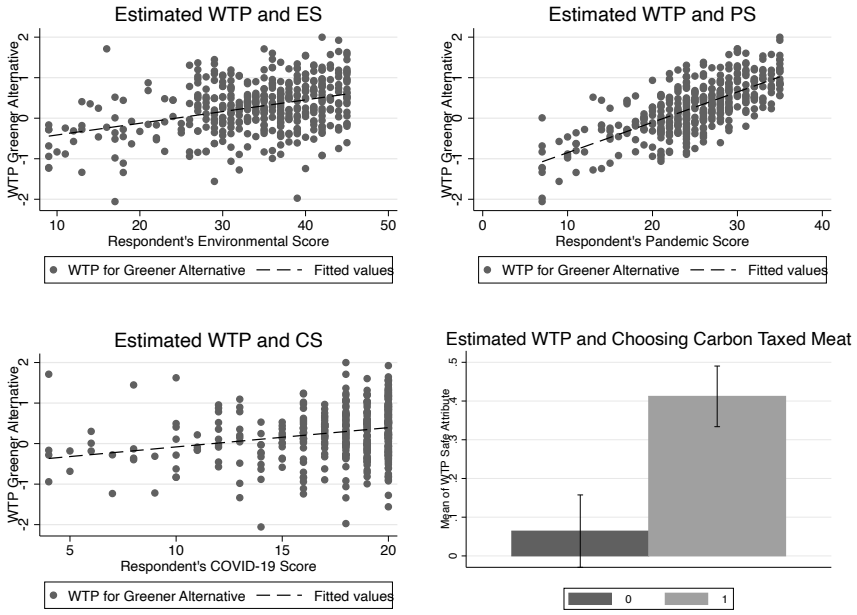
	Treated Group		Control Group		California*
	N	%	*N*	%	%
Female	102	48.6	108	50	50.7
Male	108	51.4	102	50	49.3
Age 18-24	22	10.5	29	13.8	6.7
Age 25-34	49	23.3	40	19	15.3
Age 35-44	54	25.7	59	26.1	13.4
Age 45-54	16	7.6	11	5.2	12.8
Age 55-64	23	11	35	16.7	12.1
65 and older	46	21.9	36	17.1	14.8
White	144	68.6	132	62.9	36.3
African American	25	11.9	26	12.4	5.5
Latino	23	11	28	13.3	39.4
Asian	13	6.2	18	8.6	14.6
Other	5	2.4	5	2.4	3.9
Income $45K or less	65	36.3	54	30.7	28.7
$50,000-$99,999	49	27.8	59	33.5	29.70
$100,000 or more	65	36.3	63	35.8	41.6
Less than some college	88	41.8	75	35.8	32.52
Associate degree, Bachelor degree	69	32.9	80	38.1	30.58
Graduate degree or more	53	25.2	55	26.2	36.89
	Average Score	*Std*	Average Score	*Std*	
Environmental Score (ES)	33.96	8.16	33.97	8.40	
Pandemic Score (PS)	25.20	6.17	24.96	6.35	
COVID-19 Score (CS)	17.78	3.12	17.40	3.60	
	%	*Std*	%	*std*	
Chose Carbon-Taxed Meat	60.00	49.01	63.33	48.21	

Table 1: Survey Summary Statistics

Note: Source Survey, Qualtrics implemented in the Winter of 2021. Sample size is 420 respondents.

* Source for the California Data: CA Census Fact Finder Database.

Figure 3: Estimated Willingness to Pay Estimates (WTP) for the Greener Alternative of the Treated Group relative to the Control Group and Respondents' Characteristics: Part 2/2



Note: This Figure depicts the Relationship between the differential WTP between the Treated and Control Groups for the Greener alternative and Respondents' Environmental Score (ES) (top left), Pandemic Score (PS) (top right), COVID Score (CS) (bottom left) and An Indicator for Having Chosen the Carbon Taxed Meat alternative instead of the Plant Based (bottom right) . Based on the Mixed Logit estimates in Table 3 column (2).

