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Consumer Preference for Grass-Fed Beef: A Case of Food Safety Halo Effect

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Consumers may perceive grass-fed beef to be superior in terms of food safety due to false impressions and a persistent, unproven narrative. Such misperception can distort the market, which may require policy intervention. Using a discrete choice experiment, results indicate that those who perceive higher food safety risks from consuming beef and those who hold the belief that grass-fed beef is safer than grain-fed have a stronger preference for grass-fed beef. This is an important finding as there is no scientific consensus that grass-fed beef is safer. This potential misperception warrants further scrutiny.

Key words: beef demand, choice experiment, food labels preference, risk perception, willingness to pay

Introduction

Grass-fed beef is a growing niche market (Xue et al., 2010; Gillespie et al., 2016; Burwood-Taylor, 2017). Credits to its popularity include nutrition, animal welfare, and potential environmental benefits (Gwin, 2009; Gillespie et al., 2016). Nevertheless, eco-labels, of which grass-fed beef is one, can generate confusion (Sörqvist et al., 2013; Brécard, 2014; Ecolabel Index, 2019). For example, consumer belief that organic food is safer has persisted despite evidence that suggests that organic food is not significantly safer (Smith-Spangler et al., 2012; Massey, O'Cass, and Otahal, 2018). In what is seen as the tendency of eco-labels to bias one's opinion about unrelated characteristics (i.e., a halo effect), respondents in sensory tests believe that falsely claimed eco-labeled products taste better, are more nutritious, and of higher quality (Sörqvist et al., 2013, 2015). Additionally, grass-fed beef was once thought to be immune to *E. coli* O157, which is a proposition that has been refuted but may be slow to vanquish (Planck, 2006; Moore, 2013). In fact, grass-fed beef has not been proven to be less likely to cause foodborne illness—from bacteria, viruses, or toxin contamination— nor is food safety officially a stated benefit of the label (Zhang et al., 2010; Moore, 2013; Lammers et al., 2015; U.S. Department of Agriculture, 2019). Discussion of whether consumer preference for grass-fed beef is fueled by a belief that it is safer than grain-fed beef is relatively muted. Such misperception about food safety could distort the market and generate inefficiency.

This study explores the extent to which food safety concerns and perceptions contribute to consumer preference for grass-fed beef. Using a discrete choice experiment, our results show that a significant number of consumers believe that grass-fed beef is safer than conventional beef and

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that this belief contributes to a higher willingness to pay (WTP). Additionally, food safety risk perception, which causes consumers to prefer attributes related to food safety (i.e., BSE testing and traceability), also increases preference for grass-fed beef. The results suggest that the food safety halo effect of grass-fed beef—and perhaps of other eco-labels—should be further scrutinized.

The grass-fed label signals the diet of cattle used in production. By doing so, the label translates information about the production method—one that may not be discernable at the point of purchase and after consumption—into an attribute that is identifiable at the point of purchase. The grass-fed label is voluntary—the government withdrew it as part of USDA-defined certification in 2019 (U.S. Department of Agriculture, 2019). Grass-fed beef has well-publicized nutritional benefits (McCluskey et al., 2005; Daley et al., 2010), but it has no notable stipulations that may clearly distinguish the food safety risk—microbial, chemical, or physical hazards—of grass-fed beef from grain-fed beef. While certain third-party grass-fed labels may restrict use of artificial hormones and antibiotics, whether such stipulations are meaningful to food safety is not certain (Refsdal, 2000; American Cancer Society, 2014).

In contrast, the organic label remains a USDA-defined certification. The USDA standard stipulates a regime of 100% organic feed and forage cattle diet, no administered antibiotics or hormones, and access to pasture (U.S. Department of Agriculture, 2019). "Organic" and "grass-fed" are not mutually exclusive; to be both, the cattle must be fed 100% organic forage and grass, and they may not be administered antibiotics or hormones. The access to pasture in both methods may enhance animal welfare. Neither method, however, can guarantee beef that is free from food safety risks, nor has either been shown to reduce food safety risks objectively and conclusively (Van Loo, Alali, and Ricke, 2012; Zhang et al., 2010).

Nevertheless, grass-fed beef has been portrayed as less prone to the risk of *Escherichia coli* O157—a potentially deadly foodborne pathogen. In 2006, a *New York Times* op-ed claimed that *E. coli* O157 is "not found in the intestinal tracts of cattle raised on their natural diet of grass, hay, and other fibrous forage," but it "thrives in…the unnaturally acidic stomachs of beef and dairy cattle fed on grain" (Planck, 2006). This notion has been disproved, where studies show that grass-fed cattle are also susceptible to E. coli O157, and in many cases, as prevalent as grain-fed cattle (Fegan et al., 2004; Jacob, Callaway, and Nagaraja, 2009; Moore, 2013; Lammers et al., 2015). However, the potentially misleading message has been echoed and has persisted (Pollan, 2006; McWilliams, 2010; Moore, 2013; Weatherbury Farm, 2020).

Further, Zhang et al. (2010), reviewing the prevalence of contamination rates and antimicrobial resistance in bacteria, find no clear advantage in grass-fed over grain-fed beef. Others have suggested that animals raised using free-range practices are exposed to a different set of food safety risks, which may not necessarily be safer (Lund, 2006; Miranda et al., 2008). Studies have also found the prevalence of foodborne pathogens and antibiotic-resistant bacteria to be similar among grass-fed, organic, and conventional feedlot cattle (Fegan et al., 2004; Reinstein et al., 2009; Van Loo, Alali, and Ricke, 2012). Recall incidences show that grass-fed beef is not immune to food safety violations (Food Product Design, 2011; Belluz, 2018). Hence, the present evidence does not conclusively support the claim of food safety superiority of grass-fed beef. Further, as the risk of contamination could be greater in the packing process, the narrow focus on cattle diet may yield misguiding implications about food safety (Ekong, Sanderson, and Cernicchiaro, 2015).

