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What to Choose? The Value of Label Claims to Fresh Produce Consumers

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We examine consumer response to label information using a hypothetical choice experiment on red leaf lettuce attribute bundles. Using survey responses, several mixed logit models with random parameters and varying correlation assumptions are estimated that provide estimates of marginal utilities (and marginal values) of various attributes related to general health claims, specific nutrition and health claims, certification logos, and certified organic claims (relative to the conventional reference group) for this fresh produce product. We find that consumers distinguish between labeling claims, and that attribute bundling effects are present, suggesting the results from main effects (linear) models may be misleading. Furthermore, the results imply that consumers may value both privately and publicly appropriable benefits of alternative technologies, such as organic production.

Key words: choice experiment, conditional distribution, preference heterogeneity, produce labels, random parameters

Introduction

As a response to shifts in consumer demand toward fresher, healthier, and more nutritious food products, producers and retailers are increasingly engaging in marketing activities that highlight these characteristics. However, there are a variety of means of communicating this information. Marketers must often choose to highlight a limited set of information from among competing claims on the same or similar attributes, or between alternative attributes. An emerging set of agribusiness market analyses show marketable characteristics might include (*a*) intrinsic, verifiable product-based attributes, such as those that contribute to nutrition or health in a specific manner, and/or (*b*) process-based attributes, like organic production (Baker and Burnham, 2001; McCarthy and Henson, 2005; Thilmany, Umberger, and Ziehl, 2006; Wirthgen, 2005).

Process-based attributes may connote at least a subset of the intrinsic benefits, but may also provide additional quasi-public values to consumers, such as perceived environmental stewardship (Thilmany, Bond, and Bond, forthcoming). Furthermore, consumers do not typically choose these attributes in a separable manner one at a time. Instead, they choose the available bundle of attributes (including price) communicated on a packaged product that provides the greatest utility in the context of their overall

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diet, food budget, and purchase motivations (Wansink, Sonka, and Hasler, 2004; Williams, 2005; Balasubramanian and Cole, 2002; Loureiro, Gracia, and Nayga, 2006; Teisl, Bockstael, and Levy, 2001).

Both private marketers (looking to identify and/or develop a market) and public organizations (looking to provide consumer information or change behavior) have an interest in understanding consumer response to alternative product information provided at point-of-sale. Three key empirical questions thus present themselves: (*a*) How do consumers respond to and value alternative claims on product and process-based attributes? (*b*) Are these responses independent or do attributes exhibit substitutability/complementarity? and (*c*) To what degree is there heterogeneity among consumers on these values?

This article addresses these issues through the use of a hypothetical choice experiment on red leaf lettuce attribute bundles. Using survey responses, several logit models are constructed to provide estimates of marginal utilities (and with the inclusion of varying prices, marginal values) of various attributes related to general health claims, specific nutrition and health claims, certification logos related to health and nutrition currently found in the marketplace, and certified organic claims.

This analysis makes several contributions to the literature in addition to testing for the most effective marketing information (defined through increased choice probabilities or willingness to pay) for our hypothetical red leaf lettuce product.

- First, multiple claims of product (health and nutrition) and process (organic production) attributes may appear on a label, some of which may be "certified" from nonproducer groups. Furthermore, the choice sets are presented using graphically designed labels in an attempt to mimic what information and choices a consumer might have during the actual purchasing experience. While this is not entirely unique and is becoming more common (see, e.g., Matsumoto, 2004; Hu et al., 2004), previous choice set experiments with a focus on labeling information have tended to focus on the presence or absence of one specific process-based claim, such as the presence of GM ingredients.[1] In real markets, consumers often face choices with potentially competing and/or complementary (and perhaps imperfectly understood) product and process information on the same label. Furthermore, as argued by Bateman et al. (2008), visual representations may help alleviate biases inherent in multi-attribute choice experiments. Consequently, further investigation of behavior in this context is warranted.

- Second, we explicitly allow for attribute interactions in our model through the experimental design, thus providing an opportunity to test for linearity in consumer response to certain claims. In a marketing context, this is equivalent to testing the effect of attribute bundling. In other words: Is the marginal effect of the presence of multiple attributes greater than, equal to, or less than the sum of the marginal effects for each attribute? For private producers, this information is useful in designing marketing strategies (e.g., deciding which information to include on a package and in which combination). For the public sector, this information can be used in a similar way to increase the effectiveness of programs aimed to change

[1] Hu et al. (2004) include a GM attribute, a health attribute, and an environmental attribute, while Matsumoto (2004) includes calorie, fat, GM, and a domestic attribute.

behavior, such as programs designed to promote healthy eating. Prior choice set applications tend to focus on main, or linear, marginal effects. A notable exception is Hu et al. (2004).

- Finally, we discuss the implications of our models as they relate to heterogeneity of preferences between consumers. As consumer heterogeneity is the basis for market segmentation and the ability to develop niche markets for producers, estimates of the relevant parameter distributions are of considerable significance for both marketers and econometric practitioners (Allenby and Rossi, 1999; Rossi, McCulloch, and Allenby, 1996). Differences across main effect and interaction model estimates imply potentially different niche market sizes, mean willingness to pay, and the degrees of heterogeneity in the sample. Note, however, that the statistical methods used in this paper are fairly well established.

Background

There are a wide variety of nutrient and health claims allowable on the labels of food products, depending on the regulatory constraints placed on such claims by individual nations (Williams, 2005). In addition to nutrient content claims listing the qualitative or quantitative level of a particular attribute in a product (e.g., nutrient contest lists or claims such as "sugar free" or "low sodium"), the World Health Organization has characterized three types of health claims: (*a*) nutrient function claims, which describe the relationship between a nutrient and "normal" body function and development; (*b*) other function claims, which may "improve or modify" body function or development; and (*c*) disease risk-reduction claims, which relate food consumption to the probability of illness (Williams, 2005; Hawkes, 2004). In the United States, the relevant legislation is the 1990 Nutrition Labeling and Education Act (NLEA) and the associated 1994 rules implemented by the U.S. Food and Drug Administration (Roe, Levy, and Derby, 1999). In essence, the regulations require packaged foods to display nutrient information in the format of the Nutrition Facts panel, as well as regulating serving size information, health claims, and descriptions of relevant nutrient content (Balasubramanian and Cole, 2002).

A number of factors contribute to the relationship between food labels and consumer choice. In addition to price and taste, individual characteristics (such as sociodemographic traits, product, nutrition, health knowledge and experience, interest in general health issues, and skepticism of advertising claims) interact with the information content of the label and the aggregate information environment (e.g., a recent health scare widely reported in the media) to influence a purchasing decision (Wansink, Sonka, and Hasler, 2004; Williams, 2005; Balasubramanian and Cole, 2002; Loureiro, Gracia, and Nayga, 2006; Teisl, Bockstael, and Levy, 2001). Clearly, these variables and their interactions are likely to result in a great deal of preference heterogeneity across any population of food consumers. Thus, structural models of consumer response to nutrient and health claims that attempt to segment consumers by individual and environmental characteristics are likely to be very data intensive and costly. In the current study, however, we use a less structured approach to represent and test these differences across consumers, without using traditional sociodemographic explanatory variables. Nevertheless, it should be noted that these characteristics could be incorporated into the analysis (by, for example, assuming a functional form for the mean of the random variables and estimating the associated parameters). We choose not to do so in order (*a*) to illustrate the estimation of heterogeneity when these data are not available, and (*b*) to focus primarily on differences between the main effects and attribute interaction parameter distributions using only a constant mean.

Previous research has investigated a number of specific hypotheses about consumer behavior and nutrition, health, and production process information. In response to NLEA, a considerable number of studies investigated preferences, use, and effectiveness of the Nutrition Facts label in the United States and the (potential) impact of similar labeling overseas (Gracia, Loureiro, and Nayga, 2007, and citations therein; Loureiro, Gracia, and Nayga, 2006; Wansink, 2003; Mojduszka and Caswell, 2000; Zarkin and Anderson, 1992; Padberg, 1992; Baltas, 2001), with mixed results regarding label use and changes in behavior. Roe, Levy, and Derby (1999) found that front-label health and nutrient claims resulted in a shift of attention away from the back-label Nutrition Facts and toward the claims, resulting in a perception of more health benefits than claimed (termed "halo" effects and/or "magic bullet" effects). Subsequently, Wansink, Sonka, and Hasler (2004) concluded short health claims on front labels tend to communicate benefits more succinctly and result in greater positive thoughts regarding product attributes than longer claims. Teisl, Bockstael, and Levy (2001) tested the effects of front-label nutrient content claims on grocery purchases of a number of common products, and found that while these claims tended to change behavior, the "healthy" alternative was not always preferred. However, other studies have contradicted some of these results, suggesting that either the Nutrition Facts label was predominantly used or that front-label health claims did not affect preferences (Williams, 2005; Keller et al., 1997; Mitra et al., 1999).

A related literature examines process-linked preferences and labeling, with a particular focus on organic or ecolabeled products and genetically modified (GM) foods. With respect to the latter, the labeling issue is particularly important due to significant domestic and international trade issues and perceptions of risk (Carlsson, Frykblom, and Lagerkvist, 2007; Gruere, 2006; Bond, Carter, and Farzin, 2003). Blaine, Kamaldeen, and Powell (2002) provide a recent review of consumer preferences toward labeling and other GM issues, while Roe and Teisl (2007) investigated the effects of the form of the label claim (presence or absence of GM ingredients) and the credibility of certifying agencies (USDA vs. FDA) on stated preferences. Interestingly, these authors found language that admits uncertainty of health or environmental impacts of GM processes on a label does not affect consumer response—which may be of some relevance to this study due to the uncertainty regarding the links between nutrient content and health (as well as only sparse evidence of the connection between nutrition, health, and organically produced foods). Kiesel, Buschena, and Smith (2005) analyzed revealed preference data in the fluid milk market, concluding that a segment of consumers do have preferences for recombinant bovine growth hormone-free milk, and that this demand has a positive relationship with voluntary labeling.

While consumer utility has generally been found to be nonincreasing in the presence of GM food attributes, organic and other ecolabeled foods tend to have nonnegative effects on consumer utility. A number of studies have examined consumer preferences for organic products [see Yiridoe, Bonti-Ankomah, and Martin (2005) for a recent review], most finding at least a subset of consumers willing to pay a premium for organic produce and marginally related process attributes such as local production and GM-free (Loureiro and Hine, 2002; Giraud, Bond, and Bond, 2005; Thompson and Kidwell, 1998). Batte et al. (2007) extended the analysis to multi-ingredient processed organic food labeled under the USDA's National Organic Program.

This study spans the presented literature by investigating consumers' (stated) preferences for various attribute claims on a hypothetical front label for packaged fresh produce—namely, red leaf lettuce. We combine nutrient and health claims (nutrient content, nutrient function, and disease risk reduction) with government-sponsored program and nonprofit organization labels of varying familiarity, as well as an organic process attribute in an experimentally designed choice experiment. By including all of these possible claims, we span much of the potential marketing information that could be used to promote a healthy produce product (or even a "functional" food) in a manner consistent with the point-of-purchase marketing information available to consumers.

Methods

Choice experiments are emerging as a popular tool to estimate nonmarket and/or unobservable valuations of goods or product attributes by decomposing relative utility into component, or marginal, effects. Particularly advantageous is the ability to value multiple attributes simultaneously, the consistency of choice experiments with random utility theory, and the similarity of the hypothetical choice posed to each respondent to real-world decisions faced every day (Lusk and Schroeder, 2004; Adamowicz et al., 1998). In addition, there is some evidence that this methodology reduces hypothetical bias relative to contingent valuation, at least in terms of marginal willingness to pay (Lusk and Schroeder, 2004; Carlsson and Martinsson, 2001). Nevertheless, in many cases, the models rely solely on stated, rather than revealed preference data, and results are conditional on exogenous analyst assumptions regarding error correlations and parameter distributions.

Previous choice studies have investigated attribute valuations of a number of food products, such as beef (Lusk, Roosen, and Fox, 2003; Tonsor et al., 2005), salmon (Alfnes et al., 2006), coffee (Arnot, Boxall, and Cash, 2006), apples (Kaye-Blake, Bicknell, and Saunders, 2005), vegetables (Hearne and Volcan, 2005), extra-virgin olive oil (Scarpa and del Giudice, 2004), and ingredients in beer (Burton and Pearse, 2002). Choice experiments related to labels have focused on process-based claims such as GM and ecolabeled products (Carlsson, Frykblom, and Lagerkvist, 2007; Hearne and Volcan, 2005; Matsumoto, 2004), though a few have looked at labels relating to other process-based attributes, such as grain-fed veal (West et al., 2002) and a "quality and safety" label on liver sausages (Enneking, 2004). To the authors' knowledge, only Teratanavat and Hooker (2006) have presented the results of a choice experiment including multiple health, nutrient, and process claims on the same label, although Hu et al. (2004) include one health and two process-based attributes ("environmentally friendly" and a GM attribute) in a descriptive format, rather than a graphically designed label.[2]

[2] This study of Ohio households used three health levels, organic vs. conventional production, and source of nutrients (natural vs. fortified), as well as price, as attributes in a soy tomato juice product. Graphical labels were not used in the Hu et al. (2004) paper.

Table 1. Summary Statistics of Socioeconomic and Demographic Characteristics (n = 1,549)

Category	Description	Mean	Standard Deviation
Age	Respondent's age in years	51.07	14.70
Gender	= 1 if female	0.74	0.44
Weekly Grocery Expenditures	1 = Less than $50 2 = $50 to $99 3 = $100 to $149 4 = $150 to $199 5 = $200 to $299 6 = $300 or more	2.36	1.01
Household Income	1 = Less than $30,000 2 = $30,000 to $49,999 3 = $50,000 to $74,999 4 = $75,000 and over	2.49	1.17
Household Size	Actual number in household; range = 1–7 members	2.41	1.34
Life Stage	= 1 if single, no children; 0 otherwise	0.26	0.44
	= 1 if couple, no children; 0 otherwise	0.40	0.49
	= 1 if couple, at least 1 child in household; 0 otherwise	0.32	0.47
Primary Fresh Produce Source (% of sample)	Supermarket	55.65	
	Health Food Store	2.19	
	Supercenter	10.39	
	Farmers' Market	25.24	
	Direct from Producer	4.84	
	Specialty Store	1.68	

The Survey

The data used in the choice experiment were collected as part of a larger ongoing research project focusing on the supply of and demand for enhanced nutritional properties of fresh produce through selection of alternative cultivars and production methods. One component of this effort was the administration of a national online survey of produce purchasing habits, contracted to National Family Opinion (NFO) in May 2006, which included the choice experiment questions used in this analysis. A stratified sampling frame of NFO's database was used to invite 3,170 potential respondents to take the survey. A total of 1,549 surveys were completed and returned, for a response rate of 48.9%. Due to the focus of the survey on food purchases, 74% of respondents are female, consistent with the higher probability that females are the primary buyers of produce for a household. The sample is geographically and demographically representative of the U.S. population, with income and household size consistent with U.S. Census data. A summary of key socioeconomic and demographic data is presented in table 1.[3]

[3] For more information about the overall survey, interested readers are referred to Bond, Thilmany, and Keeling Bond (2008), and Keeling Bond, Thilmany, and Bond (2006).

Table 2. Attributes and Levels in the Choice Experiment

Variable	Value	Description
General Marketing Attribute		
	0	Selected for natural benefits! (base)
Gen	1	More natural nutrition for a healthy immune system!
Nutrient Attribute		
	0	None (base)
Vit C	1	Excellent source of vitamin C, an antioxidant nutrient
Health Attributes		
	0	None (base)
Health A	1	Healthy diets rich in fruits and vegetables may reduce the risk of coronary heart disease and some types of cancer.
Health B	1	Vegetables like red leaf lettuce that contain dietary fiber, vitamin A, and vitamin C may reduce the risk of coronary heart disease and some types of cancer.
Logo Attribute		
	0	Both (base)
FiveaDay	1	Five-a-Day
AOX	1	AOX
Organic Attribute		
	0	No (base)
Org	1	Yes
Price Attribute		
Price	\$1.99	Price per 4-oz. clamshell
	\$2.99	
	\$3.99	

Experimental Design and Choice Sets

The choice experiment asked respondents to choose between two "New Red Fire" red leaf lettuce products with varying label claims and price levels, informed by comments made in the related project's consumer focus groups (centered on nutrition issues), science-based results from production studies and the food science literature (for realistic nutritional content claims), and current market price levels. In general, our goal was to include the full realm of potential label information that may influence a consumer's fresh produce decision, with specific attention to the attributes that were the focus of the research project (nutritionally superior cultivars, organic production, and prices).

In particular, as detailed in table 2, we vary two general marketing claims related to nutritional aspects of the product, a specific nutrient claim regarding vitamin C content of the lettuce, two claims relating specifically to potential health benefits that were fairly broadly defined, two logos that would theoretically certify the product was endorsed by a government or nonprofit-sponsored health program, and an organic claim. This set of attributes is consistent with the types of issues that emerged most frequently in focus group discussions on fresh produce purchasing and consumption decisions, both in probing and open-ended question formats. It should be noted that local purchases were also discussed frequently, but not included in the choice sets because of the complexity of including a local claim in a survey with national distribution.

At the mean, we expect a negative relationship between the probability of choosing an alternative and price ceteris paribus (law of demand), and a positive relationship between choice probabilities and the presence of the vitamin C claim (Rosen, 1974; Huang, 1996; Beatty, 2007), either of the two health claims, and the organic claim (Dhar and Foltz, 2005; Loureiro, McCluskey, and Mittelhammer, 2001). However, heterogeneous preferences could result in these signs being reversed for some individuals. In terms of the logos, we have no prior expectations, as some may be unfamiliar to respondents, and multiple logos might constitute a distraction or other confounding effects. In addition, these logos are clearly application-specific, with parameter results that are not readily generalized. Nevertheless, such logos are clearly present in the produce marketplace, so their inclusion adds realism to the label choices.

Inclusion of a "no claim" option for the vitamin C attribute and health claims, and a "both" option for the logos, resulted in a total of 72 unique produce labels. Three price levels were included in the final analysis, with the second ($2.99/4-oz. clamshell) roughly corresponding to observed red leaf lettuce retail prices in Colorado grocery stores immediately preceding administration of the survey (May 2006). With the exception of the price level, all attributes were dummy coded, with a base level of "none" for the vitamin C and health claims, and "both" for the logos. Choice sets were designed with two label/price options per decision, with an additional choice of no preference between the two. A software-generated fractional factorial experimental design maximizing the D-efficiency criterion,[4] with main effects and selected interactions (organic/vitamin C, vitamin C/health, health/logo), was constructed using SAS 9.1 to allow for testing of attribute bundling [see Lusk and Norwood (2005) for a comparison of design alternatives and tradeoffs involved with each]. Forty choice sets were constructed overall, with the final number chosen by the authors on the basis of efficiency, parsimony, and ease of implementation. The design resulted in low sample correlations between each attribute, with most correlations less than 0.2. As the nonprice attributes were informational in nature and, due to heterogeneity, not a priori directional in terms of utility, clearly dominated alternatives were not an issue.

Each respondent was randomly offered 8 choices from the 40 constructed choice sets, preceded by the following instructions:

> In this section, we would like you to consider a hypothetical market choice between New Red Fire lettuce products at different prices. You will be presented with a series of choices, each with three options. Two of the choices include a label describing two differently priced products with similar, but not identical, attributes. This label would appear on a plastic clamshell container holding approximately 4 ounces of the New Red Fire lettuce product. The third choice, Choice C, indicates no preference between Choices A and B. Please indicate which choice you prefer.

Accordingly, respondents at each choice occasion could choose among three alternatives with a total sample of 12,392 choices. The first choice set is displayed in figure 1.

[4] The D-efficiency criterion is a function of the geometric mean of the eigenvalues of the information matrix containing the design attributes. A high D-efficiency score implies low correlation between attributes, and thus a model with good explanatory power with low multicollinearity.

Figure 1. Choice set #1 as presented to respondents (no-preference option not shown)

Econometric Model Specification

Because development of the formal choice experiment model has been extensively discussed elsewhere (see, e.g., Louviere, Hensher, and Swait, 2000; Train, 2003; Hensher, Rose, and Greene, 2005), we only briefly state the structure of the model here. Assuming each individual i in the sample has full and complete preferences over each potential choice j for each (nonindexed) choice occasion, the utility obtained from j is represented as:

$$U_{ij} = V_{ij} + \varepsilon_{ij},$$

where V_{ij} is deterministic utility and ε_{ij} is a random component. An individual chooses j from the set of choices C_i only if $U_{ij} \geq U_{ik} \; \forall \, k \in C_i$, and thus the probability of choosing j can be written as $\Pr\{j \text{ chosen}\} = \Pr\{V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik}\}$ for each k. Parameterizing the deterministic portion of utility (linearly) and assuming the ε_{ij} are distributed Type I extreme value, the probability statement can be rewritten as:

$$(1) \qquad \Pr\left\{j \text{ chosen} \mid \mathbf{X}_{ij}, \boldsymbol{\beta}\right\} = \frac{e^{V_{ij}(\mathbf{X}_{ij}, \boldsymbol{\beta})}}{\sum_{k \in C} e^{V_{ik}(\mathbf{X}_{ik}, \boldsymbol{\beta})}},$$

where $\mathbf{X}_{ij}$ is a vector of individual characteristics or choice-specific attributes and $\boldsymbol{\beta}$ is a vector of parameters to be estimated.

In the simplest case, there is no unobserved heterogeneity, the ε_{ij}s are independent and identically distributed (i.i.d.), and (1) is a multinomial logit (MNL) model. However, with the statistical assumption of i.i.d., the MNL suffers from the implied independence of irrelevant alternatives (i.i.a.) behavioral assumption, which if not met, results in biased and inconsistent coefficient estimates. An alternative is the mixed logit (ML), also called the random parameters logit (RPL) model, which allows for a relaxation of this assumption (via correlations in the error term between alternatives and choices) by assuming that a subset of the parameter vector varies by individual i according to an analyst-specified distribution.[5] Most generally, the parameter vector could be decomposed into fixed and random components specified as follows:

$$\begin{bmatrix} \boldsymbol{\beta}_F \\ \boldsymbol{\beta}_{iR} \end{bmatrix} = \begin{bmatrix} \bar{\boldsymbol{\beta}}_F \\ \bar{\boldsymbol{\beta}}_R + \boldsymbol{\Omega}_R \boldsymbol{\Gamma}_i \end{bmatrix},$$

where $\bar{\boldsymbol{\beta}}_F$ and $\bar{\boldsymbol{\beta}}_R$ are parameter means for the fixed and random parameters, respectively, $\boldsymbol{\Gamma}_i$ is a vector of random variables distributed according to the assumption made by the analyst (typically normal, as is the case in this paper) that accounts for heterogeneity across respondents, and $\boldsymbol{\Omega}_R$ represents the structure of the (symmetric) variance-covariance matrix of $\boldsymbol{\beta}_{iR}$. In this case, the left-hand side of (1) is conditional on the mean and variance parameters characterizing the random coefficients, as well as the assumed joint distribution of the random parameters. The panel nature of the data is exploited by assuming each individual in the sample is unique, but admits identical preferences across choice occasions. Estimation is carried out via maximum simulated likelihood (see Stern, 1997; Hensher, Rose, and Greene, 2005; Train, 2003).

Results

Unlike previous studies (e.g., Lusk, Roosen, and Fox, 2003; Hu, Adamowicz, and Veeman, 2006), we chose not to report results for the MNL model specifications for several reasons. First, using a Hausman test based on restricted alternatives in each choice set (Hausman and McFadden, 1984), the assumption of i.i.d./i.i.a. is rejected with p-values less than 0.0001. Second, coefficient ratios between MNL and ML models are similar in sign and magnitude, thus adding little to the economic discussion. We therefore focus discussion on only the ML model results. All estimation was performed using NLOGIT 3.0.25 using 100 Halton draws and (multivariate) normal distributions for the random parameters (Train, 2000).

Linear/Main Effects Models

Table 3 provides estimation results for four ML models: two with no interaction terms assuming either uncorrelated or correlated main effects random coefficients, and two with interaction terms and similar assumptions on parameter correlations. Following Ruud (1996), we assume the price parameter is fixed in each specification, and further assume interaction coefficients are fixed as well. As such, these parameters essentially shift only the mean of the main effect parameter distributions. A fully random specification with full correlation was estimated (121 parameters), and a likelihood-ratio test rejected zero restrictions on the additional coefficients.[6] However, the diagonal elements of the Cholesky matrix (used to estimate the covariance of the random parameters) associated with the interaction terms were jointly insignificant, and qualitative results in terms of parameter ratios and correlations of main effects were similar. Hence, this specification adds little to the discussion, and is not included here.

[5] The nested logit model also relaxes this assumption.

[6] These results are available from the authors on request.

Table 3. Mixed Logit (ML) Model Results with Alternative Restrictions and Correlation Structures

	— MAIN EFFECTS ONLY —			
	No Correlations		Full Correlations	
Variable	Mean	Standard Deviation	Mean	Cholesky Diagonal
Gen	0.364***	1.103***	0.360***	0.603***
	(0.050)	(0.064)	(0.045)	(0.053)
Vit C	0.092**	0.824***	0.159***	0.115
	(0.043)	(0.062)	(0.041)	(0.109)
Health A	1.038***	1.283***	1.126***	0.412
	(0.060)	(0.070)	(0.068)	(0.346)
Health B	0.714***	0.761***	0.826***	0.085
	(0.053)	(0.082)	(0.060)	(0.259)
FiveaDay	0.292***	0.758***	0.269***	0.207
	(0.053)	(0.075)	(0.055)	(0.230)
AOX	0.113**	0.447***	−0.027	0.077
	(0.051)	(0.102)	(0.053)	(0.226)
Org	0.355***	1.307***	0.359***	0.764***
	(0.053)	(0.062)	(0.049)	(0.071)
Price	−1.480***		−1.448***	
	(0.029)		(0.022)	
Constant	−3.916***		−4.194***	
	(0.099)		(0.084)	
Org ∗ *Vit C*				
Vit C ∗ *Health A*				
Vit C ∗ *Health B*				
Health A ∗ *FiveaDay*				
Health A ∗ *AOX*				
Health B ∗ *FiveaDay*				
Health B ∗ *AOX*				
Pseudo R^2	0.267		0.306	
No. of Choices	12,392		12,392	

Notes: Double and triple asterisks (*) denote statistical significance at the 5% and 1% levels, respectively. Values in parentheses are standard errors. Cholesky diagonal elements are reported for models with full correlations. Off-diagonal elements may be significant.

[table extended . . . →]

Table 3. Extended

	— INTERACTION EFFECTS —			
	No Correlations		Full Correlations	
Variable	Mean	Standard Deviation	Mean	Cholesky Diagonal
Gen	0.346*** (0.050)	1.089*** (0.065)	0.336*** (0.044)	0.561*** (0.057)
Vit C	0.163 (0.091)	0.855*** (0.063)	0.317*** (0.098)	0.113 (0.099)
Health A	1.405*** (0.111)	1.334*** (0.071)	1.663*** (0.126)	0.299 (0.311)
Health B	0.780*** (0.103)	0.810*** (0.081)	1.044*** (0.112)	0.332** (0.154)
FiveaDay	0.034 (0.094)	0.828 (0.075)	0.199** (0.097)	0.057 (0.233)
AOX	0.515*** (0.091)	0.474*** (0.101)	0.546*** (0.094)	0.107 (0.191)
Org	0.086 (0.067)	1.310*** (0.063)	0.155** (0.064)	0.761*** (0.070)
Price	–1.475*** (0.029)		–1.437*** (0.023)	
Constant	–3.901*** (0.122)		–4.019*** (0.113)	
*Org *Vit C*	0.464*** (0.082)		0.317*** (0.087)	
*Vit C *Health A*	–0.315*** (0.098)		–0.298*** (0.107)	
*Vit C *Health B*	–0.446*** (0.103)		–0.410*** (0.104)	
*Health A *FiveaDay*	–0.012 (0.131)		–0.293** (0.134)	
*Health A *AOX*	–0.800*** (0.130)		–1.052*** (0.128)	
*Health B *FiveaDay*	0.684*** (0.121)		0.462*** (0.119)	
*Health B *AOX*	–0.348*** (0.117)		–0.614*** (0.121)	
Pseudo R^2	0.273		0.313	
No. of Choices	12,392		12,392	

Each of the four models reported in table 3 is significant at the 99% level, with individual main effects coefficients (those on the single attributes) generally significant and of the expected sign. Restricting attention to the linear (main effects) models without interactions, mean parameter coefficients corresponding to each health claim, the vitamin C claim, and the organic attribute coefficient were nonnegative, implying positive marginal utility of the claim on average. In both linear models, the mean coefficient of health claim A (focusing on healthy diets and fruits and vegetables in general) is significantly greater than that of health claim B (which mentions fiber, vitamin A, and vitamin C), even though both focused on reducing risks of coronary disease and some types of cancer. In fact, the mean coefficient on health claim A was the largest of the nonprice attributes, suggesting consumers in this sample tended to respond most to a label marketing a generally healthy diet, rather than specific product nutritional or process attributes. This finding is consistent with those from the *2007 Food & Health Survey: Consumer Attitudes Toward Food, Nutrition & Health* study conducted by the International Food Information Council (2007). When asked (without prompting) what changes they are making to improve the healthfulness of their diet, Americans indicated they are both increasing (36% in 2007 vs. 23% in 2006) and decreasing (29% in 2007 vs. 21% in 2006) consumption of specific foods and beverages, rather than noting specific vitamins and nutrients they are trying to increase in their diet.

While these results were expected, the signs on each of the nonprofit logo variables (a generally familiar "five-a-day" logo from the newly renamed Produce for Better Health Foundation and a new, unexplained antioxidant "*AOX*" logo most commonly found in branded tea products) were mostly positive (relative to the baseline of both labels). This result suggests that the probability of choosing a product with only one logo is greater than if both logos appear (or alternatively, the lack of one of the logos is a "good"). It may be that unfamiliarity with the *AOX* logo relative to *Five-a-Day* is driving this result, or perhaps multiple certification logos are distracting to respondents. In any case, we conclude that respondents distinguished between labels on the basis of the attributes included in this choice experiment, confirming similar results reported by Teratanavat and Hooker (2006).

Attribute Interactions and the Partial Quadratic Models

Although previous empirical evidence suggests linear main effects models typically account for approximately 70%–90% of the variance in linear models (Dawes and Corrigan, 1974), our experimental design allowed for testing of a few potentially significant interactions (organic/vitamin C claim, health claims/vitamin C claims, and logos/health claims). These interactions (to the exclusion of others) were chosen on the basis of a priori expectations of potential significance and the qualitative data and response patterns collected in focus groups.

The last four columns in table 3 report the models with the experimentally designed interactions included. As the models are naturally nested, joint insignificance of these effects for each correlation structure can be tested via likelihood-ratio tests, and is strongly rejected in each case (test statistic = 169.83 for the independent random parameter model, 191.89 for the fully correlated model, with critical $\chi^2_{[7]} = 18.48$ at 1%). In addition, all but one individual interaction is statistically significant. This implies nonlinear responses to bundles of alternative product claims; however, the effects tend to be claim/logo specific in terms of direction.

Negative coefficients on the health claim/*AOX*, vitamin C claim/health claim, and health claim A/*Five-a-Day* logo interactions indicate that the marginal utility of (and thus marginal willingness to pay for) any of these attributes in the joint presence of the interacted claim is less than if it appeared alone. For example, in the full correlations interaction model, the marginal utility of including the vitamin C claim (on average) is:

(2) $$MU_{vit\text{-}C} = 0.317 - 0.298HealthA - 0.410HealthB + 0.317Org,$$

where *HealthA*, *HealthB*, and *Org* are dummy variables, and $HealthA + HealthB \leq 1$.[7] As such, the marginal utility of the vitamin C claim in the presence of either health claim is clearly less than if it appeared without them. In other words, attributes associated with negative interaction terms tend to be substitutes for each other, perhaps due to the perception of repetition in label information. One example is the higher relative magnitude of the interaction term for health claim B (vs. claim A) and vitamin C, since this more specific health claim also mentions the vitamin C content of red leaf lettuce.

On the other hand, the positive coefficients on organic/vitamin C and health claim B/*Five-a-Day* logo imply a complementary relationship between the attributes. For example, the marginal utility of the vitamin C claim is greater when organic production is indicated on the label as well [see equation (2)]. One explanation is that the response to the organic attribute is due to public good aspects of the production process, while the addition of the nutrient claim induces a response to organic production that takes both public and private benefits into consideration. Alternatively, consumers may still be searching for relevant benefits from organic produce, so that bundling claims conveys information about the unfamiliar or possibly ambiguous product certification. Note also that the joint presence of the more specific health claim B with the (presumably more familiar) *Five-a-Day* logo on a red lettuce label would appear to be an excellent marketing strategy.

Willingness to Pay

With inclusion of a price attribute in the choice exercise, the dollar value necessary to equate utility levels across choices with different attribute sets can be computed, and thus marginal WTP (or the value of attribute inclusion on any label) for a particular attribute can be recovered through coefficient ratios.[8] In this context, these values could be considered premia (or discounts) that could be charged for alternative red leaf lettuce attributes without materially affecting an individual choice.

Table 4 presents a subset of the point estimates of marginal WTP for each attribute for the full correlations partial quadratic interactions model reported in the last column of table 3. Table 4 values represent the marginal WTP for attribute inclusion in the joint

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[7] More generally, marginal utility from inclusion of attribute *j* is of the form

$$MU_j = \hat{\beta}_j + \sum_{k=1}^{K} \hat{\beta}_{jk} X_k,$$

where X_k are dummy variables representing the absence or presence of attribute *k*, and $\hat{\beta}_j$ and $\hat{\beta}_{jk}$ are coefficient estimates on dummy variable X_j (a single attribute) and dummy variable $X_j X_k$ representing interactions, respectively.

[8] Recall that in choice models, WTP for an attribute is calculated through the ratio of a nonprice attribute coefficient to the price attribute coefficient, the latter of which is assumed fixed here. Thus, the distributions of WTP are directly proportional to the distributions associated with each random parameter.

Table 4. Marginal Value of Attribute Inclusion on Label (marginal willingness to pay) Conditional on the Presence of Zero or One Related Attributes

Attribute	Jointly Claimed With ...			
	None	*Health A*	*Health B*	*Org*
Vit C	0.22***	0.01	−0.06	0.44***
	(0.068)	(0.058)	(0.055)	(0.064)
	None	*Vit C*	*FiveaDay*	*AOX*
Health A	1.16***	0.95***	0.95***	0.43***
	(0.088)	(0.087)	(0.080)	(0.071)
Health B	0.73***	0.44***	1.05***	0.30***
	(0.079)	(0.072)	(0.071)	(0.072)
	None	*Health A*	*Health B*	
FiveaDay	0.14***	−0.06	0.46***	
	(0.068)	(0.064)	(0.061)	
AOX	0.38***	−0.35***	−0.05	
	(0.066)	(0.063)	(0.058)	
	None	*Vit C*		
Org	0.11**	0.33***		
	(0.044)	(0.046)		
	None			
Gen	0.23***			
	(0.031)			

Notes: Double and triple asterisks (*) denote statistical significance at the 5% and 1% levels, respectively. Table values indicate the negative of the marginal utility of attribute inclusion on label divided by marginal disutility of price for the interaction model with full parameter correlations. Direct column indicates marginal value of inclusion when all interaction terms equal zero. Other columns report the marginal value if attribute in column heading is present, with all other interaction terms equal to zero. Multiple interactions not included. Asymptotic standard errors (in parentheses) calculated via the delta method using mean coefficient estimates and associated standard errors from table 3. Additional marginal values can be calculated using interaction variable coefficients in table 3. For example, the marginal value of the vitamin C attribute conditional on the presence of both the organic and health A claims equals (0.317 + 0.317 − 0.298)/1.437 = $0.234.

presence of the attribute listed in the column heading, calculated as the negative ratio of the marginal utility [as in equation (2)] and the price coefficient. For example, the marginal WTP for the vitamin C attribute on a product label without either health claim or the organic attribute is calculated as 0.317/1.437 = $0.22, while marginal WTP for this same attribute on a label with health claim A (but not health claim B or the organic attribute) is (0.317 − 0.298)/1.437 = $0.01. Similarly, the marginal value of vitamin C on a label appearing with the organic attribute (but neither health claim) is (0.317 + 0.317)/1.437 = $0.44. Multiple interactions are not reported in the table, but can be calculated from the coefficient estimates in table 3. Standard errors for marginal WTP are calculated via the delta method using the estimated variance-covariance of the estimated mean coefficients in table 3.[9]

[9] As such, the standard errors reported in table 4 do not account for the standard deviation parameter estimates (or their associated standard errors) used to represent heterogeneity across the sample. Rather, they capture the statistical inefficiency of the mean attribute estimates only. A full information simulation that incorporates the covariance matrix parameters and their associated standard errors could also be performed, and would tend to increase the variance for each WTP ratio.

When appearing without interacted terms, health claim A appears to be worth the most of all the individual attributes when presented alone at approximately $1.16, while health claim B is second and worth a significantly lower $0.73 (relative to the baseline with neither health claim). Note, however, that the presence or absence of other attributes can greatly affect the marginal value of inclusion of any claim, and in all cases except the organic/vitamin C and health B/*Five-a-Day* interactions, the sign of this effect is negative. In other words, the total value of the included attribute bundle is *less* than the sum of the individual attribute linear effects.

As noted, however, this is not the case for the organic and vitamin C attributes, suggesting complementarities in value between these two claims. The organic production premium without additional information regarding vitamin C is worth $0.11 at the mean (a 3.7% premium over the $2.99 base price), but a positive interaction effect increases the value of the *bundled claims* of vitamin C source and organic production to (0.317 + 0.155 + 0.317)/1.437 = $0.55, or an approximate 18% price premium.[10]

In contrast, another section of the survey used a payment card to elicit willingness to pay for a variety of attributes associated with melons and potatoes (as opposed to the red leaf lettuce product considered in the choice experiment). In that case, the organic premium, when stated alone, garnered a 22% (for melons) to 37% (for potatoes) premium from the respondents, which rose to 26% for melons when bundled with a claim about higher vitamin C content and local production. For potatoes, the premium actually declined (from 37% to 33%) when organic was bundled with purple color and an antioxidant claim (although that format does not let us assess pairwise bundling of just two of the claims).

This set of results suggests consumers may believe that the bundle validates organics as a higher quality product, but it is dependent on the additional claim(s), with nutritional and local claims showing the greatest impact. In fact, although the product/label worth the most (defined as the bundle of attributes with the highest mean utility) includes the general claim regarding a healthy immune system (health claim A), the vitamin C claim, and is certified organic. In the model without correlations, inclusion of the *Five-a-Day* claim increases WTP for the combined attribute bundle still further.

While these point estimates are likely the most familiar to the reader, the random parameters of the model suggest there is heterogeneity in marginal WTP for each associated attribute. This is discussed in the next subsection.

Parameter Correlations

As discussed above, a panel mixed logit specification allows for variation in preference parameters across individuals, implying a distribution of estimated parameters and willingness to pay across the sample. In addition, this model allows for correlations across the random parameter estimates, the presence of which suggests unobserved correlations across choice opportunities for each individual (Hensher, Rose, and Greene, 2005). Results can subsequently be used for market segmentation, identification of niche and specialty markets, and other applications such as optimal pricing (Scarpa and del Giudice, 2004; Allenby and Rossi, 1999).

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[10] This value can be obtained from table 4 by adding the marginal value of the organic attribute appearing jointly with the vitamin C claim and the marginal value of the vitamin C claim alone, or alternatively adding the marginal value of the vitamin C attribute appearing jointly with the organic claim and the marginal value of the organic claim alone.

Table 5. Cholesky Decomposition of Covariance Matrix and Associated Correlation Matrix, Partial Quadratic Interaction Model

	Gen	Org	Vit C	Health A	Health B	FiveaDay	AOX
— Cholesky Matrix —							
Gen	0.561***						
Org	0.585***	0.761***					
Vit C	0.488***	0.273***	0.113				
Health A	1.265***	0.046	−1.000***	0.299			
Health B	0.941***	−0.182	−0.512***	−0.256	0.332**		
FiveaDay	0.679***	−0.075	0.121	−0.111	0.203	0.057	
AOX	0.273***	−0.049	0.021	−0.116	0.122	−0.066	0.107
— Correlation Matrix —							
Gen	1.000						
Org	0.609	1.000					
Vit C	0.856	0.901	1.000				
Health A	0.771	0.492	0.552	1.000			
Health B	0.808	0.368	0.529	0.846	1.000		
FiveaDay	0.926	0.483	0.776	0.583	0.804	1.000	
AOX	0.783	0.366	0.615	0.502	0.800	0.881	1.000

Notes: Double and triple asterisks (*) denote statistical significance at the 5% and 1% levels, respectively, for Cholesky terms.

Although common practice is to assume the random parameters are independent,[11] likelihood-ratio tests on our data suggest correlated parameters (test statistic = 1,062.48 for the no-interactions model, 1,084.52 for the interactions model, with critical $\chi^2_{[21]}$ = 38.93 at 1%).[12] Estimation results for the models with correlated parameters are presented in table 3. Using the diagonals of the Cholesky-decomposed covariance matrix as suggested by Hensher, Rose, and Greene (2005),[13] the general marketing attribute and organic coefficients have standard deviation estimates significantly different from zero in the linear/main effects model, while these and the coefficient on health claim B are significant in the interactions model.

The full Cholesky decomposition for the interaction model (preferred on the basis of likelihood-ratio tests) and corresponding correlation matrix is reported in table 5, and shows significant and positive covariances between the general claim and all other random parameters, as well as the vitamin C and organic, health claim A, and health claim B coefficients. All correlations were positive, and we focus on this model in the discussion that follows.

As the general marketing claim states, "More natural nutrition for a healthy immune system," it is perhaps not surprising to find high correlations with the vitamin C nutrient

[11] One supposes that this will change as a greater number of statistical packages offer pre-programmed routines for correlated parameter estimation.

[12] In addition, the correlated parameters model appears to more accurately recreate the population parameters at the mean of the conditional distribution.

[13] The Cholesky-decomposed covariance matrix is defined as the lower-triangular matrix Γ such that the covariance matrix $\mathbf{\Omega}_R = \Gamma\Gamma'$.

claim and the two health claims. More interesting, however, is the high correlation between the vitamin C claim and the organic claim. A positive correlation suggests that those respondents who value organic production also tend to highly value vitamin C content, which is clearly a privately appropriable benefit. While we have no means of formally testing for it, this result suggests that attributing value in organic produce to solely environmental or public good considerations or to solely privately appropriable benefits may be misleading.

Two different focus group exercises held in Colorado in the summers of 2005 and 2006 tend to validate our experimental result. In both cases, the perceived safety (not tested here) and nutritional benefits of organic production were raised in open-ended question formats significantly more often than environmental benefits expected from supporting organic production systems. Among industry market analyses, there is also some support for this idea. In Whole Foods' 2005 Trend Tracker study, which it uses to evaluate and track the organic consumption habits of Americans, of those who regularly consume organic foods and beverages, nearly three-quarters (72.4%) of respondents said that organic foods have more nutrients than traditional products, and 87.6% believed organic foods are better for their health (http://www.wholefoodsmarket.com/pressroom/pr_11-18-05.html). In contrast, only 52.4% believed organic foods were "better for the environment."

Preference Heterogeneity

The estimated joint distribution of the parameters in the linear (main effects) and partial quadratic interaction models can be used to simulate the price discount necessary to exactly compensate an individual for the lack of an attribute bundle relative to the baseline label. Alternatively, this same dollar figure can be interpreted as the price premium an individual would be willing to pay to obtain the attribute bundle and keep utility constant. We define this compensation as "total relative WTP" to distinguish it from the marginal value of one particular attribute.

For example, the mean total relative WTP for a lettuce product with the vitamin C, organic, and health claim A attributes can be defined as:

$$Total\ WTP = -\frac{\left(\beta_{vit\text{-}C} + \beta_{org} + \beta_{HealthA} + \beta_{org*vit\text{-}C} + \beta_{vit\text{-}C*HealthA}\right)}{\beta_{price}},$$

where the interaction coefficients $\beta_{org*vit\text{-}C}$ and $\beta_{vit\text{-}C*HealthA}$ are restricted to be equal to zero in the linear main effects model.[14] In addition, by drawing from the estimated joint distribution of the random coefficients, we can trace the distribution of total relative WTP, thus providing information about the nature of preference heterogeneity across the sample.[15]

[14] Note that for an indirect utility function of the form $V(a_1, a_2, p; \boldsymbol{\beta}) = \beta_1 a_1 + \beta_2 a_2 + \beta_{12} a_1 a_2 + \beta_p p$, where p is price, total relative WTP (W) for the attribute bundle (a_1, a_2) is defined implicitly as $V(1, 1, p; \boldsymbol{\beta}) = V(0, 0, p - W; \boldsymbol{\beta})$, or

$$W = -\frac{\beta_1 + \beta_2 + \beta_{12}}{\beta_p}.$$

[15] Recent results suggest there may be a propensity of ML models to overstate preference heterogeneity when there is none, mainly due to confounding of preference heterogeneity and heteroskedasticity, but that ML models tend to perform well in-sample (Islam, Louviere, and Burke, 2007).

A graphical representation of the estimated total relative WTP distributions for the organic, vitamin C, and health claim attributes based on 5,000 draws from the unconditional parameter distributions from the models with full parameter correlations is provided in figure 2, while table 6 gives additional numerical information regarding associated percentiles. These distributions were obtained by drawing from the estimated multivariate normal distribution implied by the mean and variance-covariance parameters partially reported in table 3, but excluding the standard errors of these estimates.[16]

In all but two cases (namely, the attribute bundles including health claim B), the mean total relative WTP for the attribute bundles is significantly different across the two models, with the interaction model tending to predict larger means. The one exception, however, is the organic claim appearing without additional vitamin C or health claims, which is valued significantly less ($0.11) in the model including interactions. Clearly, then, exclusion of interaction terms may bias total relative WTP estimates, and this may be especially true in the presence of general or poorly misunderstood claims.

In marketing applications, the second and higher-order moments of preference distributions are of great importance as well, as this heterogeneity forms the basis for differentiation, market segmentation, and targeted marketing campaigns (Allenby and Rossi, 1999). Figure 2 and table 6 provide information regarding the total relative WTP distributions for the organic, vitamin C, and health claim attributes included in this study. A natural segmentation that allows for a determination of potential (niche) market size is the percentage of the sample who view an attribute combination as a "good," with positive total relative WTP. For example, as observed in table 6, approximately 65% of respondents view the organic attribute as a "good" using the linear main effects model, while this percentage drops to 56% when interaction terms are included. Thus, one would expect between one-half to two-thirds of the population to be potential organic lettuce consumers (ceteris paribus) on the basis of this attribute alone. Interestingly, this estimated percentage is virtually the same when the organic attribute is bundled with the vitamin C claim for the main effects model, but jumps to slightly less than three-quarters of respondents in the interaction model. However, the largest market segment identified is for a product with the vitamin C/health claim A bundle. Dispersion, as measured by estimated standard deviations of the estimated total relative WTP, tends to be of similar magnitude across models, with slightly more heterogeneity in the interaction model.

While conceptually important for distinguishing between "good" and "bad" attributes, a WTP of zero is essentially arbitrary for the purposes of segmentation. For example, producers of high-cost produce may be interested in the potential market for those willing to pay, say, a 40% premium over the average price of a product. Here, using the interaction model, only 5% of the sample is willing to support such a premium ($1.19) for organic lettuce without bundled claims, which is fairly similar to the market share for this produce item in the U.S. market (Organic Trade Association, 2006).

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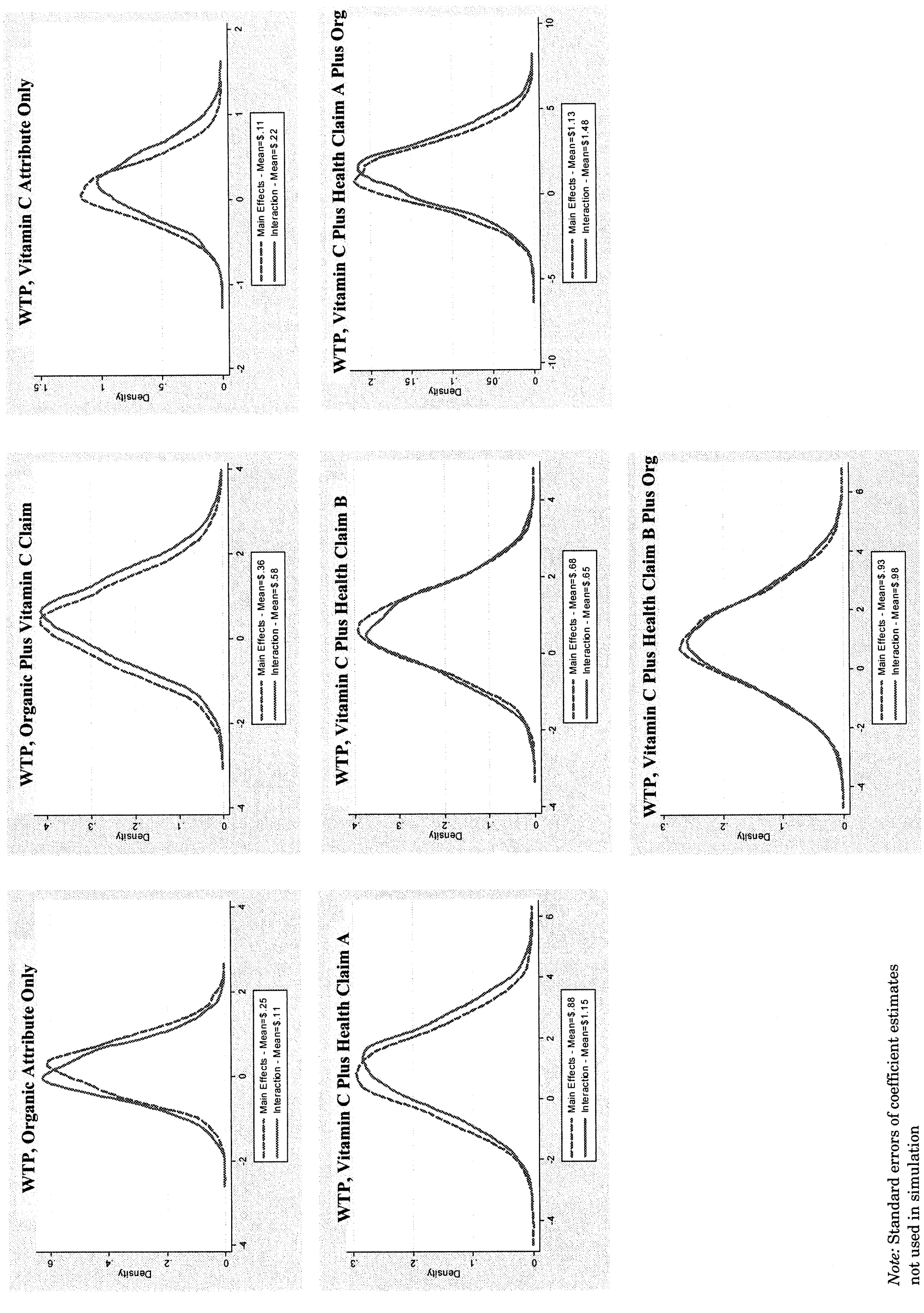
[16] The full Cholesky matrix was used to draw from the estimated distributions, but only diagonals are reported in table 3. A full information simulation incorporating both the mean/variance-covariance parameters and their associated standard errors could also be performed by first drawing a point estimate of the mean/variance-covariance parameters from the asymptotic distribution of the coefficients themselves, then using these estimates to define a multivariate normal distribution from which a subsequent draw can be made. However, as our focus here is on heterogeneity within the sample, such an exercise does not substantially change the discussion.



Note: Standard errors of coefficient estimates not used in simulation

Figure 2. Simulated total relative WTP distributions for select attribute bundles from linear main effects and partial quadratic interaction models with full random parameter correlations

Table 6. Selected Percentiles and Probabilities of Total Relative Willingness to Pay, Linear Main Effect and Partial Quadratic Interaction Models, Full Correlation Specification

		Percentile							
Description		5th	10th	25th	50th	75th	90th	95th	Pr(*WTP* > 0)
Org only	Main	–0.81	–0.60	–0.21	0.25	0.69	1.11	1.35	0.65
	Interaction	–0.96	–0.72	–0.33	0.09	0.56	0.95	1.19	0.56
Org plus *Vit C*	Main	–1.22	–0.91	–0.32	0.36	1.01	1.62	1.99	0.64
	Interaction	–1.01	–0.69	–0.10	0.58	1.24	1.85	2.22	0.72
Vit C only	Main	–0.46	–0.33	–0.12	0.10	0.34	0.56	0.67	0.62
	Interaction	–0.42	–0.28	–0.05	0.21	0.49	0.73	0.87	0.71
Vit C plus *Health A*	Main	–1.31	–0.84	0.00	0.88	1.77	2.60	3.09	0.75
	Interaction	–1.17	–0.67	0.20	1.16	2.07	2.93	3.45	0.79
Vit C plus *Health B*	Main	–0.97	–0.61	0.00	0.67	1.38	1.98	2.35	0.75
	Interaction	–1.12	–0.75	–0.07	0.63	1.37	2.05	2.44	0.73
Vit C plus *Health A* plus *Org*	Main	–1.83	–1.19	–0.08	1.11	2.32	3.45	4.16	0.74
	Interaction	–1.62	–0.89	0.21	1.48	2.71	3.96	4.62	0.78
Vit C plus *Health B* plus *Org*	Main	–1.55	–0.99	–0.07	0.91	1.92	2.86	3.40	0.74
	Interaction	–1.55	–1.03	–0.06	0.96	2.00	3.03	3.61	0.74

Note: Standard errors of coefficient estimates are not used in the simulation.

Furthermore, information about preference heterogeneity can be used in optimal pricing decisions, as detailed in Rossi, McCulloch, and Allenby (1996), and Allenby and Rossi (1999). Assuming an expected profit framework for a producer or retailer, and that the probability of purchase for an item with a particular attribute bundle over the population is equal to the probability that aggregate total relative WTP is equal to or greater than the price, one can solve for the premium that will maximize profits over the heterogeneous population. Formally, let $z_i = \Pr[WTP \geq m_i]$, where z_i is the share of the sample over support i, WTP is the total relative valuation of the attribute bundle, and m_i is the premium over the base price. Expected profits can be defined as $E[\pi_i] = z_i(p + m_i - c_i)$, where p is the base price and c_i denotes average costs per unit. Maximization of expected profits implicitly defines the profit-maximizing premium, which depends on the structure of the heterogeneity (z), base price, and average costs. In our specific case for the vitamin C/organic bundle, assuming p = \$2.99 and c_i = \$2.30, the optimal premium is about \$0.43, or an approximate 14.5% premium.

Conclusions and Implications

Consumers face an ever-increasing set of information and claims regarding the nutritional content of food products, the associated health effects of a product's nutritional profile, and the private and public good aspects of process-based attributes (like organic production). In addition, food markets typically offer a large number of substitutes which compete via marketing efforts to highlight the potential positive impact of nutritionally superior cultivars or products. Understanding consumer preferences and responses related to these claims and processes is not only important to producers attempting to capitalize on this information, but also to policy makers who are tasked with reducing the large number of Americans suffering from heart disease, cancer, obesity, and other ailments impacted by nutritional intake.

Against a backdrop of increased health care costs, an understanding of what factors might encourage increased consumption of healthful foods is especially important to government agencies charged with promoting nutritional options (through education and dietary guidelines) and regulating claims to protect consumer interest (through regulations on criteria needed to support claims and certifications). This article used a choice experiment to estimate the marginal utilities and WTP for a number of health, nutrition, nonprofit-sponsored logo, and production process attributes for a hypothetical brand of packaged red leaf lettuce. The results reveal that consumers do distinguish between competing claims and logos, though the impacts are not always as expected, likely due to the information set used at the time of the choice. In our experiment, general health claims relating a "healthy diet rich in fruits and vegetables" to reduction in coronary heart disease risk proved most effective in attracting consumers (i.e., the greatest marginal utility), although more specific health claims were highly valued as well. The process attribute—organic production—was not valued as highly on its own.

However, we found some evidence of attribute bundling between one health claim and the familiar *Five-a-Day* program logo, and between organic production and a claim regarding vitamin C content. These results presumably can be used to more effectively (a) market to consumers for the private sector, and (b) design programs to persuade consumers to change their behavior for the public sector. In conjunction with the bundling result, a positive correlation between parameter estimates for the organic and vitamin C attributes suggests consumers value both the privately appropriable benefits from organic production and the public attributes, and may look for additional certification standards and scientific evidence of the organic product as higher quality. The role of the government in supporting such research and thoughtfully integrating such information into existing standards is thus motivated by this study.

From a statistical standpoint, the results confirm previous findings that the MNL model (and more specifically, its associated error and behavioral assumptions) can be misleading due to a lack of accounting for preference heterogeneity within the sample. We further extend this result to empirical estimates of the distribution of the random parameters in the presence of interaction effects, and discuss how estimated market size and niches can be affected by these complementarities. In short, misspecification may create misleading impressions regarding the existence and size of specialized niche markets, the response of consumers to varying health, nutrition, or process claims, and/or the response of consumers to the introduction of new products with these (or similar) claims.

Further research is needed in order to assess the potential for generalization of these results to additional choice settings. First, these models were estimated using stated, rather than revealed, preferences, and thus the possibility of hypothetical bias is present. Methods incorporating binding scenarios (such as those in Alfnes et al., 2006; Lusk and Schroeder, 2004) could be pursued in order to alleviate this problem. Second, while we hypothesize that observed choices are significantly influenced by the information set available to an individual at the time of the response (e.g., the meaning of a logo, the nutritional content of a food, or the relationship between nutritional content and health), more research is needed to understand this relationship. At a minimum, this understanding could help identify the source of the preference heterogeneity represented by the random parameters and place individuals more precisely on the distribution. Experiments that investigate consumer response to information revelation would be helpful. Third, the product and associated attributes are clearly specific to this application, and additional claims, processes, and logos could be modeled.

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References

Adamowicz, W., P. Boxall, M. Williams, and J. Louviere. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation." *Amer. J. Agr. Econ.* 80(1998): 64–75.

Alfnes, F., A. G. Guttormsen, G. Steine, and K. Kolstad. "Consumers' Willingness to Pay for the Color of Salmon: A Choice Experiment with Real Economic Incentives." *Amer. J. Agr. Econ.* 88,4(2006): 1050–1061.

Allenby, G. M., and P. E. Rossi. "Marketing Models of Consumer Heterogeneity." *J. Econometrics* 89(1999):57–78.

Arnot, C., P. C. Boxall, and S. B. Cash. "Do Ethical Consumers Care About Price? A Revealed Preference Analysis of Fair Trade Coffee Purchases." *Can. J. Agr. Econ.* 54,4(2006):555–565.

Baker, G. A., and T. A. Burnham. "Consumer Response to Genetically Modified Foods: Market Segment Analysis and Implications for Producers and Policy Makers." *J. Agr. and Resour. Econ.* 26,2(December 2001):387–403.

Balasubramanian, S. K., and C. Cole. "Consumers' Search and the Use of Nutrition Information: The Challenge and Promise of the Nutrition Labeling and Education Act." *J. Marketing* 66(2002): 112–127.

Baltas, G. "The Effects of Nutrition Information on Consumer Choice." *J. Advertising Res.* 41,2(2001): 57–63.

Bateman, I. J., A. P. Jones, S. Jude, and B. H. Day. "Reducing Gains/Loss Asymmetry: A Virtual Reality Choice Experiment (VRCE) Valuing Land Use Change." Work. Paper No. EDM 06-16, Centre for Social and Economic Research on the Global Environment (CSERGE), Norwich, UK, 2008.

Batte, M. T., N. H. Hooker, T. C. Haab, and J. Beaverson. "Putting Their Money Where Their Mouths Are: Consumer Willingness to Pay for Multi-Ingredient, Processed Organic Food Products." *Food Policy* 32(2007):145–159.

Beatty, T. K. M. "Recovering the Shadow Value of Nutrients." *Amer. J. Agr. Econ.* 89,1(2007):52–62.

Blaine, K., S. Kamaldeen, and D. Powell. "Public Perceptions of Biotechnology." *J. Food Sci.* 67,9(2002): 3200–3208.

Bond, C. A., C. A. Carter, and Y. H. Farzin. "Medium Grains, High Stakes: Economics of Genetically Modified Rice in California." *AgBioForum* 6,4(2003):146–154.

Bond, C. A., D. D. Thilmany, and J. Keeling Bond. "Understanding Consumer Interest in Product and Process-Based Attributes for Fresh Produce." *Agribus.: An Internat. J.* 24,2(2008):231–251.

Burton, M., and D. Pearse. "Consumer Attitudes Towards Genetic Modification, Functional Foods, and Microorganisms: A Choice Modeling Experiment for Beer." *AgBioForum* 5,2(2002):51–58.

Carlsson, F., P. Frykblom, and C. J. Lagerkvist. "Consumer Benefits of Labels and Bans on GM Foods—Choice Experiments with Swedish Consumers." *Amer. J. Agr. Econ.* 89,1(2007):152–161.

Carlsson, F., and P. Martinsson. "Do Hypothetical and Actual Marginal Willingness to Pay Differ in Choice Experiments?" *J. Environ. Econ. and Mgmt.* 41(2001):179–192.

Dawes, R., and B. Corrigan. "Linear Models in Decision Making." *Psychological Bulletin* 81(1974): 95–106.

Dhar, T., and J. D. Foltz. "Milk by Any Other Name ... Consumer Benefits from Labeled Milk." *Amer. J. Agr. Econ.* 87,1(2005):214–228.

Enneking, U. "Willingness to Pay for Safety Improvements in the German Meat Sector: The Case of the Q&S Label." *Eur. Rev. Agr. Econ.* 31,2(2004):205–223.

Giraud, K. L., C. A. Bond, and J. J. Bond. "Consumer Preferences for Locally Made Specialty Food Products Across Northern New England." *Agr. and Resour. Econ. Rev.* 34,2(2005):204–216.

Gracia, A., M. Loureiro, and R. M. Nayga. "Do Consumers Perceive Benefits from the Implementation of an EU Mandatory Nutritional Labeling Program?" *Food Policy* 32,2(2007):160–174.

Gruere, G. P. "A Preliminary Comparison of the Retail Level Effects of Genetically Modified Food Labeling Policies in Canada and France." *Food Policy* 31(2006):148–161.

Hausman, J., and D. McFadden. "Specification Tests for the Multinomial Logit Model." *Econometrica* 52(1984):1219–1240.

Hawkes, C. *Nutrition Labels and Health Claims: The Global Regulatory Environment.* Paris: World Health Organization, 2004.

Hearne, R. R., and M. Volcan. "The Use of Choice Experiments to Analyze Consumer Preferences for Ecolabeled and Organic Produce in Costa Rica." *Quart. J. Internat. Agr.* 44,4(2005):381–397.

Hensher, D. A., J. M. Rose, and W. H. Greene. *Applied Choice Analysis: A Primer.* London/New York: Cambridge University Press, 2005.

Hu, W., W. L. Adamowicz, and M. M. Veeman. "Labeling Context and Reference Point Effects in Models of Food Attribute Demand." *Amer. J. Agr. Econ.* 88,4(2006):1034–1049.

Hu, W., A. Huennemeyer, M. M. Veeman, W. L. Adamowicz, and L. Srivastava. "Trading Off Health, Environmental, and Genetic Modification Attributes in Foods." *Eur. Rev. Agr. Econ.* 31,3(2004): 389–401.

Huang, K. S. "Nutrient Elasticities in a Complete Food Demand System." *Amer. J. Agr. Econ.* 78,1(1996):21–29.

International Food Information Council. *2007 Food & Health Survey: Consumer Attitudes Toward Food, Nutrition & Health.* Online. Available at http://www.ific.org/research/foodandhealthsurvey.cfm. [Accessed June 1, 2007.]

Islam, T., J. J. Louviere, and P. F. Burke. "Modeling the Effects of Including/Excluding Attributes in Choice Experiments on Systematic and Random Components." *Internat. J. Res. in Marketing* 24,4(2007):289–300.

Kaye-Blake, W., K. Bicknell, and C. Saunders. "Process versus Product: Which Determines Consumer Demand for Genetically Modified Apples?" *Austral. J. Agr. and Resour. Econ.* 49,4(2005):413–427.

Keeling-Bond, J., D. D. Thilmany, and C. A. Bond. "Direct Marketing of Fresh Produce: Understanding Consumer Purchasing Decisions." *Choices* 21(4th Quarter 2006):229–235.

Keller, S., M. Landry, J. Olson, A. Velliquette, S. Burton, and J. Andrews. "The Effects of Nutrition Package Claims, Nutrition Facts Panels, and Motivation to Process Nutrition Information on Consumer Product Evaluations." *J. Public Policy and Marketing* 16(1997):256–269.

Kiesel, K., D. Bushena, and V. Smith. "Do Voluntary Biotechnology Labels Matter to the Consumer? Evidence from the Fluid Milk Market." *Amer. J. Agr. Econ.* 87,2(2005):378–392.

Loureiro, M. L., A. Gracia, and R. M. Nayga. "Do Consumers Value Nutritional Labels?" *Eur. Rev. Agr. Econ.* 33,2(2006):249–268.

Loureiro, M. L., and S. Hine. "A Comparison of Consumer Willingness to Pay for a Local (Colorado-Grown), Organic, and GMO-Free Product." *J. Agr. and Appl. Econ.* 34,3(2002):477–487.

Loureiro, M. L., J. J. McCluskey, and R. C. Mittelhammer. "Assessing Consumer Preferences for Organic, Eco-labeled, and Regular Apples." *J. Agr. and Resour. Econ.* 26,2(December 2001):404–416.

Louviere, J. J., D. A. Hensher, and J. D. Swait. *Stated Choice Methods: Analysis and Application.* London/New York: Cambridge University Press, 2000.

Lusk, J. L., and F. B. Norwood. "Effect of Experimental Design on Choice-Based Conjoint Valuation Estimates." *Amer. J. Agr. Econ.* 87,3(2005):771–785.

Lusk, J. L., J. R. Roosen, and J. A. Fox. "Demand for Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn: A Comparison of Consumers in France, Germany, the United Kingdom, and the United States." *Amer. J. Agr. Econ.* 85,1(2003):16–29.

Lusk, J. L., and T. C. Schroeder. "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Beef Steaks." *Amer. J. Agr. Econ.* 86,2(2004):467–482.

Matsumoto, S. "Consumers' Responses to Front vs. Back Package GM Labels in Japan." *J. Agr. and Food Industrial Org.* 2,1(2004):1–23.

McCarthy, M., and S. Henson. "Perceived Risk and Risk Reduction Strategies in the Choice of Beef by Irish Consumers." *Food Quality and Preference* 16,5(2005):435–445.

Mitra, A., M. Hastak, G. Ford, and D. Ringold. "Can the Educationally Disadvantaged Interpret the FDA-Mandated Nutrition Facts Panel in the Presence of an Implied Health Claim?" *J. Public Policy and Marketing* 18(1999):106–117.

Mojduszka, E. M., and J. A. Caswell. "A Test of Nutritional Quality Signaling in Food Markets Prior to Implementation of Mandatory Labeling." *Amer. J. Agr. Econ.* 82,2(2000):298–309.

Organic Trade Association (OTA). *The OTA 2006 Manufacturers' Survey Review.* Data presented at 2008 Organic Trade Association meetings, Chicago, IL, June 2008. Overview available online at http://www.ota.com/pics/documents/2004SurveyOverview.pdf.

Padberg, D. I. "Nutritional Labeling as a Policy Instrument." *Amer. J. Agr. Econ.* 74,5(1992):1208–1212.

Roe, B., A. S. Levy, and B. M. Derby. "The Impact of Health Claims on Consumer Search and Product Evaluation Outcomes: Results from FDA Experimental Data." *J. Public Policy and Marketing* 18,1(1999):89–105.

Roe, B., and M. F. Teisl. "Genetically Modified Food Labeling: The Impacts of Message and Messenger on Consumer Perceptions of Labels and Products." *Food Policy* 32(2007):49–66.

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *J. Polit. Econ.* 82,1(1974):34–55.

Rossi, P. E., R. E. McCulloch, and G. M. Allenby. "The Value of Purchase History Data in Target Marketing." *Marketing Sci.* 15,4(1996):321–340.

Ruud, P. "Approximation and Simulation of the Multinomial Probit Model: An Analysis of the Covariance Matrix Estimation." Work. Paper, Dept. of Econ., University of California, Berkeley, 1996.

Scarpa, R., and T. del Giudice. "Market Segmentation via Mixed Logit: Extra-Virgin Olive Oil in Urban Italy." *J. Agr. and Food Industrial Org.* 2(2004):1–18.

Stern, S. "Simulation-Based Estimation." *J. Econ. Lit.* 35(1997):2006–2039.

Teisl, M. F., N. E. Bockstael, and A. Levy. "Measuring the Welfare Effects of Nutrition Information." *Amer. J. Agr. Econ.* 83,1(2001):133–149.

Teratanavat, R., and N. H. Hooker. "Consumer Valuations and Preference Heterogeneity for a Novel Functional Food." *J. Food Sci.* 71,7(2006):533–541.

Thilmany, D., C. Bond, and J. Bond. "Going Local: Exploring Consumer Behavior and Motivations for Direct Food Purchases." *Amer. J. Agr. Econ.* (December 2008): forthcoming.

Thilmany, D., W. J. Umberger, and A. R. Ziehl. "Strategic Market Planning for Value-Added Natural Beef Products: A Cluster Analysis of Colorado." *Renewable Agr. and Food Systems* 21,3(2006): 192–203.

Thompson, G. D., and J. Kidwell. "Explaining the Choice of Organic Produce: Cosmetic Defects, Prices, and Consumer Preferences." *Amer. J. Agr. Econ.* 80,2(1998):277–287.

Tonsor, G. T., T. C. Schroeder, J. A. Fox, and A. Biere. "European Preferences for Beef Steak Attributes." *J. Agr. and Resour. Econ.* 30,2(August 2005):367–380.

Train, K. "Halton Sequences for Mixed Logit." Work. Paper No. E00-278, Dept. of Econ., University of California, