TRADEOFF BETWEEN ANIMAL WELFARE AND ENVIRONMENTAL IMPACTS OF BEEF PRODUCTION: AN ANALYSIS OF PRESENTATION EFFECTS ON CONSUMER CHOICE

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ABSTRACT

Schmiess, Jacob M.Sc., Purdue University, August 2020. Tradeoff Between Animal Welfare and Environmental Impacts of Beef Production: An Analysis of Presentation Effects on Consumer Choice. Major Professor: Jayson Lusk.

This study uses a choice experiment to investigate consumer preference for beef when faced with a tradeoff between increased animal welfare and lower levels of environmental impact. Results were obtained via an online survey consisting of 1,559 participants from the U.S. in Summer 2019. Participants were shown one of three presentation designs, as well as one of three information treatments (control, pro-environment, and pro-animal welfare). Consumers were shown to have significantly higher WTP for animal welfare attributes than environmentally friendly characteristics.

Participants which were shown the purely informational design regarded only price and whether the beef was grassfed and free of added growth hormones when choosing. The second presentation used sizing and coloring to convey environmental impact, producing higher WTP for environmental attributes and slightly lower WTP for animal welfare qualities. Participants in the third design were shown packages of ground beef with labels in place of the attribute levels. These participants had the least variance between attribute WTP and had 1.5-2 times greater WTP for a meat option than the other presentation treatments.

Pro-animal welfare information had the highest effect within the informational design, which had the highest overall WTP for animal welfare attributes. The visual presentation was influenced most heavily by the pro-environment information. Information treatments had no effect on the labels presentation.

While improvements in farm animal welfare might coincide with environmental improvements, the two issues can often come into conflict, particularly when it comes to greater intensification of production systems. This study aims to determine consumer preferences for ground beef when faced with a tradeoff between increased animal welfare and lower levels of environmental impact. A discrete choice experiment was conducted with over 1,500 U.S. consumers in mid-2019. Because of the high degree of consumer unfamiliarity likely associated with animal welfare and environmental impacts of beef production, we sought to determine the sensitivity of results by systematically varying how attributes were presented (textually, visually, or via labels) and what information was available to respondents (control, pro-environment, or pro-animal welfare). If shown only textual attribute information, consumers were unresponsive to environmental impacts such as land use, water use, and greenhouse gas emissions; these issues were more impactful when communicated visually or via labels. Using pictures of ground beef with labels significantly increased the odds one of the meat options was chosen relative to treatments that presented choices in tabular form. Avoidance of the use of added growth hormones was one of the preferable seven attributes studied. Providing pro-environment or pro-animal welfare information had small, but statistically significant impacts on consumer choice. Overall, results suggest consumers are willing to trade environment for animal welfare, but the extent of this tradeoff strongly depends on how the attributes are presented.

CHAPTER 1. INTRODUCTION

The US Census Bureau predicts global population will reach 9 billion by the year 2048 (US Census Bureau, 2004). Increased global affluence will result in an increase in global protein requirements per capita (Keyzer et al., 2005). The Food and Agriculture Organization of the United Nations argues protein from animals will need to increase by 70% from 2005 to 2050 to match the rise in population (FAO, 2009). However, animal agriculture contributes to many environmental issues including climate change, reactive nitrogen emissions, and biodiversity loss (Gerber et al., 2013). Meat-based diets have been shown to require six times more land than wheat-based (Gerbens-Leenes & Nonhebel, 2002), calling into question the efficiency of animal agriculture. One potential way to meet protein demand while mitigating environmental damages is intensification of animal agriculture, reducing environmental impact per unit of food produced (Fiala, 2008). However, intensification practices such as battery cages, gestation crates, and feedlots are argued to decrease farm animal well-being (Knowles et al., 2008; Gonyou, 2005; Loneragan et al., 2001).

Public concern regarding the effects of meat production on both animal welfare and environmental quality continues to rise (Verbeke & Viaene, 2000), prompting policy changes and industry shifts. Recent examples include Proposition 12 in California and the emergence of plant-based and lab-grown meat substitutes. Commonly, animal welfare and environmental stewardship regarding meat production are considered separately or are believed (incorrectly) to be congruent. Recent studies, however, have demonstrated a nexus between these two issues, illustrating a tradeoff in which improvements for animal welfare often result in greater environmental impact from meat production and vice versa (Place & Mitloehner, 2014; Shields & Orme-Evans, 2015; Place, 2018). Understanding consumer knowledge and attitude towards this tradeoff could be useful to policy makers and industry leaders alike. For instance, the recent pledges by major U.S. food providers Walmart, McDonalds and Kroger to move towards cage-free eggs could have major implications for the egg-producing industry (J. Lusk, 2018).

The primary objective of this study is to determine consumer preference for attributes of beef products, specifically when presented a tradeoff between reductions in environmental impact and improvements in animal welfare. Because consumers are largely unknowledgeable of meat production practices (Verbeke & Viaene, 2000; J. L. Lusk, 2018), it might be expected that consumer choice will be significantly influenced by the way information and choices are presented to them. As a result this study also incorporates multiple survey designs and information treatments to determine the effect of presentation on consumer choice. We also address consumer knowledge and beliefs about beef production as it relates to these two issues.

CHAPTER 2. LITERATURE REVIEW

2.1 Environmental Inputs in Animal Agriculture

Clapper Clapper2011 compared environmental inputs for beef production systems in the US in 1977 and in 2007. They found that the increases in efficiency in modern beef production systems resulted in considerably fewer resources than a similar system in 1977. Production of an equivalent amount of beef in 2007 required 69.9% of animals, 81.4% of feedstuffs, 87.9% of water and 67.0% of land than that of a comparable system in 1977. She also showed that greater efficiency resulted in reduced carbon emissions of 16.3%, demonstrating a positive relationship between agricultural intensification and reduced environmental impact. Capper et al. (2009) demonstrated the same effect on reduced environmental impact in dairy production from 1944 to 2007.

The relationship between agricultural production and intensification has been studied across other animal production systems as well. Havenstien et al. (2003) compared broiler chicken production systems from 1957 and 2001 and showed similar increases of efficiency. The study showed that the 1957 broilers required 101 days and an average of 8022g of feed to reach a body weight of 1815g. Broilers in 2001 reached the same body weight after just 32 days and 2668g of feed. These findings were corroborated in a study of the Canadian poultry industry by Verge et al. (2009) who found that greenhouse gas emissions per kilogram of live weight for broiler chickens had decreased by 19% from 1981 to 2006.

In the swine industry, large indoor confinement systems have been shown to result in decreased nutrient leaching, soil compaction and nutrient loading in soils compared to outdoor housing systems (Quintern & Sundrum, 2006). These findings suggest that a potential solution to meet the growing global demand for food protein while reducing environmental harm could be further intensification of animal agriculture. However, the benefits derived by animal agriculture intensification could have adverse effects on the animals themselves.

2.2 Farm Animal Welfare Overview

A main driver of increased production efficiency is genetic selection of animals that demonstrate higher growth rates, milk production and feed efficiency (Place, 2018). However, these genetic "improvements" potentially have a negative impact on the overall well-being of the animals. Efficiency increases in broiler chicken production from genetic selection have been linked to lameness and difficulty walking (Knowles et al., 2008) and higher tendency toward cardiovascular problems (Julian, 1999). The concern for animal welfare extends to the breeder birds as well, with studies showing higher male aggression levels toward females (Millman et al., 2000), decreased fertility (McGary et al., 2002) and other reproductive issues (Robinson et al., 1991; Bilcik & Estevez, 2005) resulting from genetic selection.

