Message bias and consumer attitudes towards antibiotics in beef and dairy

Pre-Analysis Plan

April 11, 2023

1. Introduction

Across high-income countries, consumers show increasing concern for food attributes. They are concerned about food quality and safety, nutritional content, methods of production deemed to have negative impacts on their health or the environment, and ethical issues such as fair working conditions and animal welfare. Consumers can perceive a range of qualities to be hazardous, such as genetic modification (GM), non-domestic country of origin, or the absence of labels or standards with claims such as humanely-raised, grass-fed, cage-free, or free-range.

The types of consumers that show concern about antibiotic use in food production has been well established in the literature. Consumers that have concerns about antibiotic use tend to be female, highly educated, and high-income individuals. The reasons for consumer concern around antibiotics in food production is also well established. The most common reason consumers are concerned about antibiotic use in agriculture is due to concerns about human health, especially residues in the food, and concerns over animal welfare, associating antibiotic use with operations that have low animal welfare (Barrett et al. 2021). Some studies have found consumer concern around the rise of antibiotic resistant bacteria as well, though this concern is less commonly found in the literature (Barrett et al. 2021).

What is less known are the kinds of informational interventions that might affect how a consumer perceives antibiotic use in food production, and the role that knowledge and cultural values play in how someone might receive information about antibiotic use in agriculture. Meerza et al. (2021) found that information about antibiotics tended to change minds the most among consumers with low subjective knowledge about antibiotic use in agriculture. Beyond this study, there is little information on how consumer purchasing intentions may be altered through an informational intervention about antibiotics.

Concerning messaging type, research on trustworthiness and bias across a number of disciplines has shown that two sided messages i.e., showing trade-offs, tend to be perceived as less biased (Wallace 2020; Rucker and Petty 2008) and more persuasive (Allen 1990; Kim 2020). This paper considers the role of messaging bias in how it might affect consumer attitudes toward credence labels such as antibiotic-free foods.

In this experiment we examine how messaging affects peoples' preferences. First, we test whether a particular information intervention might affect consumer perception about antibiotic use in beef and dairy production. Specifically, we test whether a one-sided or two-sided message affects consumers' willingness to pay for the antibiotics free premium. Second, we examine the kinds of consumers that are most receptive to either of the messages. Specifically, we examine factors potentially affecting a consumer's receptivity to messages, such as existing subjective and objective knowledge about antibiotics, their scientific literacy, their education level and their cultural attitudes. Finally, we study a potential mechanism through which the messages change people's preferences. We hypothesize whether a person that delivers a balanced message is perceived as more trustworthy than a person that delivers a biased message and therefore the consumer is more open to contrary positions.

By providing insights into factors driving consumer perceptions of food hazards, and testing the effects of different types of messaging interventions in consumer attitudes, the results of this survey will inform targeted outreach programs to more effectively reach the public, dispel food hazard misconceptions, and help consumers make more informed food choices.

2. Literature Scan

A scan of the academic literature about perceived food hazards suggests that there is ample research describing *what* foods consumers perceive to be hazardous. However, it is not well understood *why* consumers perceive different foods as hazards, or *how* outreach and education can dispel misinformation.

Experiments that test education interventions on behavior change have mixed results, leading to behavior change in some cases but not others. A review of experimental interventions that attempt to alter behavior found that education has some impact on behavior in terms of

waste production decisions, but educational interventions had mixed or no effect on consumer behavior in terms of family planning, land management, meat consumption, and transportation choices (Byerley et al., 2018). More specifically to agri-food issues, studies using educational interventions to reduce meat consumption found no differences in the levels of meat consumption between groups that received education and those that did not (Campbell-Arvai et al., 2014; Campbell-Arvai and Arvai, 2015), while others found small self-reported reductions in meat consumption (Monroe et al., 2015).