Variable	Greener Option Chosen (%)
Female	49
Male	51
18-24	50
25- 34	54
35- 44	59
45- 54	48
55- 64	40
65 and older	42
$24,999 and less	47
$25,000 - $44,999	43
$45,000 - $64,999	47
$65,000 - $89,999	59
$90,000 - $144,999	51
$115,000 and more	52
No high school diploma/GED	44
High school diploma/GED	50
Some college no degree or Associate's Degree	45
Bachelor's degree	49
Graduate's degree	58
Control	47
Treatment	53

Table 2: Frequency of Greener Option Chosen

Note: Source Survey, Qualtrics implemented in the Winter of 2021. Sample size is 420 respondents.
* Source for the California Data: CA Census Fact Finder Database.

	Likelihood of Choosing the Greener Choice	
	(1)	(2)
Price	-0.54***	-0.59***
	(0.06)	(0.07)
Env Score	0.04***	0.04**
	(0.01)	(0.02)
Pandemic Score	0.05***	0.03
	(0.02)	(0.02)
Covid Score	-0.02	-0.02
	(0.03)	(0.04)
Treatment	0.22*	-1.00
	(0.13)	(0.99)
White		-0.05
		(0.23)
Income		-0.03
		(0.06)
Age		-0.05
		(0.06)
Chose Carbon Taxed Meat		-1.40***
		(0.20)
Treatment X Env Score		-0.01
		(0.03)
Treatment X Pandemic Score		0.05
		(0.03)
Treatment X Covid Score		-0.01
		(0.06)
Treatment X White		-0.49
		(0.31)
Treatment X Age		0.02
		(0.09)
Treatment X Income		0.08
		(0.08)
Treatment X Chose Carbon Taxed Meats		0.23
		(0.28)
Constant	-2.00***	0.06
	(0.45)	(0.72)
Observations	2,100	2,100
Log Likelihood	-729	-675
Akaike Inf. Crit.	1,479	1,393

Table 3: Mixed Logit Choice Model Regression Results

Note: Robust standard errors in parentheses. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$. The table displays the estimates of mixed Logit specifications with interactions of respondents' Treatment and Demographics. The dependent variable is equal to one if the greener product is chosen and equal to zero otherwise. The estimated parameters represent Marginal Utilities. Robust standard errors in parentheses. Source Authors' calculations.

	(1) Mixed Logit WTP for Greener alternative for the Treated Relative to the Control Group
Respondent's Income Category	0.179***
	(0.012)
Respondent's Age Category	0.023**
	(0.012)
Respondent is White	-0.816***
	(0.044)
Respondent's Environmental Score	0.029***
	(0.002)
Chose Carbon Taxed Meat	0.358***
	(0.038)
Constant	-1.180***
	(0.115)
Num of Obs.	420
R squared	0.644

Table 4: Regression of Respondents' Mixed Logit WTP Estimates for the Greener Alternative on Respondents' Characteristics

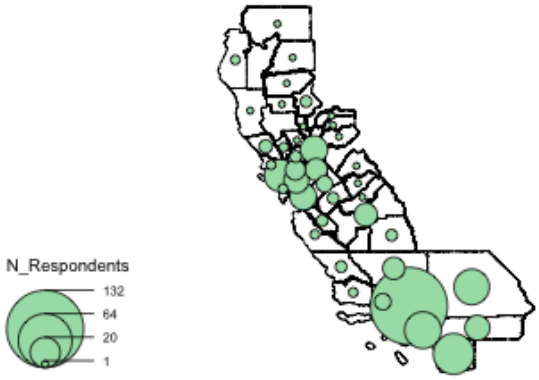
Note: Robust standard errors in parentheses. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$. The dependent variable is each respondents' estimated implied Willingness to Pay (WTP) for the Greener alternative from the mixed Logit estimates Table 3 column (2). The estimated parameters represent the correlation between the WTP and each variable controlling for the other variables in the multivariate linear regression. Source Authors' calculations.

A Survey Instrument links

The full survey can be found HERE.

B Additional Tables and Figures

Figure 4: Density of Participants by Counties



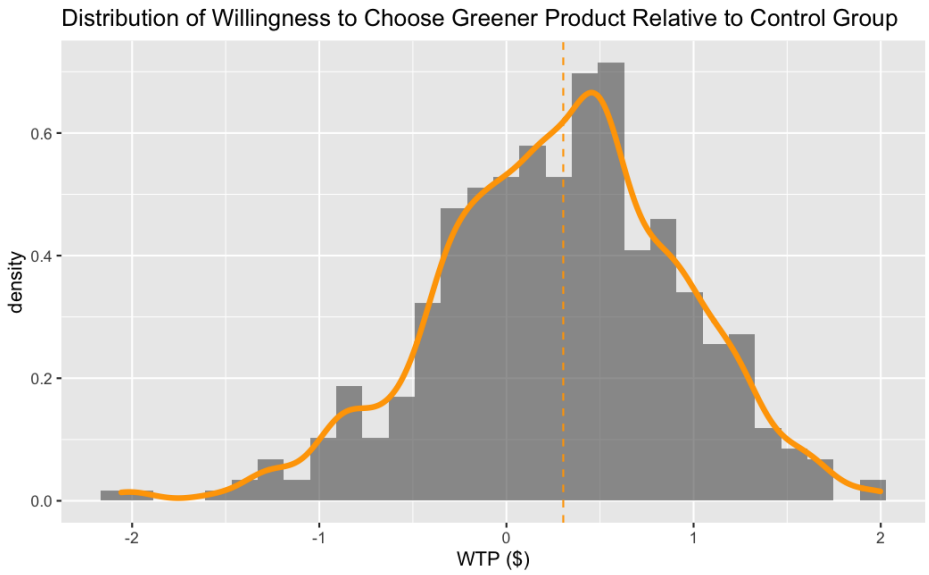
Note: More participants from counties with major cities such as Los Angeles and San Francisco Bay Area along the population density

	Control		Treatment	
	N	%	N	%
Beef ($1.00)	52	0.25	53	0.25
Pork ($0.07)	29	0.14	22	0.10
Poltry ($0.03)	52	0.25	51	0.24
Plantbased Food (No Tax)	77	0.37	84	0.40

Table 5: Results on Hypothetical Tax Choice

Note:Hypothetical tax was set for food products that exceed the mean emission introduced in Springmann M (2018) and based on its emission footprint. These three common meat products were chosen to be displayed compared to plant based foods. Majority of plant based foods are under the threshold, thus no tax.

Figure 5: Kernel Density of Estimated Willingness to Pay (WTP) for the Greener Alternative in the Treated Group Relative to the Control Group



Note: This Figure depicts an overlap of the Histogram and the estimated kernel density of the Estimated Willingness to Pay (WTP) for choosing the Greener Alternative for the Treated Group relative to the Control Group based on the Logit estimates in Table 3 column (2).

Figure 6: Treatment Image shown to Respondents assigned to the Treatment Arm of Survey in Figure 1: Pandemic Impact Global Emission Reduction