The use of gestation crates and group stalls in swine production generate welfare concerns including decreased mobility, confinement injuries and denial of benefits arising from exercise (Gonyou, 2005). It should be noted that the benefits to welfare of these practices, such as regulated individual feeding and protection from aggression, can potentially mitigate the negative concerns (Croney & Millman, 2007), although the evidence is inconclusive.

In the cattle industry, the use of feedlots to quickly add weight to an animal before slaughter has potential negative animal welfare implications. Loerch and Fluharty (1999) showed that during transportation from farm to feedlot, some beef cattle experience feed and water deprivation, overcrowding and low quality sanitation. Once put in the feedlot, animals may be subjected to new pathogens and low air quality, which can cause bovine respiratory disease (BRD) and increased mortality rates (Loneragan et al., 2001). BRD has been reported to affect 14.4% of cattle in feedlots (Edwards, 2010). Death loss from BRD also increased from 10.3 per thousand in 1994 to 14.2 deaths per thousand in 1999 (Loneragan et al., 2001).

2.3 Consumer Willingness to Pay Research for Sustainability and Animal Welfare Attributes in Meat

A number of studies have been conducted on willingness to pay (WTP) for attributes of meat products related to farm animal welfare and sustainability (Loureiro & Umberger, 2004; McCluskey & Loureiro, 2003; J. L. Lusk et al., 2012; Li et al., 2015) and the ability of information to cause a change in WTP (Loureiro & Lotade, 2005; Steg & Vlek, 2009; Campbell-Arvai et al., 2014).

Lusk et al. (2003) used a choice experiment (CE) to uncover consumer WTP for rib-eye steaks with varying levels of marbling, tenderness, price and use/non-use of growth hormones and genetically modified corn. They found U.S. consumers' mean WTP was $8.12/lb for beef from cattle with no added growth hormones and $3.31/lb for beef not fed genetically modified corn. Another choice-based conjoint experiment by Abidoye et al. (2011) found consumers were willing to pay an additional $0.76/lb (1% of premium) for beef production using no growth promotants and $3.44/lb (34% of premium) for grass-fed systems.

Two non-hypothetical, in-store sensory CE studies by Xue et al. (2010) and Evans et al. (2011) found conflicting results about consumer taste preference between conventional and grass-fed beef. However, both generated similar WTP premiums for grass-fed over conventional beef at roughly $2/lb on average. Umberger et al. (2002) found 62% of consumers in a U.S. study were willing to pay, on average, an additional $1.61/lb for domestic, corn-fed beef. Twenty-three percent had a WTP of $1.36/lb for foreign, grass-fed beef, and 15% of participants were indifferent. A laboratory market approach by Dickinson and Bailey (2002) consisted of participants being given a free meat sandwich and asked if they would be willing to upgrade some of the sandwich's characteristics. Participants were willing to pay an average premium of $0.50 to add assurances of animal welfare, defined in the experiment as ”humane treatment procedures and no added growth hormones used in production of the meat” (Dickinson & Bailey, 2002). In a study using both hypothetical and non-hypothetical conjoint experiments, mean WTP for beef products which were forage-fed ranged from $1.17 to $2.56/lb, while beef with no added hormones had mean WTP between $1.42 and $4.08/lb (Fields et al., 2006).

There has also been a large amount of research done recently on WTP for ”environmentally friendly” and ”sustainably produced” beef (Tonsor & Shupp, 2009; Li et al., 2016; Belcher et al., 2007). White and Brady (2014) found that consumers were willing to pay a 10% premium to reduce water use in beef production. A conjoint analysis of a nationwide sample of the U.S. showed consumers had a mean WTP of $0.55/lb of beef for a label which read ”raised carbon friendly” (Li et al., 2015). Other studies show positive WTP amounts for environmental reductions in the pork industry as well (J. L. Lusk et al., 2007; Hurley et al., 2006).

2.4 Overview of Discrete Choice Models

An important distinction is whether a CE is revealed or stated preference. Revealed preference studies observe actual purchasing decisions of agents and use these decisions to determine consumer value for the purchased item’s attributes. Stated preference experiments are hypothetical in nature and no transaction occurs beyond compensation for participation in the study. Stated preference studies typically utilize online or mail surveys, however some are conducted face-to-face. Because the decisions made during stated preference experiments have no consequences on the participant, there is the possibility for hypothetical bias (Campbell-Arvai et al., 2014).

A common way economists attempt to mitigate such bias is the use of cheap talk scripts (J. L. Lusk, 2018; Van Loo et al., 2014). These ask participants to treat the experiment as non-hypothetical, as though the options they select are actual transactions occurring in a store setting. While revealed preference experiments are preferred over stated preference, they are not always practical. Fortunately, numerous studies (J. Lusk & Schroeder, 2004; Adamowicz et al., 1994; Mark & Swait, 2004) have demonstrated that marginal WTP amounts for various attributes are similar for both CE types.

2.5 Presentation Effect on WTP

Stated preference experiments can be complex and bring an element of cognitive difficulty to participants. This complexity arises as the result of the design dimensions, including the number of choice options per question, the number of attributes which define each alternative, the amount of levels possible for each attribute, the range between each attribute level and the number of choice option questions each participant must answer (Caussade et al., 2005). Henshner et al. (2005) found that the elimination of available attributes to respondents can produce significantly different WTP amounts from a base design with all available attributes.

Another crucial aspect of CE design is the way in which each of the tradeoffs are presented to the respondent. Jansen et al. (2009) found significant differences in respondent preferences for attributes of housing structures when presented as: text only, text and color photo, and text and black-and-white impression. They suggest respondents are more likely to develop their preference from images than text. Orzechowski (2005) compared the use of verbal descriptions and multimedia (virtual reality) presentations on housing preferences. The verbal- description-only presentation style produced better face validity of the price attribute, where the estimated models were more successful at predicting participants' holdout choices made prior to the CE. However, the multimedia approach implied fewer random and inconsistent responses. Bateman et al. (2009) suggest improvement of the ease of evaluation of CE information can affect preferences in land use studies. Comparing numeric, numeric + virtual reality (VR), and VR only presentation styles, VR produced the lowest level of response variability and a significant reduction in the asymmetry between willingness-to-pay and willingness-to-accept (Bateman et al., 2009).

Another consideration when constructing attribute levels is the range of values (for numeric attributes) and the size of graphics (for visual attributes). Chandon and Wansink (2007) use a "psychophysical" model to observe how subjects' ability to accurately assess increases in meal size and calorie count diminishes as variables and image representations grow larger. This effect is important to note when surveys use large numeric values and visual representations of attributes.

CHAPTER 3. DATA AND METHODS

3.1 Choice Experiment and Survey Design

This study uses a choice CE to determine consumer preference as is common practice in meat demand analysis (J. Lusk et al., 2003; Mennecke et al., 2007; J. L. Lusk, 2018). These studies use similar CE methods and, under certain conditions, have been shown to create WTP estimates which are not statistically different from real purchases (J. Lusk & Schroeder, 2004; Chang et al., 2009). Refer to Louviere et al. (2000) for a thorough overview of CE methods.

We developed three CE surveys to analyze consumer preference for meat when a tradeoff between improvements in farm animal welfare and reductions in environmental cost is presented. Respondents made repeated choices between options for a pound of ground beef with varying levels of attributes, including price. To present the intended tradeoff, a list of seven attributes was created, including three regarding animal welfare, three representing environmental costs, and price. Levels for price ranged from \$1.99 to \$5.99 in \$0.50 increments, while the remaining six attributes had only a high and low level (or presence/absence of a label) as shown in Table 3.1.