The debate about the extent upon which the grass-fed system is an environmental solution has also been ongoing: It may be more taxing in land use, time, less productive in yield, and may not lessen greenhouse gas than the grain-fed method (Capper, 2012; Clark and Tilman, 2017; Hayek and Garrett, 2018). Despite this, the literature and public discussions frequently refer to the grass-fed system as a green or eco-label (American Grassfed Association, n.d.; Gwin, 2009; Ecolabel Index, 2019; Lynch, 2019).

Consumers' interpretations of eco-labels have been a hotbed of confusion (Harbaugh, Maxwell, and Roussillon, 2011). For example, consumers confound organic and other food labels for characteristics such as natural and local (Campbell et al., 2010; Massey, O'Cass, and Otahal, 2018).

Studies have also highlighted the ability of certain labels to influence consumers psychologically and neurologically. For example, in blind tastings, foods deceptively claimed to be eco-labeled are consistently rated as tastier, healthier, and higher quality, even though identical products were tested (Sörqvist et al., 2013, 2015). Similarly, a mere glance of a Fair Trade label activates brain regions associated with taste perception (Enax et al., 2015). This type of bias has been referred to as the "halo effect" of eco-labels (Sörqvist et al., 2013, 2015; Enax et al., 2015).

The halo effect raises a distinct possibility that consumers may interpret grass-fed beef as safer, especially if consumers see grass-fed beef in a similar light as organic. Organic is well-documented as being perceived as less risky in terms of food safety (Williams and Hammitt, 2001; Michaelidou and Hassan, 2008; Smith-Spangler et al., 2012; Van Loo, Alali, and Ricke, 2012; Barański et al., 2017; Rana and Paul, 2017; Massey, O'Cass, and Otahal, 2018). However, there have not been many investigations on the halo effect of nonorganic eco-labels.

Fueled by food scares such as the 1993 E. coli and bovine spongiform encephalopathy (BSE) outbreaks, consumers are concerned about the food safety of beef (Pennings, Wansink, and Meulenberg, 2002; Schroeder et al., 2007). Those who are motivated by food safety risk are willing to pay a premium for the BSE test, traceability, and other food safety attributes to mitigate risk (Hayes et al., 1995; Loureiro and Umberger, 2007; Lim et al., 2013). In other instances, they rely on indirect cues—such as country of origin—to infer the food safety quality of beef (Lim et al., 2014; Berry et al., 2015).

Whether grass-fed beef is purchased to mitigate food safety risk is not well established in the literature. In a qualitative study in four European countries, Van Wezemael et al. (2010) find that the grass-fed label is used as a food safety cue. The question remains whether this observation will hold generally across continents; if so, the extent to which food safety perceptions affect preferences and valuation for grass-fed beef. In this study, we construct a choice experiment to tease out the role of food safety perceptions on consumer preference for grass-fed beef.

Method

We determine whether food safety motivates the preference for grass-fed beef in three ways. First, we examine whether the perception of food safety risk motivates the preference for grass-fed beef. Second, we assess whether the perception of food safety benefit of grass-fed beef motivates its preference. Third, we compare the results against organic and other attributes known to be used for food safety (BSE test and traceability). The choice experiment data and perception measurements are collected in a nationally distributed online survey.

Food Safety Perceptions Measurements

This study uses two measurements related to food safety. First, we measure the level of food safety risk perceived to be present from eating beef; a higher risk perception may push consumers to substitute conventional beef for grass-fed beef. Second, we measure the level of food safety quality that consumers perceive from grass-fed (and organic) beef. The premise is that the perceived benefit may draw consumers to purchase these differentiated beef products.

We measure risk perception with a psychometric scale similar to that used in other, closely related research (Pennings, Wansink, and Meulenberg, 2002; Tonsor et al., 2009; Lim et al., 2013). The question appears as, "When eating beef, I am exposed to . . . (of) food safety risk." Respondents fill in the blank with one of the choices on a five-point Likert-type scale: "none at all," "a little," "a moderate amount," and "a lot/a great deal."[1] Prior to the question, we defined food safety risk as a "risk of food contamination with bacteria, viruses, and toxins that cause illnesses." The scales record

[1] The categories "a lot" and "a great deal" consist of only 9.8% of the sample combined, which are grouped in the analyses.

Table 1. Characteristics of the Sample

	Sample Mean	Population Mean
Age	46.1	47.1
At least some college	60.0%	59.0%
Female	57.2%	51.0%
Male	42.87%	49.0%
Primary shopper	85.4%	
Eat beef frequently	80.2%	
Eat beef irregularly	19.5%	
Don't eat beef but buy for household	0.3%	
"When eating beef, I am exposed to ... (of) food safety risk." (rp)		
none at all ($rp1$)	11.9%	
a little ($rp2$)	56.1%	
a moderate amount ($rp3$)	22.2%	
a lot/a great deal ($rp4$)	9.8%	
"Grass-fed beef is safer than conventional beef" (g)		
Strongly disagree ($g = 1$)	6.4%	
Disagree ($g = 2$)	10.4%	
Neither disagree nor agree ($g = 3$)	47.2%	
Agree ($g = 4$)	23.2%	
Strongly agree ($g = 5$)	12.8%	
"Organic beef is safer than conventional beef" (o)		
Strongly disagree ($o = 1$)	6.8%	
Disagree ($o = 2$)	11.7%	
Neither disagree nor agree ($o = 3$)	35.0%	
Agree ($o = 4$)	28.6%	
Strongly agree ($o = 5$)	17.9%	

a Cronbach Alpha score of 0.74, reflecting an acceptable internal consistency (Online Supplement Table S1, see www.jareonline.org). The variable is referred to as rp henceforth.