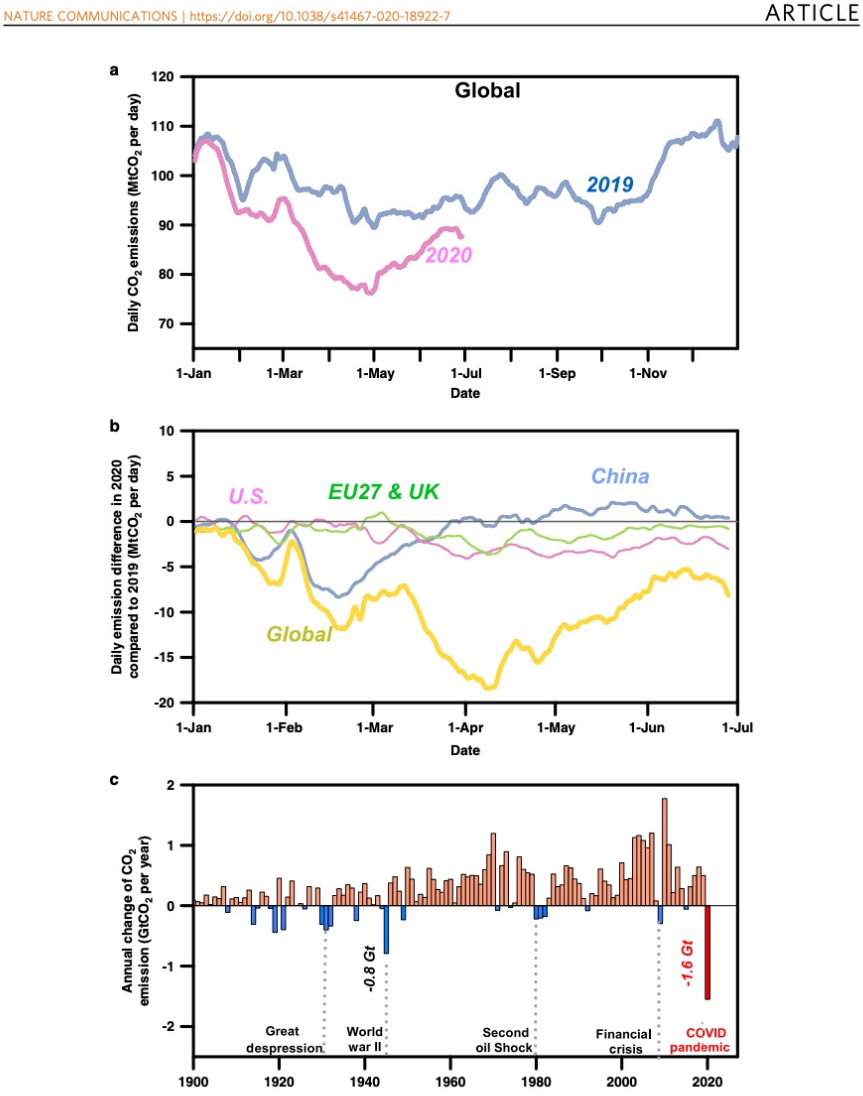
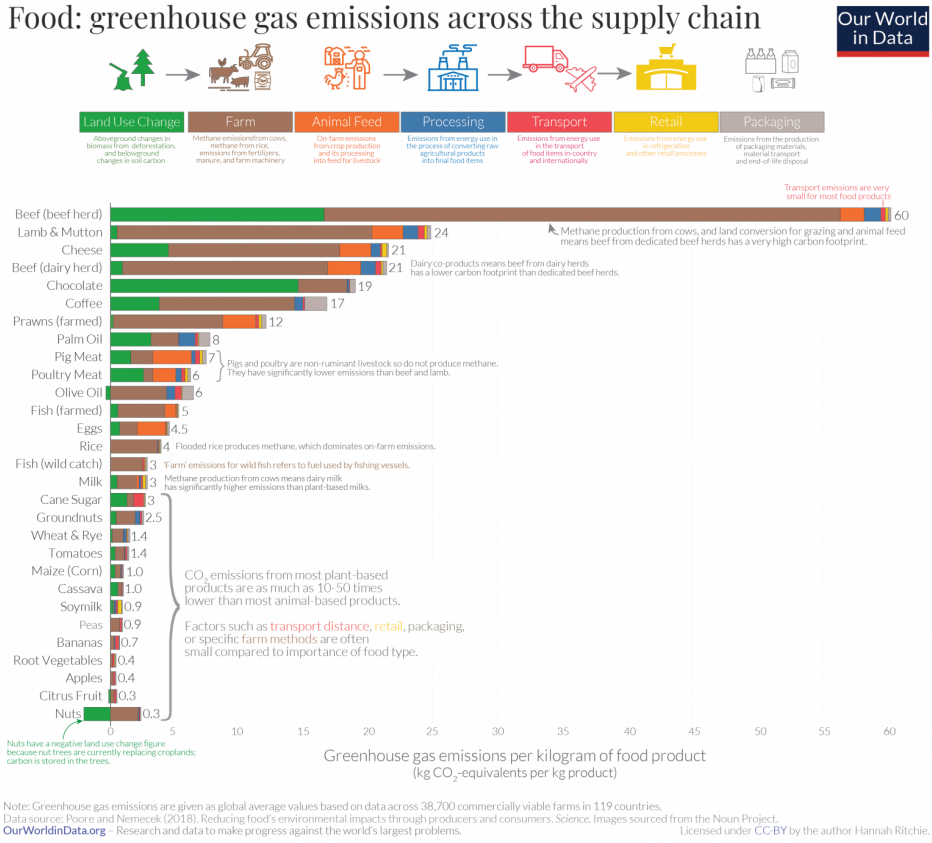


Fig. 1 Effects of COVID-19 on global CO_2 emissions. **a** Daily CO_2 emissions in 2019 and 2020 (7-day running mean); **b** Global emissions aggregate different timing of effects in different regions (7-day running mean); **c** COVID-19 causes the largest annual decrease of CO_2 emission since 1900.

Note: This Figure depicts the first piece of two images given in the Treatment branch of the sustainability Survey as depicted in Figure 1

Figure 7: Treatment Image shown to Respondents assigned to the Treatment Arm of Survey in Figure 1: Environmental Impact in Terms of Green House Gas Emissions of Food by Life Cycle Stage



Note: This Figure depicts the second piece of two images given in the Treatment branch of the Survey as depicted in Figure 1

Figure 8: Summary Stats of Answers on a scale of 1 to 5 (1 strongly disagree, 5 agree strongly) to a set of representative Questions Used to Construct a COVID Score, a Pandemic Score, and an Environmental Score for each Respondent

Environmental Questions	Ave Score (out of 5)	SD
Changing lifestyle can reduce environmental damage.	4.1	1.0
Climate change has an impact on wildfire frequency and severity.	4.1	1.1
Climate change is caused by human activities and is already affecting people and other living species worldwide.	4.1	1.1
Climate change is the most important issue in our global society today.	3.6	1.3
Individuals should pay higher prices or taxes to address climate change.	3.0	1.3
Large scale animal agriculture (animals kept and raised in confined situations to mass produce animal products such as meat, milk and eggs) has negative effects on the environment.	3.4	1.2
My government should do more to mitigate climate change and environmental damage.	4.1	1.2
Personal food choices can affect the environmental impact of agriculture.	3.8	1.1
Tax money should be used more to mitigate environmental damage and climate change.	3.6	1.3
Covid-19 Questions	**Ave Score (out of 5)**	**SD**
Individual actions (wearing masks, washing hands and keeping social distance) can save lives.	4.6	0.89
My government should prioritize advice from public heath experts most when drafting pandemic responses.	4.3	0.97
The Covid-19 pandemic has economic and political aspects but is above all an issue of public health.	4.3	1.05
Wearing masks helps to prevent the spread of Covid- 19.	4.4	1.12
Pandemic Questions	**Ave Score (out of 5)**	**SD**
During pandemic lockdowns and shelter-in-place orders I have seen an improvement in environmental factors such as air quality (excluding wildfire).	3.8	1.1
Pandemic lockdowns and shelter-in-place orders raised my awareness of the environment and climate change.	3.5	1.2
Since March 2020 (shelter-in-place order), - I feel like I do more for the environment.	3.6	1.1
Since March 2020 (shelter-in-place order), - I have been consuming less animal products (eating less meat etc).	3.1	1.3
Since March 2020 (shelter-in-place order), - I have been driving less (for environment).	3.8	1.2
Since March 2020 (shelter-in-place order), - I have been recycling more.	3.7	1.1
Since March 2020 (shelter-in-place order), - I have been using plastic less.	3.6	1.2

Note: This Figure depicts the Average Response to a each of an illustrative and representative subset of questions we use to construct three scores for each respondent: an Environmental Score (ES) in the top, a Pandemic Score (PS) in the middle, and a COVID-19 Score (CS) in the bottom of the Figure. There are a total of nine questions used to construct an Environmental Score (ES) for each respondent. If a respondent strongly agrees (a 5 in a scale of 1 to 5) with all nine questions this results in a score of 45, if he strongly disagrees with all 9 questions this results in an ES of 9. In terms of the Pandemic Score (PS) there are a total of seven questions, and based on the scale answers the PS of a respondent can get a minimum value of 7 and a maximum of 35. Finally, using the answers to four remaining questions we construct a COVID-19 score (CS), and given the scale answers, a respondent can get a minimum CS of 4 and a maximum of 20. We note that, based on the data, the sample average for each of the three score types are not statistically different between the treated arm and the control arm respondents, consistent with the random assignment having succeeded along these score classifications also.

Figure 9: Score Result per Counties