We used a number of peer-reviewed sources to generate realistic levels for environmental costs of beef production (Beckett & Oltjen, 1993; de Vries & de Boer, 2010; Capper, 2010; Clapper, 2011; Herrero et al., 2013). The amounts were adjusted slightly to ensure that the use of color and sizing to convey these costs were not out of proportion. For example, Capper (2010) finds that grassfed systems use roughly four times more water than conventional beef but only 1.4 times as many fossil fuels. To compensate for this disparity, each of the high levels of environmental input were approximately 1.5 times as much as the low level. Each question presented two

Table 3.1.
Attribute Representations and Levels in Three Presentation Designs

Attribute	**Text**	**Visual**	**Label**
Land Use	320 sq ft, 220 sq ft	320 sq ft 220 sq ft	Land Protection Certified
CO2 Emissions	18 lbs, 12 lbs	18 lbs 12 lbs	CERTIFIED CARBON NEUTRAL
Water Use	500 gal, 380 gal	500 gal 380 gal	WaterSense Meets EPA Criteria
Feedlot Use/Grassfed Label	Feedlot, Grassfed	None, American Grassfed®	American Grassfed®
Mortality Rate/Animal Welfare Label	5%, 2%	5% 2%	Animal Welfare APPROVED
Added Hormone Use	Yes, No	None, NO ADDED HORMONES	NO ADDED HORMONES

options for a pound of ground beef with varying attribute levels, as well as a third option to purchase neither.

With 6 attributes varying at two levels and price varying over nine, there are $2^6 \times 9 = 576$ different ground beef options which could be presented. To reduce this number of possibilities to a more reasonable amount while still extracting as much consumer preference as possible, we selected 12 options using D-efficiency criteria in software Ngene. This was done to minimize the standard errors of a multinomial logit model, which reduces attribute collinearity. Each survey design used the same experimental design, such that each choice option conveyed the same magnitude of environmental and welfare tradeoff across surveys. For example, Figures 3.1, 3.2, and 3.3 show the same choice option presented uniquely by each design.

	Option 1	Option 2	Option 3
Land Use:	320 sq ft	320 sq ft	
CO2 Emissions:	18 lbs	12 lbs	
Water Use:	500 gal	380 gal	
Finishing System:	Grass Fed	Feedlot	Would not purchase either
Mortality Rate:	5%	2%	
Added Hormone Use:	No	Yes	
Price:	$2.49/lb	$3.99/lb	

Figure 3.1. Text Design Example

	Option 1	Option 2	Option 3
Land Use:	320 sq ft	320 sq ft	Would not purchase either
CO2 Emissions:	18 lbs	12 lbs	
Water Use:	500 gal	380 gal	
Grassfed Label:	American Grassfed	None	
Mortality Rate:	5%	2%	
Added Hormone Use Label:	NO ADDED HORMONES	None	
Price:	$2.49/lb	$3.99/lb	

Figure 3.2. Visual Design Example

Figure 3.3. Labels Design Example

3.2 Presentation Treatments

Respondents were randomly assigned to one of three presentation designs; text, visual, or labels. The text design was designed to be purely informational, requiring the participant to analyze each option closely to understand the tradeoff being presented. The visual design used color, sizing and the presence/absence of two labels to convey the attribute levels more intuitively and quickly than the text design. To illustrate the intended tradeoff in a way which more closely resembles a grocery store setting, the labels design displayed options as packaged ground beef with various labels representing the attributes displayed in the other designs. Since no suitable label representation for mortality rate exists, it was replaced by an "Animal Welfare Approved" label. An important distinction between the use of labels in the visual and labels designs is that the visual design specifies both presence and absence of the given label, where the labels design doesn't indicate which labels are absent. So the more desirable attribute level in the labels design (presence of a given label) could be seen more as a "bonus" than the opposite of an undesirable attribute level. This is shown to have a significant effect on WTP estimates later.

3.3 Information Treatments

In addition to presentation treatments, participants were randomly placed in one of three information treatments to observe whether the presentation of additional information prior to the CE could affect consumer preference. The first treatment is the control where no information was given prior to the choice option section of the survey. The respondents in the second information treatment were shown a summary of findings by Capper (2010) which demonstrated the environmental inefficiencies of grassfed systems compared to conventional beef production, including the use of feedlots and added growth hormones. This is referred to as the "pro-environment" treatment. Members of the third information treatment were asked to read a brief overview of a study by Loerch and Fluharty (1999) which outlined the negative welfare effects that stressors from feedlots can produce on beef cattle. This is the ”pro-animal welfare” treatment. For a breakdown of total observations by design and information treatment, refer to table 3.2.

Table 3.2.
Observations by Design and Information Treatment

		Information Treatment			
		Control	Pro-Environment	Pro-Animal Welfare	Total
	Text	192	181	186	559
Survey Design	Visual	166	166	168	500
	Labels	166	166	168	500
	Total	524	513	522	1559

3.4 Sample

We designed the surveys using Dynata software and administered them online to a nationally representative sample of U.S. consumers during June and July of 2019. Table 3.3 shows the demographics of the collected sample are slightly older and more well-educated than a nationally representative sample (Bureau, 2017). The collected sample also has a higher proportion of female respondents (64%) than the national sample (51%). Because of our focus on grocery shoppers, the survey immediately ended for anyone who indicated they do 0% of the grocery shopping for their household (4.8% or total participants). While social norms are changing in the U.S., a recent study sponsored by the Bureau of Labor Statistics suggest that of families with children, 71% have the shopping primarily done by the mother (Schaeffer, 2019). We also observed the demographics for each of the nine design/treatment groups to ensure no treatment varied wildly from the collective sample. These results can be found in the appendix.

Table 3.3.
Demographics of sample compared to U.S. population

Demographic Characteristic	Description	% U.S. Population	% Sample
Gender	Male	49.2%	36.4%
	Female	50.8%	63.6%
Age	18-34	29.5%	28.4%
	34-54	32.8%	24.4%
	Over 54	37.7%	47.2%
Income	Low Income=<$40,000	33.4%	32.6%
	Middle Income=$40,000-$140,000	52.8%	54.7%
	High Income=>$140,000	13.8%	12.7%
Education	Less than a Bachelor's Degree	71.6%	53.5%
	Bachelor's Degree or Higher	28.4%	46.5%

3.5 Choice Model

CE data were analyzed using a random utility model (McFadden, 1974), where the utility each individual i receives from selecting choice option j in treatment t is:

$$U_{itj} = V_{tj} + \epsilon_{itj} \tag{3.1}$$

Individual i will select choice option j over k if $U_{itj} > U_{itk}$. More generally, they will choose option j out of a set of J options if $U_{itj} > U_{itk}$ $\forall k$ in J. Since utility is stochastic in nature, it can only be estimated that $Prob(U_{itj} > U_{itk})$. If the error term has a Type 1 extreme value distribution with scale parameter equal to 1, then $Prob(U_{itj} > U_{itk})$ equals:

$$s_{tj} = \frac{exp(V_{tj})}{\sum_{k=1}^{J} exp(V_{tk})} \tag{3.2}$$

where s_{tj} is the probability of selecting choice option j in treatment t. This is the multinomial logit (MNL) or conditional logit method. The term V_{tj} from equation 3.1 can be expanded to:

$$V_{tj} = \beta_{tj} + \alpha p_j + \sum_{k=1}^{J} \theta_t^k d_j^k \tag{3.3}$$

where β_{tj} is the utility of option j in treatment t relative to the "purchase neither" option, α is the marginal utility of change in price, p_j is the price of option j, d_j^k represent dummy variables indicating whether option j has the hypothesized more favorable attribute level (i.e., grassfed, no added hormones, lower environmental inputs and mortality rate) or the presence/absence of attribute label representations, and θ_t^k show consumer preference for each kth attribute in treatment t. Consider two options for a pound of ground beef that are identical in every way including price, except one has a more favorable level of a given attribute ($d_{j=1}^k = 1$) while the other option does not ($d_{j=1}^k = 0$). WTP for this given attribute can be calculated $\frac{-\theta_t^k}{\alpha}$.

The MNL method assumes that all individuals have the same preferences over observed attributes. A useful tool to navigate around this downside is the latent class model (LCM). The LCM categorizes respondents into distinct groups or classes, each one having distinct preferences. The unconditional choice probability for the LCM is defined as:

$$\text{Prob}(i \text{ chooses } j \text{ in treatment } t) = \sum_{c=1}^{C} P_{itc} \frac{exp(V_{tjc})}{\sum_{k=1}^{K} exp(V_{tkc})} \tag{3.4}$$

where P_{itc} is the probability that individual i is in treatment t and class c, and V_{tjc} is defined as in equation 3.3 except parameters are now specific to a given class c. The LCM can help relieve the assumption of preference heterogeneity across respondents. The LCM can also identify people who do not consume or use the product in the survey (non-meat eaters in this case) and select the "purchase neither" option for each question (Burton & Rigby, 2009). WTP for each class can be calculated as $\frac{-\theta_{tc}^k}{\alpha_c}$. Using the Krinsky-Robb bootstrap method, we establish confidence intervals for the LCM.

CHAPTER 4. RESULTS

4.1 Likelihood Ratio Test Results

To test the goodness of fit for each of the three information treatments and three survey designs, we utilized the likelihood-ratio test (LRT). We first separated the data by survey design and ran the MNL for each. Within each design, we separated the data further into each of the three information treatments for an additional nine models. The log likelihood values for each of these models were used to generate chi squared statistics, which were then compared to critical values for $2x9 = 18$ degrees of freedom. The resulting p-values are given in LRTs 1, 2, and 3 in table 4.1. The same procedure was repeated by separating the data by information treatment first, then by survey design. These are shown in LRTs 4, 5, and 6 in table 4.1. The null hypothesis is only rejected when comparing information treatments across the labels design, implying the presentation of information to participants had no effect on the resulting data. The remaining five LRTs have sufficiently low p-values to indicate a statistically significant difference between model parameters.

4.2 Choice Experiment Results

Table 4.2 shows the coefficient estimate results for the MNL model by survey design (but pooled across information treatment). Dummy variables are used for the selection of each meat option to compare consumer preference for a meat option compared to the "purchase neither" option. These are referred to as alternative specific constants (ASCs). Beginning with the text design, all three environmental attributes have small and insignificant estimates, implying little consumer concern

Table 4.1.
Likelihood Ratio Test Results

LRT 1. Text Design*

	Control	Pro-Environment	Pro-Animal Welfare	Pooled		Likelihood Ratio Test
Number of participants	192	181	186	559	Chi-sq. stat	78.06
Number of observations	6912	6516	6696	20124	Critical value	28.87
Log likelihood value	-2177.26	-2074.35	-2251.23	-6541.88	P-value	0.00

*Null hypothesis: parameters for the text design are the same across information treatments

LRT 2. Visual Design**

	Control	Pro-Environment	Pro-Animal Welfare	Pooled		Likelihood Ratio Test
Number of participants	166	166	168	500	Chi-sq. stat	38.15
Number of observations	5976	5976	6048	18000	Critical value	28.87
Log likelihood value	-1881.88	-1858.64	-1916.93	-5676.52	P-value	0.00

**Null hypothesis: parameters for the visual design are the same across information treatments

LRT 3. Labels Design***

	Control	Pro-Environment	Pro-Animal Welfare	Pooled		Likelihood Ratio Test
Number of participants	166	166	168	500	Chi-sq. stat	23.99
Number of observations	5976	5976	6048	18000	Critical value	28.87
Log likelihood value	-1641.67	-1650.92	-1586.30	-4890.88	P-value	0.16

***Null hypothesis: parameters for the labels design are the same across information treatments

LRT 4. Control Treatment****

	Text Design	Visual Design	Labels Design	Pooled		Likelihood Ratio Test
Number of participants	192	166	166	524	Chi-sq. stat	130.50
Number of observations	6912	5976	5976	18864	Critical value	28.87
Log likelihood value	-2177.2646	-1881.8812	-1641.667	-5766.06	P-value	0.00

****Null hypothesis: parameters for the Control treatment are the same across designs

LRT 5. Pro-Environment Treatment*****

	Text Design	Visual Design	Labels Design	Pooled		Likelihood Ratio Test
Number of participants	181	166	166	513	Chi-sq. stat	176.40
Number of observations	6516	5976	5976	18468	Critical value	28.87
Log likelihood value	-2074.3542	-1858.6366	-1650.9188	-5672.11	P-value	0.00

*****Null hypothesis: parameters for the Pro-Environment treatment are the same across designs

LRT 6. Pro-Animal Welfare Treatment******

	Text Design	Visual Design	Labels Design	Pooled		Likelihood Ratio Test
Number of participants	186	168	168	522	Chi-sq. stat	298.44
Number of observations	6696	6048	6048	18792	Critical value	28.87
Log likelihood value	-2251.2283	-1916.927	-1586.298	-5903.68	P-value	0.00

******Null hypothesis: parameters for the Pro-Animal Welfare treatment are the same across designs

for those characteristics. Mortality rate was similarly insignificant, while grassfed, no added hormone use and both ASCs are significant at the 1% level and positive. This implies that the presence of these attributes increase consumer utility. For the visual design, all attribute estimates are positive and significant at the 1% level, save water use which is significant at 5%. In the labels design, utility increases with the presence of all labels other than the water use label, which is statistically insignificant. Price is negative and significant for all three designs, as expected.

Table 4.2.
Coefficient Estimates for Multinomial Logit Model by Survey Design

	Estimate (Std. Error)			
Attribute	Text Design	Visual Design	Labels Design	Pooled
Land Use	0.013	0.114***	0.254***	0.123***
	(-0.035)	(-0.036)	(-0.039)	(0.021)
CO2 Emissions	0.012	0.201***	0.129***	0.117***
	(-0.035)	(-0.035)	(-0.037)	(0.020)
Water Use	-0.021	0.086**	-0.038	0.006
	(-0.037)	(-0.038)	(-0.039)	(0.022)
Finishing System/Grassfed Label	0.475***	0.494***	0.231***	0.407***
	(-0.04)	(-0.041)	(-0.042)	(0.024)
Mortality Rate/Animal Welfare Label	0.038	0.124***	0.108***	0.092***
	(-0.037)	(-0.039)	(-0.041)	(0.022)
Added Hormone Use	0.699***	0.550***	0.605***	0.623***
	(-0.045)	(-0.047)	(-0.048)	(0.027)
Meat Option 1	0.629***	0.795***	1.982***	1.054***
	(-0.124)	(-0.135)	(-0.142)	(0.076)
Meat Option 2	0.702***	0.862***	2.057***	1.125***
	(-0.122)	(-0.134)	(-0.142)	(0.075)
Price	-0.298***	-0.290***	-0.476***	-0.345***
	(-0.018)	(-0.019)	(-0.020)	(0.011)

Superscripts ***, **, * indicate significance at 1%, 5%, 10% levels.

We used the estimates from figure 4.2 to calculate mean WTP shown in figure ??. Participants in the text design have high WTP for grassfed and no added hormone use but were not influenced by mortality rate or any environmental attribute. The visual design produce positive WTP for all six attributes, although grassfed and no added hormone use are over twice that of the remaining attributes. Recall the visual design used coloring and sizing to display levels of environmental input. So the relatively higher WTP for environmental attributes in the visual design is not surprising.

The labels design produces much less variability across attribute WTP. Interestingly, the preference for grassfed beef in the labels design is less than a third of the other survey designs. Participants actually had greater WTP, albeit slightly, for the land protection certified label than the grassfed label.

Mean WTP for both ASCs in the labels design are 1.5 times higher than the visual design and nearly 2 times higher than the text design. This suggests that consumers'

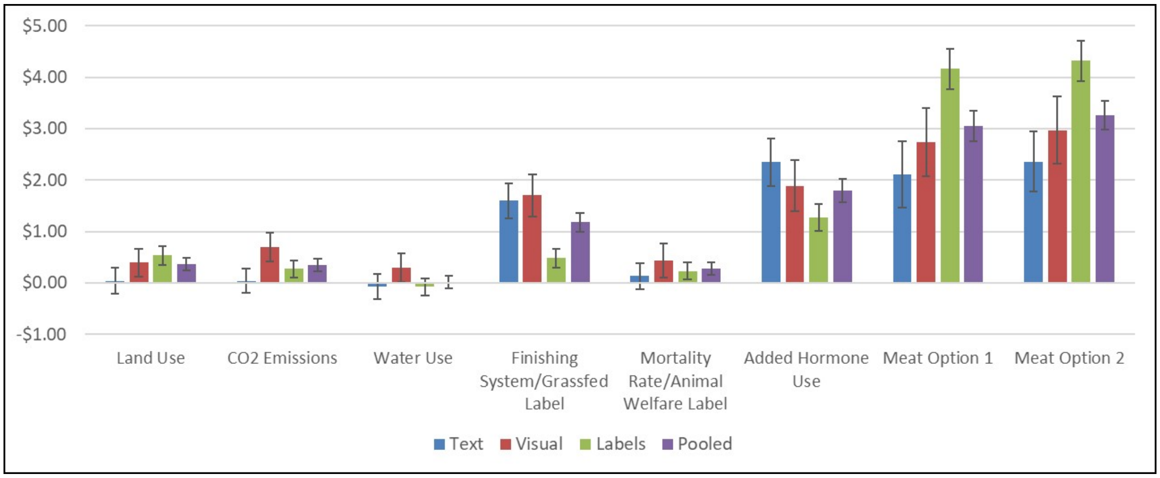

Figure 4.1. Mean Marginal WTP for Multinomial Logit by Survey Design

likelihood of selecting a meat option increases as the CE becomes more akin to a grocery store setting (i.e. use of labels and images of beef). High WTP for meat options in the labels design could also be due to the lack of stated negative effects of a selection in the labels design. The presence of a given label could be seen as a bonus to an already attractive product, rather than a mix of desirable and undesirable attribute levels. This suggests consumers in the text and visual designs might exhibit lower WTP in an actual purchasing scenario.

4.3 Information Treatment Results

Figures 4.3, 4.3, and 4.3 show WTP for each survey design broken down by information treatment. Recall from the LRT results, we expect to see variation across treatments for the text and visual designs but not for the labels design. In the text design, participants in the pro-animal welfare treatment had a mean WTP for grass-fed beef over two times greater than the control and pro-environment treatments. The pro-animal welfare information also resulted in a significantly lower WTP for the ASCs. We know that the participants in the text design only paid attention to the grassfed and AGH free attributes. So it makes sense that additional information regarding these two attributes would elicit increased WTP. Figure 4.3 shows variance across information treatments, however this does not appear to be caused by the informational content. The consistency of WTP across treatments in the labels design implies additional information had no effect on consumer choice.