The perceived benefit measurements quantify the degree to which the respondent believes that grass-fed (g) and organic beef (o) is safer than conventional beef, which is grain-fed and not organic certified. These are measured with two Likert-type questions (see Table 1).

Choice Experiment

The choice experiment features a pound of striploin beefsteak, following previous studies (Tonsor et al., 2009; Lim and Hu, 2016; Lim, Vassalos, and Reed, 2018). Five attributes are examined—*grass-fed*, *organic*, *BSE-tested*, *traceability*, and prices (Table 2).[2]

As noted, *BSE-tested*, and *traceability* are expected to be used by consumers as food safety cues. The *BSE-tested* attribute denotes whether the product has been screened for the prion that causes bovine spongiform encephalopathy, while the *traceability* attribute signifies that the parties involved

[2] Italicized when referring to attributes of the choice experiment.

Table 2. Attributes and Levels of the Choice Experiment

Attribute	1	2	3	4
Grass-fed claim	No grass-fed claim	Grass-fed		
Organic claim	No organic claim	USDA Organic		
BSE tested	No BSE-tested claim	BSE tested		
Traceability	No traceability claim	Traceable		
Prices ($/lb)	$8.49	$11.49	$14.49	$17.49

in the food supply chain are accountable from farm to fork; both are intended to address food safety concerns (Schroeder and Tonsor, 2012; Lim et al., 2013).

The prices, which range from $8.49 to $17.49, are selected based on the authors' observation of retail prices and the Consumer Price Index (U.S. Bureau of Labor Statistics, 2019). The respondents were presented with the definitions of the attributes (Figures S1 and S2).

The choice sets are generated with the Bayesian D-Optimality procedure of JMP 14. The procedure uses a set of priors to reduce dominant choice profiles, which can diminish the efficiency of the experiment. The priors consist of estimates from previous studies and the authors' best guesses (Crabbe and Vandebroek, 2012). The design records a relative D-efficiency score of 94.99, where all main-level effects and first-order interaction effects can be estimated (Kuhfeld, 2010). Forty-eight unique choice profiles and the opt-out option are generated and distributed across 32 choice sets. Each choice set contains two choice profiles and the opt-out option. The choice profiles are randomly divided into four blocks of eight choice sets each to minimize respondent fatigue (Czajkowski, Giergiczny, and Greene, 2014). Each respondent was randomly assigned to a block.

Before the choice experiment, the respondents were presented a cheap talk script adapted from Lusk (2003), which has been shown to reduce the magnitude of hypothetical bias (Lusk, 2003; Penn and Hu, 2018, 2019).

Econometric Models

Our main objective is to determine how food safety risk and benefit perceptions motivate the preference for grass-fed beef. The hypotheses are tested with two conditional logit models, which capture the perception-to-preference effect with interaction terms. Further, we apply a latent class logit model to reveal the impact of the perceptions on the heterogeneous taste associated with these labels. A mixed logit model with just the main attributes is also estimated to provide some basic context for the data; it is not used for hypothesis testing.

Models 1 and 2: Conditional Logit Models with Perception-Attributes Interaction Terms

The first model incorporates only risk perception terms. Consumers' utility is described as

$$U_{ijt} = \alpha_1 optout_{ijt} + \alpha_2 price_{ijt} + \boldsymbol{\beta x}_{ijt} + \boldsymbol{\theta d}_{ijt} + \varepsilon_{ijt}, \tag{1}$$

where U represents the utility from choosing the beefsteak in alternative j, choice set t for consumer i; α_1 denotes the expected (negative) utility associated with forgoing the choice to consume by opting out from purchasing. α_2 denotes the marginal utility associated with price, expected to be negative by the law of demand. The error term, ε_{ijt}, is assumed to follow the Gumbel distribution, which gives rise to the logit estimator (Train, 2009).

The nonprice attributes interact with *rp* in vector $\boldsymbol{x}$. This permits the effect of risk perception to be differentiated across attributes. If the attributes are viewed as food safety measurements, we expect that the utility from the attributes to increase with *rp*. Formally, $\boldsymbol{x}_{ijt} = [grass\text{-}fed \times rp1, \ldots, \; grass\text{-}fed \times rp4, \ldots; \; traceability \times rp1, \ldots, \; traceability \times rp4]_{ijt}$, where *rp* are dummy coded to allow for nonlinearity. Lastly, the vector $\boldsymbol{d}_{ijt}$ includes the interaction terms of the attributes and consumers' demographic characteristics, $\boldsymbol{d}_{ijt} = [grass\text{-}fed \times age, \ldots, grass\text{-}fed \times income; \ldots; traceability \times age, \ldots, traceability \times income]_{ijt}$, a vector with 16 elements used as control variables. θ are unknown associated coefficients to be estimated.

Given that *traceability* and *BSE-tested* have direct connections to food safety, they are expected to increase with *rp*. Also, following Williams and Hammitt (2001), *organic* is expected to increase with *rp*. If the preference for *grass-fed* is instead independent of risk perception, it would be constant in *rp*, as null hypothesis *a* shows:

$$H_o^a : \beta_{grassfed \times rp1} = \ldots = \beta_{grassfed \times rp4}.$$

A rejection, particularly if the preference for *grass-fed* increases with *rp*, would suggest that consumers' preference for grass-fed beef is motivated by food safety risk perception.

Model 2 expands Model 1 with the level of food safety benefits that consumers associate with *organic* and *grass-fed*. The risk and benefit perceptions are expected to be positively correlated (Alhakami and Slovic, 1994). As collinearity may impact the estimations, Models 1 and 2 are estimated separately.