People respond to informational and persuasive interventions, but also to how these interventions are framed and communicated (Kamenica, 2012). Research has covered interventions aimed to affect the contextual variables – commitments, defaults, messenger, norms, priming, and salience – as well as traditional behavior-change interventions – financial incentives and education (Byerly et al., 2018). Studies that tested the effectiveness of communication for attitude change around GM foods have found no change in attitude (Frewer et al., 1996, Frewer et al., 2003) or an unintended change toward more negative attitudes (Frewer et al., 1999, Scholderer and Frewer, 2003, Valente and Chaves, 2018, Zhu and Xie, 2015).

Consumer research has examined whether perceptions of ulterior motives behind marketing result in greater consumer skepticism and reduced persuasion of new messages (Wallace et al., 2020). Sources are viewed as biased when they have a skewed perception and untrustworthy when they are dishonest; both can undermine persuasiveness of the new message by serving as reasons to view a source as lacking credibility.

Key elements of trust in many contexts – including agri-food issues – are related to beliefs in perceptions of ‘transparency’ in the activities of the trusted agent (Muringai and Goddard, 2019). Perceived bias is a major source of distrust, and when people perceive a source to be biased or untrustworthy, they are less likely to be open to learning new information or changing their beliefs. A study of source bias and content bias found that presenting information from unbiased and slanted sources had a moderating effect on confirmation bias (Westerwick et al., 2017). Experiments have tested the effect of source expertise, source bias, and message format on perceived source credibility (e.g. Artz and Tybout, 1999; Choi et al., 2013).

However, there is little known about how information presented from the same source but with different message skewness affects the persuasion of new messages. In our study, people are presented with 1) a **positive, one-sided message** about antibiotics that is biased toward antibiotic use among farmers or 2) a **negative one-sided message** about antibiotics that is biased biased against antibiotic use among farmers, or 3) a **positive, two-sided message**, that covers both sides of the issue but is biased toward antibiotic use among farmers. Does telling both sides of the issue reach consumers more effectively than presenting only one side or the other?

Research across marketing, communication studies, and political science suggests that a two-sided message framing will increase perceived trustworthiness and decrease perceived bias. Hendriks et al. (2022), for example, found that two-sided messages from experts about COVID-19 were found to be the most trustworthy. Research has shown consumers tend to find messages more trustworthy if a two-sided message is given (Hoyer and MacInnis 2004). Scholars have shown that one-sided messages tend to work well in low-risk purchasing situations, while others have shown that two sided messages have also been shown to be effective with the issue is somewhat risky (such as purchasing a high-priced product, or supporting a novice political candidate) (Etgar and Goodwin, 1982). Work in political science suggests that two-sided messages can be more effective than one-sided messages in persuading people about the negative attributes of politicians within their own party. However, one-sided messages were more effective in persuading people of the negative attributes of politicians in a different party (Kim 2020).

The literature suggests that specific strategies designed according to different consumer knowledge levels and presented by trusted sources can enhance their acceptance of foods that could be perceived as hazardous. People connect new knowledge to what they already know in order to learn; they interpret incoming information through the lens or frame of their existing beliefs and assumptions (Ambrose et al. 2010). The most effective communication programs are likely those that provide information about perceived food hazards according to consumers' levels of objective and subjective knowledge, with information that is delivered on the communication medium that each consumer trusts to find credible information. Presenting both sides of an issue may build on a consumers' existing knowledge in a way that makes them open to new information.

Research on risk perception suggests that, in addition to perceived bias, information can be processed differently according to individual level worldviews, attributes, and beliefs. For example, a survey about the safety of pesticide residue on foods and of eating GM foods found that right-leaning people perceived a lower hazard than left-leaning people (Pew Research Center, 2015). Personality traits also help explain the public's perception of hazardous foods. Some scholarship suggests that a person's cultural cognition affects how they process expert information about potentially risky issues. For example, Kahan (2019) found that individuals with a egalitarian-communitarian cultural frame tended to agree there was expert consensus on issues, such as climate change, that has associated policy prescriptions that are favorable to this cultural worldview. Those with a hierarchial-individualist frame tended to agree there is expert consensus on issues that are congruent with their policy stances (eg. concealed handgun carry leads to less crime).

There is a robust literature on messaging, both message type and the types of people that are receptive to messages. Nevertheless, there is a relatively sparse behavioral economics and food choice literature on agri-environmental issues, leaving tremendous opportunity for new work to fill in gaps around the kinds of effective messaging that might change perceptions concerning agricultural practices that are perceived as risky. Large gaps in our understanding of how particular interventions can influence people's choices require further research; there is a need to understand how and why consumer trust for various information differs. Our study will contribute valuable insights about the effective delivery of fact-based information about controversies in agri-food. We ask the question: One-sided arguments, or presenting all the information and letting the consumer decide: Which is more likely to influence consumer perception of controversial foods?

3. Objectives and hypotheses

Our first objective is to identify the individual features that correlate with the premium for antibiotic free products, i.e. the difference between the willingness to pay (WTP) for the antibiotic free product and the WTP for the product raised using antibiotics.

Our second objective is to determine how one-sided and two-sided messages affect the premium. There are two one-sided messages: a message against antibiotics use ("negative message") and a message in favor of antibiotics use ("positive message"). The two-sided message includes the positive message but also presents arguments against antibiotics ("balanced message"). Video scripts are presented in Appendix A. The hypotheses related to the one-sided messages are:

H1: The negative message increases the antibiotic free premium.

H2: The positive message reduces the antibiotic free premium.

Moderators might vary the magnitude of treatment effects. We hypothesize that the treatment effects depend on the following moderators:

H3: Pre-treatment premium. The effect of the balanced message depends on the sign of the pre-treatment premium (Crowley and Hoyer 1994). A positive pre-treatment premium indicates that participants prefer antibiotic-free food products instead of the ones raised with antibiotics; a negative pre-treatment premium indicates the opposite. If the pre-treatment premium is positive (individual values more antibiotic-free products), the effect of the balanced message is negative and the balanced message is more effective than the positive message. If the pre-treatment premium is negative, the effect of the balanced message on the antibiotic free premium is positive. Therefore, the average effect of the balanced message will depend on the composition of the sample. If the sample is mainly composed of people with a positive pre-treatment premium, the average effect of the balanced message would be negative.

H4: Subjective knowledge. We hypothesize that people that show high levels of subjective knowledge are less affected by one-sided or two-sided messages (Huffman et al. 2007). Also we hypothesize that the difference between the effect of the balanced message and the effect of the positive message is higher, the higher the level of subjective knowledge if the pre-treatment premium is positive.

H5: Cultural cognition. We hypothesize that people that are at the extreme ends of the "individualism/ communitarianism" and the "hierarchical/egalitarianism" scales are less affected by one-sided or two-sided messages. Also we hypothesize that the difference between the effect of the balanced message and the effect of the positive message is higher for people that are at the

extreme ends of the “individualism/ communitarianism” and the “hierarchical/egalitarianism” scales, if the pre-treatment premium is positive.

H6: Scientific literacy, objective knowledge and education. Previous literature suggests that two-sided messages become more effective than one-sided messages as the education of the participants increases (Hovland et al. 1949 in Xu and Petty 2021). Therefore, we hypothesize that the difference between the effect of the balanced message and the effect of the positive message is higher for people that show higher scientific literacy scores, higher objective knowledge and higher levels of education, if the pre-treatment premium is positive.

H7: Comprehension: The effect of either of the messages is higher for participants that understand the messages better.

We also analyze the effect of the treatment videos on two intermediate variables “trusting messenger” and “biased information”.

H8: We hypothesize that individuals that receive the balanced message consider the information less biased and trust the messenger more than participants that receive the one-sided messages (Crowley and Hoyer 1994). This explains why they are more willing to change their view about the products.

4. Experimental design

Our survey will be administered by *Qualtrics*, an online survey platform. The survey approximately takes 15 minutes to complete.

Sample recruitment criteria

Participants are a population-representative sample that matches the national U.S. composition in terms of the age, gender, income, race, and rural/urban distribution. They are required to be 18 years old or older and eat meat and drink milk. Participants are considered inattentive and dropped from the sample if they meet one or more of the following criteria: (i) they spent 45% of the median time or less on the survey, (ii) provided pattern-based responses in

the two matrix shaped cultural worldview questions and (iii) entered impossible height and weight values.

Sample size

We conducted a power analysis to calculate the minimum detectable effect and sample size to measure the effect of three information messages on the willingness to pay for a premium for antibiotic-free food. Because of budget constraints, we are limited to a sample size of 1,500 individuals. We calculate that with this sample size we can detect a minimal detectable effect of the balance message of 16% and of the biased messages of around 5% each with a power of 0.8. Two previous studies have estimated the effects of similar types of messages on willingness to pay (Rousu et al., 2007; Valente & Chaves, 2018).

Survey

We will pose the survey questions before and after the information treatment. Before the treatment we will ask some socio-demographic questions (age, gender, race, education and income) and a subjective knowledge question. After these questions we will ask people for their willingness to pay (WTP) for products with the antibiotic-free label and without it. The products are ground-beef and milk. The WTP questions are hypothetical and open-ended. The format of the question is "Please enter the maximum amount you would be willing to spend, in USD, for each of the following products". Following Carlsson et al. 2011 and other studies, we add "cheap talk" in the introduction to the WTP questions to reduce the hypothetical bias by describing the propensity of participants to exaggerate or understate their WTP, and request participants to state their true WTP. After the treatment we will repeat the WTP questions. In total each participant will provide eight WTP values. Additionally, we randomize the order in which the beef and milk questions appear before and after the video.

As discussed by Carlsson et al. 2011, the open-ended WTP question has important advantages. We obtain the exact WTP information and there is no anchoring effect. Moreover, we are interested in only one feature of the product, so we do not require a discrete choice format. With these questions, we can calculate the antibiotic-free premium as the difference

between the WTP for antibiotic-free product and the WTP for the product without that feature. According to Lusk & Schroeder (2004), even though WTP survey questions are known to generate a hypothetical bias, using the difference in WTP eliminates it.

After the second round of WTP questions we ask additional questions that we believe correlate with the premium or could moderate the treatment effect. We ask these questions at the end to avoid priming participants (Folk and Zimmerman, 2013; Grewenig et al. 2020).

Information treatment

We randomly assign participants to one of the three videos about the use and effects of antibiotics (the positive message, the negative message or the balanced message) or to a control video (see Appendix). The "control video" is about a different topic entirely.

At the beginning of each video we added the same opening chyron that introduced the speaker as a professor of a renowned university (see Appendix). No other reference to sources is mentioned in the videos. By harmonizing the source of the information, we expect that the effect of the message will depend only on its content and not on people's perception about the quality of the information.

5. Statistical Procedures

We will apply ordinary least squares (OLS) regression to analyze the correlation between the individual characteristics and the antibiotic free premium, i.e. the difference in WTP for an antibiotic free product and a product raised using antibiotics. We will do the analysis for each product.

$$P_{1i} = \beta_0 + \beta_1 * X_i + \beta_2 * Z_i + \epsilon_i \quad (1)$$

where P_{1i} is the antibiotic free premium for individual i before the treatment, X_i are sociodemographic variables and Z_i are a set of individual features that we believe are associated with the premium. The set of variables X_i are:

1. age

2. gender
3. race
4. Income

The set of variables Z_i are:

1. lived/worked in a farm
2. purchase frequency
3. primary shopper
4. eat healthy food
5. beef from farmer's market or local butcher
6. organic food
7. times that visited health professional
8. exercise
9. BMI
10. subjective knowledge
11. objective knowledge
12. scientific literacy
13. individualism/ communitarianism/ neither
14. hierarchical/ egalitarianism/ neither
15. individualism X hierarchical (interaction variable, 13 X 14)

Since we will conduct multiple statistical tests on the same data, we will adjust the significance level of the statistical tests based on the number of tests.

The next part of the analysis focuses on the information treatment. Using variables X_i and Z_i, we analyze the covariate balance by treatment arm. We will apply OLS regression to study the effect of the information treatment on the change in the antibiotic free premium for each product.

$$P_{2i} - P_{1i} = \alpha_0 + \alpha_1 * V_{Pi} + \alpha_2 * V_{Ni} + \alpha_3 * V_{Bi} + \varepsilon_i \qquad (2)$$

where P_{2i} is the antibiotic free premium after the information is provided, and V_{Pi}, V_{Ni} and V_{Bi} are dummy variables that indicate the type of video that the individual watches. We will conduct a covariate adjusted specification including variables that were imbalanced among treatment arms if needed.

We analyze the moderators' effects using equation (3) where M stands for either of the moderators.

$$P_{2i} - P_{1i} = \delta_0 + \delta_1 * V_{Pi} + \delta_2 * V_{Pi} * M_i + \delta_3 * V_{Ni} + \delta_4 * V_{Ni} * M_i + \delta_5 * V_{Bi} + \delta_6 * V_{Bi} * M_i + \xi_i \quad (3)$$

Finally, we apply ordered probit estimation to test the effect of the treatment on the ordinal intermediate variables where I_i is the intermediate variable, I_i^* is a latent variable which is unobservable and η_j represent the latent variable's thresholds.

$$I_i^* = \rho_0 + \rho_1 * V_{Pi} + \rho_2 * V_{Ni} + \rho_3 * V_{Bi} + \rho_4 * X_i + \rho_5 * Z_i + \varepsilon_i \quad (4)$$

$$I_i = j \text{ if } \eta_{j-1} < I_i^* \leq \eta_j$$

6. Measurement

We follow Kahan et al. 2009 to create the cultural worldview questions. To determine whether an individual is individualistic, communitarian or neither, we will calculate each participant's score in these questions, the mean score, and the standard deviation. Individualistic and communitarian participants have scores one standard deviation from the mean in each direction. We follow the same procedure for the "hierarchical/ egalitarianism/ neither" variables.

We ask fourteen questions to test participants' knowledge on the effects and regulation of antibiotics. We use ten of these questions to test participants' comprehension of the positive message (5 questions), negative message (5 questions) and the balanced message (10 questions) (variable "message comprehension"). The remaining four questions are designed to measure participants' pre-treatment knowledge about antibiotics (variable "objective knowledge").We ask all the questions after the treatment but we make sure the content of the four questions to test participants' knowledge before treatment was not part of the video messages. To create the

variables “message comprehension” and “objective knowledge”, we add up the correct answers and divide the participant’s score by the total number of questions. To test whether the videos affect participants’ score of the objective knowledge variable we compare the score means in each of the three treatment groups and the control group.

For the “scientific literacy” variable, we use eight scientific literacy questions taken from Kahan et al. 2017. We add up the correct answers and divide the participant’s score by the total number of questions.

All the variables used as moderators are coded as dummy variables (above/below median score).

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Appendix A: Video messages

The beginning of each message that had an opening Chyron that said: "Dr. Larry Jennings, School of Public Health, Cornell University"

Highlighted text are when on screen text appears in the video, either the highlighted text itself or a paraphrased version of the highlighted text (indicated in brackets).

Script #1: Positive Message

Antibiotics are needed to treat a wide range of bacterial infections in cows, just like in people. When dairy cows get painful udder infections called mastitis, or when beef cows get respiratory infections, antibiotics are needed to treat these animals to prevent further suffering, and to keep the farm productive. There are also a number of regulatory safeguards to prevent antibiotic overuse and to keep antibiotic residues out of our food. Farmers cannot use antibiotics unless they have a prescription from a veterinarian [On Screen Text: "Farmers must have a prescription to use antibiotics"]. It is also illegal to sell food with antibiotic residue [On Screen Text: same as highlighted), and meat and dairy products are regularly tested [On Screen Text: same as highlighted). When animals are treated with antibiotics, farmers are required to wait before they are put back in production. This is to ensure there are no antibiotic residues in the final food product. In a typical year, less than one half of one percent of tested meat products contain antibiotic residue and only 2 in every 10,000 milk tankers contain antibiotic residue. Products that do test positive are immediately discarded. No farmer wants to sell products with antibiotic residue.

Script #2: Negative Message

Whenever antibiotics are used, bacteria can evolve to resist their effects. The overuse of antibiotics can lead to drug resistant bacteria, and this poses a major health risk to humans and animals. It makes infections harder - and sometimes impossible - to treat. This has become a significant public health problem. Each year antibiotic resistant bacteria account for roughly 700,000 deaths worldwide [On Screen Text: "Antibiotic resistance causes 700,000 deaths worldwide]. Many public health experts are concerned that using antibiotics in animals may raise the risk of transmitting drug-resistant bacteria to humans. This is because animal agriculture uses almost 70% of all antibiotics [On Screen Text: "Agriculture uses 70% of all antibiotics"] sold in the United States. Antibiotic use in the beef and dairy industry is widespread and routine. For example, concentrated animal operations, such as beef feedlots, are ideal breeding grounds for respiratory diseases in cows. Over 87% of all feedlots routinely use antibiotics [On Screen Text: "Most feedlots routinely use antibiotics"]. Currently, only two states have passed laws restricting antibiotic use by farmers.

Script #3: Balanced Message

Any time antibiotics are used, bacteria can evolve to resist their effects. The overuse of antibiotics can lead to drug resistant bacteria, and this poses a major health risk to humans and animals. Each year antibiotic resistant bacteria account for roughly 700,000 deaths worldwide [On Screen Text: "Antibiotic resistance causes 700,000 deaths worldwide"]. Animal agriculture uses 70% of all antibiotics [On Screen Text: same as highlighted] and many public health experts are concerned that agriculture is contributing to this problem. Beef and dairy cows can get udder, respiratory, hoof, and eye infections for which antibiotics are required. Timely treatment of these conditions with antibiotics is needed to prevent animal suffering, and to keep farms productive. Good antibiotic stewardship is possible in agriculture, and there are a number of regulatory safeguards in place to prevent antibiotic overuse, and to eliminate antibiotic residues in our food. Farmers cannot use antibiotics unless they have a prescription from a veterinarian [On Screen Text: "Farmers must have a prescription to use antibiotics"], and it is illegal to sell food with antibiotic residue [On Screen Text: same as highlited]. Meat and dairy products are regularly tested [On Screen Text: same as highlighted]. In a typical year, less than one half of one percent of tested meat products contain antibiotic residue and only 2 in every 10,000 milk tankers contain antibiotic residue. Products that do test positive are immediately discarded. No farmer wants to sell products with antibiotic residue.

Script #4: Control message: Not about antibiotics at all

(Text taken from the Fallingwater Wikipedia page: https://en.wikipedia.org/wiki/Fallingwater)

Fallingwater is a house designed by the architect Frank Lloyd Wright in 1935 in the Laurel Highlands of southwest Pennsylvania, about 70 miles southeast of Pittsburgh. It is built partly over an active waterfall [On screen text: built over a waterfall] that runs beneath the house. The house was designed to serve as a weekend retreat for Liliane and Edgar J. Kaufmann, the owner of Pittsburgh's Kaufmann's Department Store. After its completion, Time Magazine called Fallingwater Wright's "most beautiful job" and it is listed among Smithsonian's "Life List of 28 Places to See Before You Die". Fallingwater stands as one of Wright's greatest masterpieces both for its dynamism and for its integration with its striking natural surroundings. Wright's passion for Japanese architecture was strongly reflected in the design [On screen text: Inspired by Japanese architecture] of Fallingwater, particularly in the importance of interpenetrating exterior and interior spaces and the strong emphasis placed on harmony between man and nature.