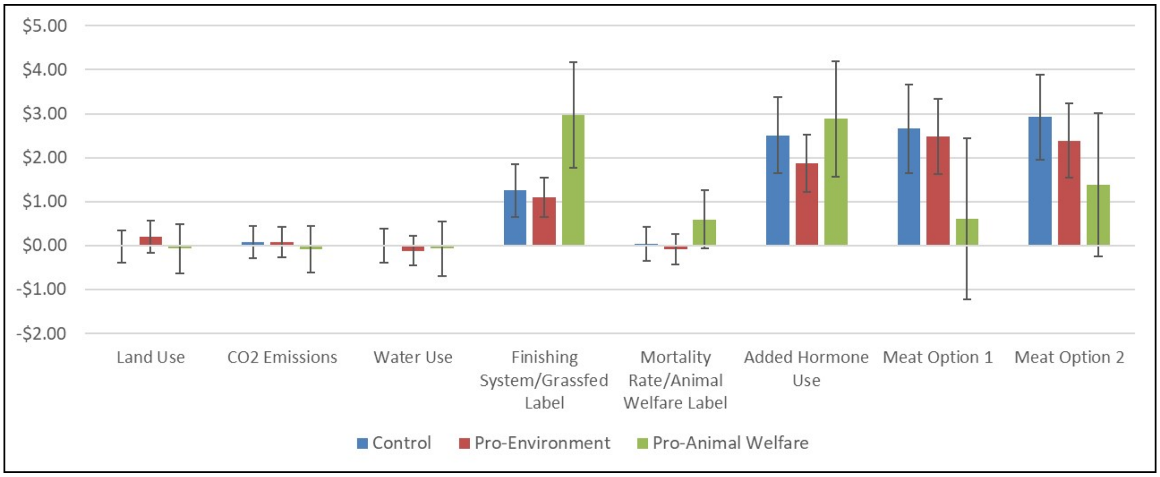

Figure 4.2. Mean Marginal WTP by Information Treatment for Text Design

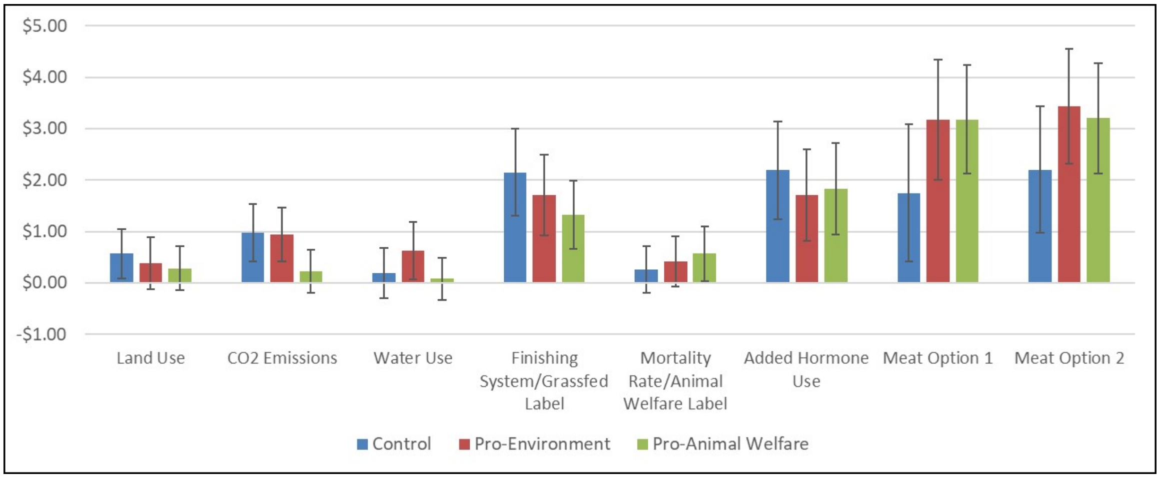

Figure 4.3. Mean Marginal WTP by Information Treatment for Visual Design

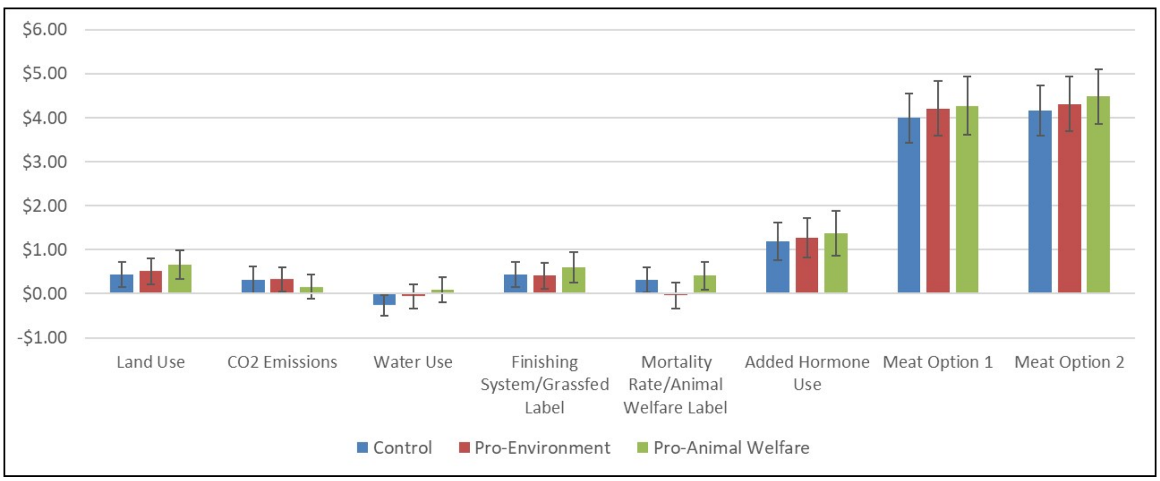

Figure 4.4. Mean Marginal WTP by Information Treatment for Labels Design

4.4 Latent Class Model Results

We used the complete data set from all three surveys to create a five class LCM with nine utility parameters (same as MNL) and 14 class membership identifiers. Class identifiers include socio-demographic characteristics as well as dummies indicating to which survey design and information treatment the respondent belonged. When comparing LCMs with an increasing number of classes, the AIC continued to decrease until the six class LCM resulted in insignificant results. Following this, the five class LCM was deemed ideal.

Looking at the class membership identifiers in table 4.3, it can be seen that classes 1, 2, and 3 are more likely to be male, which is expected given the higher utility derived by these classes from selecting a meat option. Classes 2 and 4 are most likely to be younger and least likely to have a bachelor's degree or higher. Class 1 was most likely to be shown the labels design or the text design with pro-environment information. Participants in class 2 were most likely shown the visual design, with the highest probability in the pro-environment treatment. Class 3 had the highest probability of being in the labels design, while class 4 was most likely shown the text or visual designs.

Interpreting WTP for the LCM, shown in table 4.4, is somewhat precarious given the insignificant price coefficients for classes 2 and 5. However, we can compare the relationships of the other coefficients in each class to understand more about preferences sets. The first class has the highest membership probability (42.2%) and their WTP is slightly lower than the overall results from the MNL model, except for grassfed which is significantly lower. Recall from the MNL results that WTP for AGH free beef was only 1.5 times higher than grassfed. For class 1 that multiplier is 6.25.

This disparity is explained in part by class 2. The second class (26.5% membership probability) has an insignificant price coefficient resulting in extreme confidence intervals and unreliable WTP measures. However, by looking at the amounts relative

Table 4.3.
Coefficient Estimates for Latent Class Model

		Estimate (Std. Error)				
Attribute		Class 1	Class 2	Class 3	Class 4	Class 5
Land Use		0.20**	0.14***	0.24	-0.05	0.51
		(0.09)	(0.05)	(0.41)	(0.05)	(0.34)
CO2 Emissions		-0.31***	0.14***	0.28	0.09*	0.61
		(0.11)	(0.04)	(0.35)	(0.05)	(0.42)
Water Use		0.14	0.14***	-0.16	0.18***	0.54
		(0.12)	(0.05)	(0.43)	(0.06)	(0.50)
Finishing System/Grassfed Label		0.30***	0.60***	-0.06	0.35***	1.00*
		(0.09)	(0.05)	(0.47)	(0.05)	(0.58)
Mortality Rate/Animal Welfare Label		0.09	0.17***	0.89**	0.05	0.56
		(0.09)	(0.05)	(0.35)	(0.05)	(0.38)
Added Hormone Use		1.85***	0.16***	1.23***	0.52***	1.18***
		(0.12)	(0.08)	(0.42)	(0.05)	(0.39)
Meat Option 1		4.96***	2.92***	7.40***	-0.56***	-6.69***
		(0.26)	(0.31)	(1.58)	(0.17)	(1.15)
Meat Option 2		5.51***	2.94***	7.76***	-0.37**	-6.64***
		(0.26)	(0.31)	(1.68)	(0.16)	(1.01)
Price		-1.23***	-0.05	-3.51***	-0.06**	0.08
		(0.04)	(0.04)	(0.41)	(0.02)	(0.14)
Class Probability		39.8%	26.5%	4.6%	20.1%	9.0%
Class Identifiers	Level					
Constant	NA	1.81***	0.73	-1.48	-1.10*	0
		(0.45)	(0.49)	(0.92)	(0.60)	0
Gender	1 = Male	0.40*	0.67***	0.66*	0.30	0
		(0.22)	(0.24)	(0.37)	(0.26)	0
Age	18-34	0.01	1.32***	-0.68	1.27***	0
		(0.28)	(0.28)	(0.55)	(0.29)	0
	35-54	0.18	0.84***	-0.12	0.30	0
		(0.26)	(0.27)	(0.43)	(0.29)	0
Education	1 = Bachelor's Degree or Higher	-0.29	-0.47**	-0.28	-0.42*	0
		(0.22)	(0.24)	(0.36)	(0.25)	0
Income	Low Income=<$40,000	0.20	0.18	1.00*	0.37	0
		(0.34)	(0.37)	(0.60)	(0.40)	0
	Middle Income=$40,000-$140,000	0.40	0.34	0.81	0.48	0
		(0.29)	(0.32)	(0.58)	(0.35)	0
Design - Treatment	Text - Control	-0.31	-0.28	0.77	1.97***	0
		(0.50)	(0.54)	(0.82)	(0.62)	0
	Text - Pro-Environment	-1.14***	-1.48***	-0.17	0.79	0
		(0.43)	(0.47)	(0.80)	(0.57)	0
	Text - Pro-Animal Welfare	-1.51***	-0.97**	-0.08	1.46***	0
		(0.44)	(0.47)	(0.82)	(0.56)	0
	Visual - Control	-1.00**	-0.37	-0.44	1.10*	0
		(0.45)	(0.47)	(0.87)	(0.58)	0
	Visual - Pro-Environment	-0.39	0.16	-0.06	1.81***	0
		(0.49)	(0.52)	(0.95)	(0.62)	0
	Visual - Pro-Animal Welfare	-0.74	-0.44	0.04	1.55***	0
		(0.46)	(0.49)	(0.85)	(0.59)	0
	Labels - Control	-0.23	-0.32	0.12	-0.07	0
		(0.46)	(0.50)	(0.82)	(0.68)	0
	Labels - Pro-Environment	-0.12	-0.36	0.46	0.23	0
		(0.47)	(0.51)	(0.82)	(0.67)	0

Superscripts ***, **, * indicate significance at 1%, 5%, 10% levels.

Table 4.4.
Mean Marginal WTP for Latent Class Model

	Class 1 (39.8%)		Class 2 (26.5%)		Class 3 (4.6%)		Class 4 (20.1%)	
Attribute	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Land Use	$0.16	[$0.02, $0.30]	$3.09	[$-89.33, $95.51]	$0.07	[$-0.15, $0.29]	-$0.83	[$-24.89, $23.22]
CO2 Emissions	-$0.25	[$-0.4, $-0.10]	$2.92	[$-91.19, $97.02]	$0.08	[$-0.14, $0.3]	$1.64	[$-44.44, $47.72]
Water Use	$0.12	[$-0.07, $0.30]	$2.93	[$-70.22, $76.08]	-$0.04	[$-0.3, $0.21]	$3.17	[$-117.3, $123.64]
Finishing System/Grassfed Label	$0.24	[$0.10, $0.39]	$12.80	[$-274.82, $300.42]	-$0.02	[$-0.31, $0.28]	$6.41	[$-181.12, $193.94]
Mortality Rate/Animal Welfare Label	$0.08	[$-0.04, $0.19]	$3.59	[$-86.90, $94.07]	$0.25	[$0.03, $0.48]	$0.88	[$-37.65, $39.42]
Added Hormone Use	$1.50	[$1.33, $1.67]	$3.46	[$-126.89, $133.81]	$0.35	[$0.09, $0.61]	$9.33	[$-269.4, $288.07]
Meat Option 1	$4.02	[$3.67, $4.36]	$62.53	[$-1024.52, $1149.57]	$2.11	[$1.55, $2.66]	-$10.13	[$-465.43, $445.17]
Meat Option 2	$4.46	[$4.17, $4.76]	$62.89	[$-1035.63, $1161.4]	$2.21	[$1.61, $2.81]	-$6.66	[$-354.65, $341.34]

to each other, we see this class has WTP nearly four times greater for grassfed than the remaining five attributes. The positive coefficients for the ASCs also suggest class 2 prefers to purchase meat over not. So it seems classes 1 and 2 could be labeled ”normal” but with distinct preferences for grassfed and AGH free beef.

Class 3 has the lowest membership probability (4.6%) and has low WTP for each of the six attributes. This class does have a positive WTP for the ASCs, implying that this class was extremely price sensitive and selected whichever meat option had the lowest price, regardless of attribute levels. Class 4 (20.1% membership probability) has negative WTP for both meat options but relatively large WTP for the remaining attributes, save land use. We can infer that this class was not as keen to select meat options as the first three classes, but had relatively greater WTP for attributes when a meat option was selected. The fifth class had a class membership orbability of 9.0% as well as a positive price coefficient. For this reason, WTP for this class is omitted from table 4.4. However, by looking back at table 4.3 we can see the relationships between the six non-price attribute coefficients and the two ASCs are proportionate to the other classes. The coefficients for both meat options are large and negative, implying this class was quite meat-averse and likely selected the ”purchase neither” option most frequently.

4.5 Simulated Choice Scenarios

Using the coefficients and class identifiers from the LCM we can run choice option simulations using any combination of attribute levels and price. Consider a choice question for three options of a lb of ground beef. Option 1 has the more desirable level for each of the three environmental attributes and the less desirable level for each attribute of animal welfare. Option 2 has the opposite levels for each attribute (high environmental impact with better animal welfare), as well as the same price as option 1. The third option is to purchase neither. With dummy variables for membership in each design/treatment and the median price value of $3.99/lb, we simulated the likelihood of each class to select these three options. Using class membership probabilities, we constructed a selection weighted average, given in figure 4.5.

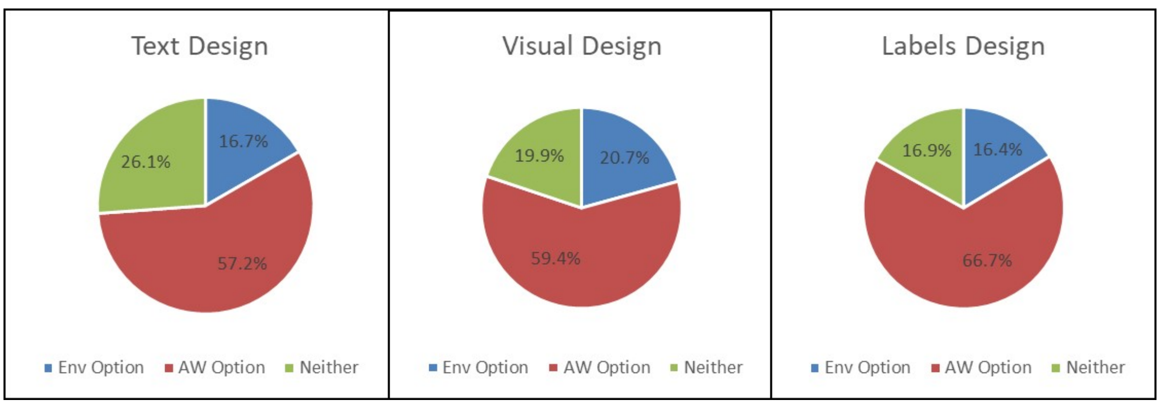

Figure 4.5. Choice Selection Likelihoods: Simulation 1

Consistent with our previous results, the text design has the highest probability of selecting neither meat option while the labels design has the lowest. The visual design has the highest likelihood of selecting the option with more desirable levels of environmental impact. This simulation reveals that participants were 3-4 times more likely to select the option with better animal welfare than reduced environmental cost at the median price level.

We ran another test using the same attribute levels as the previous simulation. Knowing that consumers were more likely to select the animal welfare option, we gave the environmental option the lowest price level of $1.99/lb. We then used Excel's Goal Seek function to simulate at which price for the animal welfare option consumers would become indifferent between the two meat options. At a price of $4.04/lb for the animal welfare option, the selection likelihoods for the two meat options both equal 41.2% with the remaining 17.6% selecting the "purchase neither" option. So consumers are willing to spend over twice as much for an option high in animal welfare than one which demonstrates lower environmental cost.

CHAPTER 5. DISCUSSION

Across all presentation designs and information treatments, participants were far more willing to pay for animal welfare attributes than environmental efficiencies. Results indicate that unique presentations of a single CE can have a significant impact on consumer responses. Participants shown the purely informational presentation (text design) disregarded all numerically presented attributes (land use, water use, CO2 emissions, mortality rate). Instead, they chose options solely on price and whether the beef was grassfed with no added growth hormones. The visual presentation incorporated coloring and sizing to illustrate the numeric attributes more intuitively. This group had significantly higher WTP for environmental attributes than the other presentations, although still lower than animal welfare attributes. The labels presentation was designed to mimic a grocery store setting, using images of packages of ground beef with labels representing each attribute besides price. Participants shown the labels design had the lowest variance across attributes for WTP, and relatively lower attribute WTP overall. Somewhat surprisingly, the land protection certified label produced slightly higher WTP than the grassfed label.

The use of pro-animal welfare information in the text design produced a significant increase in WTP for animal welfare attributes, as well as lower preference for ASCs. Pro-environment information had no effect on any design.

Participants in the labels design were shown to have 1.5-2 times higher WTP for a meat option over a "purchase neither" option than the other designs. This group was also the most heavily influenced by price and had relatively low attribute WTP overall. One potential reason for this is that the labels design does not display a "less desirable" level of each attribute, only the absence of a desirable label. It's possible these labels are seen as bonuses to an already desirable product, rather than a better alternative to an explicitly "undesirable" quality. Another possible explanation is that the use of images of ground beef cause participants to see each option more as an actual product than a hypothetical collection of attributes. The disparity in attribute WTP across the three presentation styles could imply that consumers are less willing to pay for a given attribute in a grocery store than they are in a CE.

It is clear that consumers prefer to pay more for animal welfare attributes of beef (specifically grassfed and no added growth hormones) than environmentally friendly qualities. However, this preference can be swayed slightly by the use of different presentation styles and additional information.

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APPENDIX

Table A1.
Demographics by Information Treatment and Design

		% U.S.	% Sample	Text Control	Visual Control	Labels Control	Text Pro-Env	Visual Pro-Env	Labels Pro-Env	Text Pro-AW	Visual Pro-AW	Labels Pro-AW
Gender	Male	49%	36%	37%	34%	37%	36%	28%	42%	38%	42%	34%
	Female	51%	64%	63%	66%	63%	64%	72%	58%	62%	58%	66%
Age	18-34	30%	28%	30%	25%	23%	30%	30%	30%	27%	27%	34%
	34-54	33%	24%	22%	28%	23%	24%	24%	25%	27%	23%	24%
	Over 54	38%	47%	48%	47%	54%	46%	46%	45%	45%	51%	42%
Income	Low income=<$40,000	33%	33%	39%	33%	31%	35%	30%	26%	32%	33%	34%
	Middle income=40,000−140,000	53%	55%	50%	57%	54%	52%	58%	61%	58%	52%	51%
	High income=>$140,000	14%	13%	11%	11%	15%	13%	12%	13%	10%	15%	15%
Education	Less than bachelor's degree	72%	54%	57%	58%	50%	54%	58%	51%	54%	46%	54%
	Bachelor's degree or higher	28%	47%	43%	42%	50%	46%	42%	49%	46%	54%	46%

Table A2.
Coefficient Estimates by Information Treatment for Text Design

	Estimate (Std. Error)			
Attribute	Control	Pro-Environment	Pro-Animal Welfare	Pooled
Land Use	-0.008	0.075	-0.015	0.013
	(0.060)	(0.063)	(0.060)	(0.035)
CO2 Emissions	0.025	0.032	-0.020	0.012
	(0.059)	(0.062)	(0.060)	(0.035)
Water Use	-0.001	-0.044	-0.014	-0.021
	(0.063)	(0.066)	(0.064)	(0.037)
Finishing System/Grassfed Label	0.397***	0.405***	0.626***	0.475***
	(0.068)	(0.071)	(0.069)	(0.040)
Mortality Rate/Animal Welfare Label	0.013	-0.029	0.125***	0.038
	(0.064)	(0.067)	(0.064)	(0.037)
Added Hormone Use	0.795***	0.670***	0.608***	0.699***
	(0.077)	(0.079)	(0.077)	(0.045)
Meat Option 1	0.844***	0.925***	0.128	0.629***
	(0.215)	(0.217)	(0.216)	(0.124)
Meat Option 2	0.927***	0.892***	0.291	0.702***
	(0.212)	(0.213)	(0.212)	(0.122)
Price	-0.317***	-0.373***	-0.211***	-0.298***
	(0.030)	(0.031)	(0.030)	(0.018)
Number of participants	192	181	186	559
Number of observations	6912	6516	6696	20124
Log likelihood value	-2177.26	-2074.35	-2251.23	-6541.88
Likelihood ratio test chi-sq. stat	78.06			
Critical value	28.87			
P-value	0.00			

Superscripts ***, **, * indicate significance at 1%, 5%, 10% levels.

Table A3.
Coefficient Estimates by Information Treatment for Visual Design

	Estimate (Std. Error)			
Attribute	Control	Pro-Environment	Pro-Animal Welfare	Pooled
Land Use	0.160**	0.108*	0.088	0.114***
	(0.065)	(0.063)	(0.063)	(0.036)
CO2 Emissions	0.277***	0.265***	0.068	0.201***
	(0.063)	(0.060)	(0.061)	(0.035)
Water Use	0.052	0.176***	0.023	0.086**
	(0.066)	(0.065)	(0.065)	(0.038)
Finishing System/Grassfed Label	0.605***	0.480***	0.409***	0.494***
	(0.074)	(0.071)	(0.071)	(0.041)
Mortality Rate/Animal Welfare Label	0.074	0.117*	0.178***	0.124***
	(0.069)	(0.067)	(0.067)	(0.039)
Added Hormone Use	0.618***	0.482***	0.565***	0.550***
	(0.083)	(0.081)	(0.080)	(0.047)
Meat Option 1	0.494**	0.894***	0.982***	0.795***
	(0.237)	(0.237)	(0.230)	(0.135)
Meat Option 2	0.620***	0.966***	0.991***	0.862***
	(0.234)	(0.237)	(0.229)	(0.134)
Price	-0.282***	-0.282***	0.309***	-0.290***
	(0.033)	(0.033)	(0.033)	(0.019)
Number of participants	166	166	168	500
Number of observations	5976	5976	6048	18000
Log likelihood value	-1881.88	-1858.64	-1916.93	-5676.52
Likelihood ratio test chi-sq. stat	38.15			
Critical value	28.87			
P-value	0.00			

Superscripts ***, **, * indicate significance at 1%, 5%, 10% levels.

Table A4.
Coefficient Estimates by Information Treatment for Labels Design

	Estimate (Std. Error)			
Attribute	Control	Pro-Environment	Pro-Animal Welfare	Pooled
Land Use	0.217***	0.239***	0.308***	0.254***
	(0.068)	(0.067)	(0.067)	(0.039)
CO2 Emissions	0.159**	0.157**	0.074	0.129***
	(0.065)	(0.064)	(0.064)	(0.037)
Water Use	-0.130*	-0.027	0.044	-0.038
	(0.068)	(0.067)	(0.069)	(0.039)
Finishing System/Grassfed Label	0.217***	0.195***	0.281***	0.231***
	(0.074)	(0.073)	(0.074)	(0.042)
Mortality Rate/Animal Welfare Label	0.158**	-0.017	0.189***	0.108***
	(0.072)	(0.070)	(0.071)	(0.041)
Added Hormone Use	0.585***	0.602***	0.639***	0.605***
	(0.083)	(0.082)	(0.085)	(0.048)
Meat Option 1	1.966***	1.989***	1.992***	1.982***
	(0.242)	(0.243)	(0.254)	(0.142)
Meat Option 2	2.050***	2.035***	2.091***	2.058***
	(0.243)	(0.242)	(0.255)	(0.142)
Price	-0.492***	-0.473***	-0.466***	-0.476***
	(0.034)	(0.034)	(0.036)	(0.020)
Number of participants	166	166	168	500
Number of observations	5976	5976	6048	18000
Log likelihood value	-1641.67	-1650.92	-1586.30	-4890.88
Likelihood ratio test chi-sq. stat	23.99			
Critical value	28.87			
P-value	0.16			

Superscripts ***, **, * indicate significance at 1%, 5%, 10% levels.