Formally, Model 2 bears the following form:

$$U_{ijt} = \alpha_1 optout_{ijt} + \alpha_2 price_{ijt} + \boldsymbol{\beta x}_{ijt} + \boldsymbol{\gamma y}_{ijt} + \boldsymbol{\theta d}_{ijt} + \varepsilon_{ijt} \quad (2)$$

The benefit variables enter in the vector $\boldsymbol{y}_{ijt} = [grass\text{-}fed \times g1, \ldots, grass\text{-}fed \times g5, organic \times o1, \ldots, organic \times o5]_{ijt}$., where *g* and *o* correspond to dummy-coded perceived food safety superiority of *grass-fed* and *organic* beef, as previously discussed.

The hypothesis from Model 2 is

$$H_o^b : \boldsymbol{\gamma}_{grassfed \times g1} = \cdots = \boldsymbol{\gamma}_{grassfed \times g5}$$

A rejection, particularly if $\boldsymbol{\gamma}$ increase with *g*, would suggest that the *grass-fed* label could be used as a food safety indicator. To further illustrate the effects of the perception in terms of marginal willingness to pay, we calculate it as $-\gamma/\alpha_2$, following Lim, Hu, and Nayga (2018).

Models 1 and 2 use the conditional logit estimation. In these models, the influence of the perception variables is modeled as observed taste heterogeneity—represented as interaction terms between the attributes and perception; our primary interest is the mean effect of the interaction terms. Specifying the interaction terms as random coefficients may heighten the concern of hard-to-detect identification issues, which yields misleading estimates (Fox et al., 2012).

Model 3: A Latent Class Logit Model with the Risk Perception Variable as Membership Assignment Criteria

As consumer preference for the attributes may be segmented, the effects of perceptions could depend on the segments. We use the latent class logit model to accommodate this perspective (Greene and Hensher, 2003). The perception variables *rp*, *o*, and *g* enter as class assignment criteria, as such, revealing how the preference might be contingent upon the perceptions. Formally, the utility model is rewritten as

$$U_{ijt|c} = \boldsymbol{\beta}_c \boldsymbol{a}_{ijt} + \varepsilon_{ijt}; \; c = 1, \ldots, C \quad (3)$$

where *c* denotes the class. Vector $\boldsymbol{a}$ represents the main attributes, $\boldsymbol{a}_{ijt} = [$*opt out*, *price*, *grass-fed*, *organic*, *BSE-tested*, *traceability*$]_{ijt}$. The model produces *C* sets of coefficients, accounting for the taste variation by segmenting the preference into discrete classes.

The class assignment, as noted in Greene and Hensher (2003), can be derived with multinomial logit:

$$H_{ic} = \frac{\exp(rp_i\delta_{rp,c} + o_i\delta_{o,c} + g_i\delta_{g,c} + \boldsymbol{d}_i\delta_{\boldsymbol{d},c})}{\sum_{c=1}^{C}\exp(rp_i\delta_{rp,c} + o_i\delta_{o,c} + g_i\delta_{g,c} + \boldsymbol{d}_i\delta_{\boldsymbol{d},c})}; \tag{4}$$

$$c = 1,\ldots,C;\ \delta_C = 0;$$

where δ in class C is the baseline category normalized as 0 and $\delta_{rp,c}$, $\delta_{o,c}$, and $\delta_{g,c}$ denote the odds ratio, in the context of class assignment, attributable to the food safety perception measurements, respectively.[3]

The Sample

The sample consists of 1,010 consumers in the United States, stratified according to gender, age, education, and income (Table 1). It corresponds closely, by design, to the U.S. population in these characteristics. The survey contains a screen-out question so that only beef consumers are targeted.

The survey is conducted online. Qualtrics was contracted for sample recruitment and survey administration. Responses were collected until the sample reached at least 1,000, and the collection took place over a month between March and April 2019. The mean time taken to complete the survey is 9.16 minutes. Upon completing the survey, respondents were compensated with a small token gift. Both the survey instrument and the sampling method obtained approval from the IRB of the lead author's institution. No deception is used in the survey instrument.

Results

Three models are developed to explain the role of food safety perceptions on consumer preference for grass-fed beef. The focus of Models 1 and 2 is to outline the role of food safety risk perception and perceived food safety benefit that respondents attribute to grass-fed beef, respectively. In Model 3, we allow consumer preferences to be segmented to examine the influence of the perception variables.

We begin with the results of the mixed logit model with only the main attributes for an overview (Online Supplement Table S2). The mean WTP for *grass-fed* is \$0.75, which is lower but not statistically different from *organic* ($\beta_{organic} = \beta_{grassfed};\ P = 0.265$). The utilities for the *grass-fed* and *organic* attributes have a positive correlation of 0.54 ($P < 0.01$)—those who prefer *grass-fed* are likely to also prefer *organic*, which reflects that the preferences may share a common motivator. *grass-fed* is also related to *BSE-tested* and *traceability*. As the latter attributes are mostly for food safety, these circumstantially indicate that *grass-fed* and *organic* could also possibly be seen as food safety measurements.

Model 1: Conditional Logit with Risk Perception Interaction Terms

From Table 1, about 70% of respondents perceive no or low food safety risk from beef consumption (where $rp = 1$ and $rp = 2$); about one-fifth perceive a moderate amount of risk ($rp = 3$); only one-tenth think that beef consumption entails high food safety risk ($rp = 4$). Thus, most respondents perceive that beef is relatively low in food safety risk.

Formally, the null hypothesis a, which postulates that *rp* does not affect consumer preference for *grass-fed*, is rejected ($P < 0.001$) (Online Supplement Table S1). Whereas consumers may prefer *organic* beef regardless of *rp*, holding other factors constant, the results reveal that those

[3] The class assignment variables in this model are specified as continuous; specifying the variables categorically prevents the model from converging.

Table 3. Results from Model 1 (conditional logit with risk perception)

			Interaction Terms			
			Grass-fed	***Organic***	***BSE-Tested***	***Traceability***
Opt-out	−3.391***	$rp = 1$	0.298***	0.316***	0.174**	0.125
	(0.079)		(0.077)	(0.076)	(0.078)	(0.078)
Price	−0.260***	$rp = 2$	0.303***	0.334***	0.0629*	0.0161
	(0.007)		(0.038)	(0.037)	(0.038)	(0.038)
		$rp = 3$	0.273***	0.408***	0.161***	0.206***
			(0.057)	(0.056)	(0.057)	(0.057)
		$rp = 4$	0.886***	0.419***	0.476***	0.436***
			(0.113)	(0.112)	(0.113)	(0.114)
		Age	−0.157***	−0.0943***	−0.103***	−0.133***
			(0.016)	(0.016)	(0.017)	(0.016)
		College	0.0493	0.173***	−0.0427	0.0541
			(0.056)	(0.055)	(0.057)	(0.056)
		Income	0.00149	0.00868	0.0124	0.00709
			(0.010)	(0.010)	(0.010)	(0.010)
		Female	−0.0944*	0.0235	−0.0134	−0.0426
			(0.056)	(0.055)	(0.056)	(0.056)
Log likelihood					−7,499.10	
Pseudo-R^2					0.155	

Notes: Numbers in parentheses are standard errors. Single, double, and triple asterisks (*,**,***) indicate significant at the 10%, 5%, and 1% level, respectively.

who perceive a high risk from beef consumption have a significantly higher utility for *grass-fed* (Table 3). The robustness of *organic* preference could be due to unobserved factors such as familiarity, environmental, and animal welfare (Massey, O'Cass, and Otahal, 2018).

Results also indicate that risk perception similarly influences the preference for *grass-fed*, *BSE-tested*, and *traceability*. Consumer preference for the attributes stands out for the high risk perception group ($rp = 4$), where they are significantly higher than groups with lower rp (this only applies nominally for *organic*). By translating preferences to WTP, we show that consumers are willing to pay significantly more for *grass-fed*, *BSE-tested*, and *traceability* when rp = 4 (Figure 1). This supports the notion that *grass-fed* correlates with risk perception in a similar pattern as *BSE-tested* and *traceability*—two attributes known to be food safety risk mitigators.

Model 2: Conditional Logit with Food Safety Benefit Perception Interaction Terms

Respondents hold diverse opinions as to whether *organic* and *grass-fed* are safer than conventional beef. Overall, those who agree or strongly agree that the differentiated products are safer outnumber those who disagree or strongly disagree (36% vs. 16.8% for *grass-fed*; 46.5% vs. 18.5% for *organic*; Table 1). The opinion suggests that the labels are viewed generally in a positive food-safety light.

Model 2 records a higher pseudo-$R^2$2 than Model 1 (0.171 to 0.155) (Table 4). A likelihood ratio test rejects that Model 2 is nested within Model 1 ($P < 0.01$); the benefit perceptions are statistically consequential to the preference for *grass-fed* and *organic*. The risk perception variables are less statistically significant overall, which suggests that the effect of perceived benefit may dominate the effect of perceived risk.

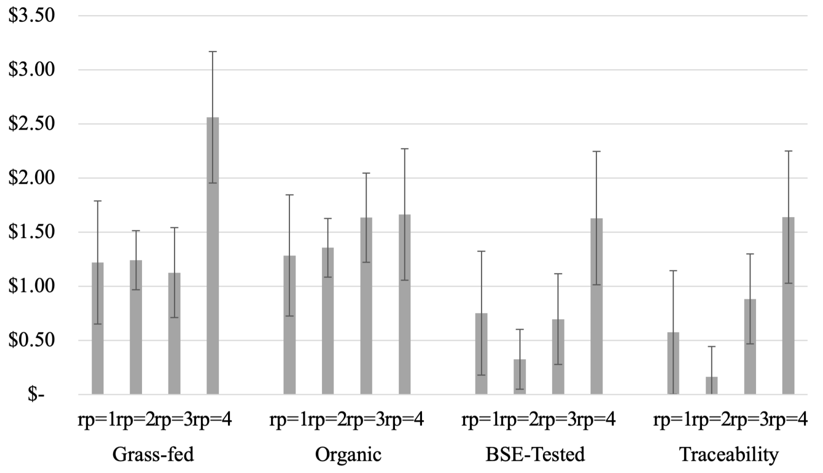

Figure 1. Willingness to Pay by Risk Perception (Model 1)

Notes: Tick marks represent 95% confidence interval.

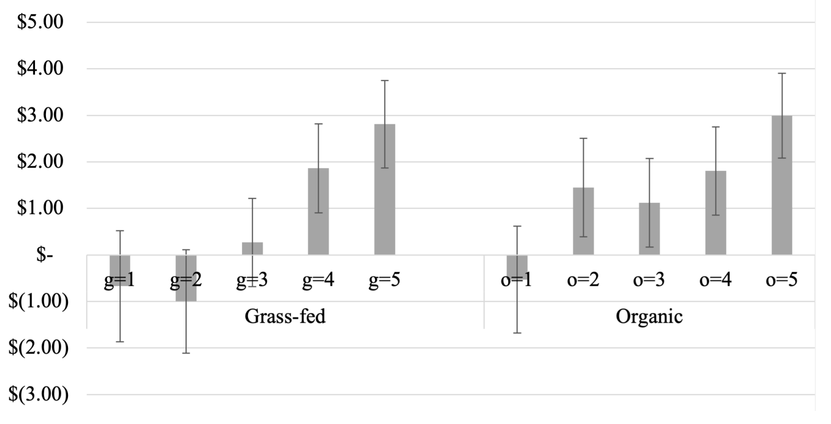

Figure 2. Willingness to Pay by Food Safety Benefit Perceptions (Model 2)

Notes: Tick marks represent 95% confidence interval.

The preference for grass-fed beef increases with the food safety superiority consumers perceived from the labels. Consumers who do not agree with the statement that *grass-fed* is safer than conventional beef are indifferent toward the label. Formally, hypotheses b is rejected, as food safety benefit perception is found to affect the preference ($P < 0.001$) (Online Supplement Table S1).

Finer points emerge. Only those that perceive *grass-fed* to be safer than conventional beef ($g = 4$ and 5) are willing to pay a premium (Figure 2). While those who believe that *organic* is safer ($o = 4$ and 5) are willing to pay a premium, when respondents either disagree or feel ambiguous about the food safety benefits of *organic*, they still maintain a positive preference for *organic*; the more robust preference for organic beef may again due to other unobserved factors.

WTP depends on the benefit perception. Notably, a wide gap exists in WTP between those who “strongly disagree” and “strongly agree” (ratings of 1 vs. 5). For both attributes, WTP increases to around $3.00/lb, with a confidence interval of about $1.00/lb, for respondents who “strongly agree” that *grass-fed* or *organic* indicate safer products, whereas WTP for the labels is insignificant and nominally negative for those who “strongly disagree” (Figure 2). WTP for the labels is highly dependent on the labels’ perceived food safety benefits.

Table 4. Results from Model 2 (conditional logit with benefit perception)

			Interaction Terms			
			Grass-fed	***Organic***	***BSE-Tested***	***Traceability***
Opt-out	−3.453***	$rp = 1$	0.139	−0.040	0.190*	0.141
	(0.080)		(0.146)	(0.144)	(0.079)	(0.079)
Price	−0.27***	$rp = 2$	0.152	−0.054	0.080*	0.030
	(0.007)		(0.130)	(0.128)	(0.038)	(0.038)
		$rp = 3$	0.0423	−0.019	0.181**	0.225***
			(0.135)	(0.134)	(0.058)	(0.058)
		$rp = 4$	0.618***	−0.040	0.504***	0.462***
			(0.167)	(0.166)	(0.115)	(0.116)
		$g/o = 1$	−0.181	−0.142		
			(0.164)	(0.158)		
		$g/o = 2$	−0.269	0.391**		
			(0.153)	(0.146)		
		$g/o = 3$	0.073	0.303*		
			(0.131)	(0.131)		
		$g/o = 4$	0.502***	0.487***		
			(0.131)	(0.131)		
		$g/o = 5$	0.759***	0.807***		
			(0.129)	(0.126)		
		Age	−0.134***	−0.077***	−0.104***	−0.132***
			(0.017)	(0.016)	(0.017)	(0.017)
		College	0.026	0.151**	−0.045	0.058
			(0.057)	(0.056)	(0.058)	(0.057)
		Income	−0.001	0.011	0.013	0.008
			(0.010)	(0.010)	(0.010)	(0.010)
		Female	−0.123*	0.007	−0.007	−0.040
			(0.057)	(0.056)	(0.057)	(0.057)
Log likelihood					−7,358.9	
Pseudo-R^2					0.171	

Notes: Numbers in parentheses are standard errors. Single, double, and triple asterisks (*,**,***) indicate significant at the 10%, 5%, and 1% level, respectively.

Model 3: Latent Class Model with Perception Terms as Class Assignment Criteria

The Bayesian information criteria indicate that four classes best fit the data (Table 5). They can be broadly categorized as value-added consumers, abstaining consumers, low-WTP consumers, and indifferent consumers. Respectively, these classes comprise about 43%, 11%, 24%, and 22% of the sample. The conventional consumers, who have large disutility for opting out and are not willing to pay a premium for any of the attributes, are set as the reference group.

The value-added consumers have the highest overall WTP: around \$7.50 for *grass-fed* and *organic* and between \$1.89 and \$2.99 for *traceability* and *BSE-tested* (Figure 3). Hence, these two labels are preferred over the food safety attributes. Notably, rp is significant as a membership assignment criterion ($\delta_{rp,1}$; $P = 0.02$), suggesting that higher rp increases the likelihood that one is

Table 5. Results from Model 3 (latent class model with class membership criteria)

	Class 1 Value-Added Consumers	Class 2 Abstaining Consumers	Class 3 Low-WTP Consumers	Class 4 Indifferent Consumers
Class probability	0.431	0.111	0.240	0.218
Price	−0.060***	−0.375***	−0.953***	−0.806***
	(0.011)	(0.068)	(0.048)	(0.056)
Opt-out	−2.330***	−0.950	−9.429***	−13.598***
	(0.162)	(0.849)	(0.490)	(0.848)
Grassfed	0.465***	−0.206	0.621***	0.113
	(0.042)	(0.300)	(0.134)	(0.134)
Organic	0.439***	0.241	0.819***	0.206
	(0.041)	(0.256)	(0.142)	(0.137)
BSE tested	0.179***	0.533*	0.128	−0.055
	(0.040)	(0.276)	(0.121)	(0.126)
Traceability	0.113***	0.411	0.647***	0.111
	(0.040)	(0.251)	(0.129)	(0.144)
Class assignment (δ)				
Constant	−1.360***	0.346	0.892*	
	(0.437)	(0.559)	(0.469)	
RP	0.285**	0.130	−0.121	
	(0.124)	(0.177)	(0.143)	
G	0.032	−0.355**	−0.159	
	(0.118)	(0.155)	(0.123)	
O	0.350***	−0.168	−0.029	
	(0.108)	(0.144)	(0.110)	
Age	−0.149**	0.513***	0.265***	
	(0.061)	(0.102)	(0.068)	
College	−0.279	−0.611**	−0.084	
	(0.206)	(0.282)	(0.234)	
Income	−0.002	−0.032	0.013	
	(0.036)	(0.051)	(0.040)	
Female	−0.023	−0.488*	−0.268	
	(0.202)	(0.285)	(0.221)	
Log-likelihood				−5,591.07
McFadden Pseudo-R^2				0.3701

Notes: Numbers in parentheses are standard errors. Single, double, and triple asterisks (*,**,***) indicate significant at the 10%, 5%, and 1% level, respectively.

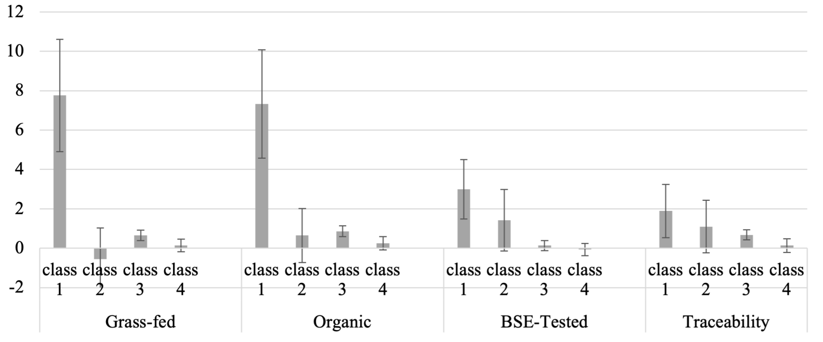

Figure 3. Willingness to Pay Inferred by the Latent Class Model

Notes: Tick marks represent 95% confidence interval.

within this group. Similarly, this group tends to be more likely to believe that *organic* is safer than the conventional product ($\delta_{o,1}$; $P = 0.01$).

The abstaining consumers are indifferent about purchasing the beefsteak, as inferred by the insignificant coefficient associated with opting out. Their WTP for *BSE-tested* at \$1.42 indicates that food safety concerns may be prevalent. They are also likely skeptical about mitigating food safety risks with the eco-labels, as indicated by the perceived food safety benefits in *grass-fed* ($\delta_{G,2} < 0$; $P = 0.02$).

Low-WTP consumers prefer *grass-fed*, *organic*, and *traceability*, where the WTPs are estimated to be below \$1.00. Their WTP is smaller than that of the value-added consumers. The perceptions are notably insignificant, which contrast with the value-added consumers.

The results yield the notions that *grass-fed* and *organic* beef are purchased for food safety. First, given that δ_{rp} is exclusively significant in Class 1, the likelihood that a person is willing to pay more for grass-fed and organic beef increases with the food safety risk they perceived from eating beef, which echoes Model 1. Second, the statistical significance of $\delta_{O,1}$ mirrors the main observation of Model 2, WTP is higher if a person believes that *grass-fed* and *organic* labels signal safer products. Thus, notwithstanding the advantage of latent class model in parsing out taste heterogeneity, the three models agree that food safety risk and benefit perceptions affect the preference for grass-fed beef.

Discussions

While some may prefer it due to health, nutritional, and other justifiable considerations, grass-fed beef does not guarantee enhanced food safety compared to grain-fed beef (Daley et al., 2010; Zhang et al., 2010). As there is no scientific consensus showing that grass-fed beef can lower food safety risks, a perfectly informed consumer would likely not be motivated to purchase this product due to food safety factors. Consumers may, however, be imperfectly informed. A misperception that grass-fed beef offers enhanced food safety could give rise to a market inefficiency as described in Spence (1977, p. 561)—where "demand votes are miscast, and the supply-side produces the wrong products." Our results show that the expectation of enhanced food safety is a salient component of the demand for grass-fed beef. The demand curve for grass-fed beef can be shifted upward by this food safety expectation, which is likely unmet.

In supplying the wrong good, producers respond to the distorted demand signal, increasing the investment and production of grass-fed beef. As producers respond to an artificially inflated demand, the inflated supply is suboptimal in terms of market efficiency. As grass-fed beef may not be superior in terms of greenhouse gas per pound of beef, the inflated supply could have environmental spillover, as conventional production is suppressed or substituted (Capper, 2012; Clark and Tilman, 2017). The cost of the spillover can be magnified if the grass-fed beef production system—as some have argued—incurs higher inputs of land and costlier supply chains (Van Loo, Alali, and Ricke, 2012; Lupo et al., 2013; Hayek and Garrett, 2018; Searchinger et al., 2018; Stanley et al., 2018). Our analysis highlights this potential pitfall, as the results infer that food safety considerations factor into consumer preference for grass-fed beef.

The Federal Trade Commission (FTC) maintains that perceptions are valid criteria in formulating regulation guidelines for the marketing of eco-labels, especially if any misperception may negatively impact "reasonable consumers" (Federal Trade Commission, 2012). Arguments about what constitutes a consumer's right to believe (even if the idea is unproven) and the role of the government in protecting consumers against misperception hangs in the balance. A disclaimer stating that grass-fed beef products (or other eco-labels) do not result in different food safety risk outcomes, in the same vein as the rBST labeling policy, could be explored (Kolodinsky, 2008). While it remains debatable whether the threshold of "reasonable consumers" is exceeded, our results show that a sizeable portion of the respondents (up to 40%) is susceptible to this potential misperception.

Last, while our results provide evidence that a nonorganic eco-label *can* project a halo of food safety, the question of whether most or all eco-labels have such tendency remains unanswered. If the projection of food safety superiority applies generally to more eco-labels, it would suggest that guidelines are necessary to safeguard consumer welfare and the interest of competing producers. This issue warrants more investigation and discussion.

Conclusion

Many eco-labels are being used to signal alternative production methods. While previous literature has found that eco-labels can emit a halo effect and food safety motivates consumers to purchase organic, no concrete evidence suggests that consumers are drawn to grass-fed beef for food safety.

With a choice experiment conducted on a nationwide sample, we investigate whether consumers may prefer grass-fed beef for food safety reasons. We found evidence that food safety risk and benefit perceptions motivate the preference for grass-fed beef. Moreover, those who perceive a food safety advantage in grass-fed beef are willing to pay more for grass-fed beef, suggesting that more weight is given to food safety in purchase decisions. Overall, our results rule out the notion that preference for grass-fed beef is independent of food safety risk consideration, raising the question of whether reasonable consumers—as defined by the FTC—misinterpret or misperceive the label. Our results imply a more concerning matter: If consumers are generally expecting unsupported food safety benefits from eco-labels, then policy intervention may be necessary to adjust the distortion created by the misperception.

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Online Supplement: Consumer Preference for Grass-Fed Beef: A Case of Food Safety Halo Effect

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Table S1. Statistical Tests of Internal Consistency and Equality between Consumer Perceptions

Internal Consistency of rp	Cronbach's $\alpha = 0.7433$
"When eating beef, I am exposed to . . . (of) food safety risk." (rp)	
"I consider eating beef . . . risky, in terms of food safety."	
"Eating beef exposes me to food safety risk."	
$H_o^a : \beta_{grassfed*rp1} = \ldots = \beta_{grassfed*rp4}$	$\chi^2(3) = 26.42; P < 0.001$
$H_o^b : \gamma_{grassfed*g1} = \ldots = \gamma_{grassfed*g5}$	$\chi^2(4) = 139.75; P < 0.001$
$H_o : \beta_{organic*rp1} = \ldots = \beta_{organic*rp4}$	$\chi^2(3) = 1.89; P = 0.596$
$H_o : \gamma_{organic*o1} = \ldots = \gamma_{organic*o5}$	$\chi^2(4) = 77.93; P < 0.001$
$H_o : \beta_{organic*os1} = \ldots = \beta_{organic*os5}$ $\beta_{grassfed*gs1} = \ldots = \beta_{grassfed*gs5}$	$\chi^2(2) = 229.77; P < 0.001$

Table S2. Main-Attribute Only Mixed Logit Model

	Coefficient	Standard Deviation	Implied WTP ($)
Opt Out	−5.266***		−13.36***
	−0.126		−0.157
Price	−0.394***		
	−0.01		
Organic	0.374***	1.371***	0.949***
	−0.059	−0.065	−0.148
Grass-fed	0.297***	1.563***	0.753***
	−0.063	−0.069	−0.159
BSE-Tested	0.12 **	0.886***	0.304 **
	−0.048	−0.059	−0.122
Traceability	0.027	1.131***	0.069
	−0.054	−0.061	−0.137

Correlation Matrix	Organic	Grass-fed	BSE-Tested	Traceable
Organic	1			
Grass-fed	0.542***	1		
	−0.049			
BSE-Tested	0.577***	0.334***	1	
	−0.065	−0.074		
Traceable	0.485***	0.5***	0.936***	1
	−0.059	−0.056	−0.114	
Log-likelihood				−6611.5
Pseudo R-square				0.2552

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Figure S1. Definitions of the Attributes as Provided to the Respondents

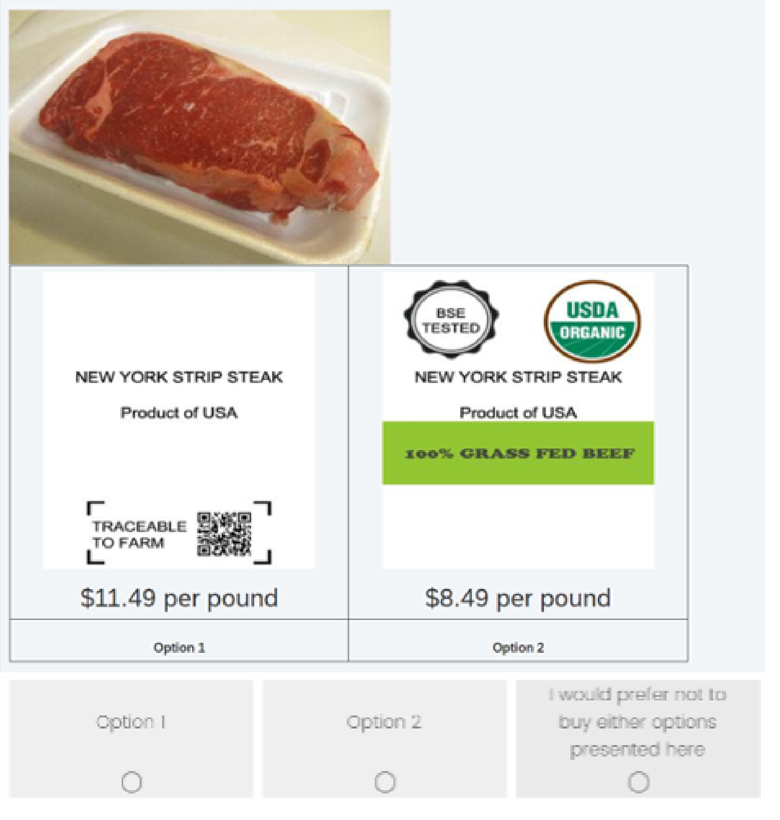

Figure S2. Example of a Choice Set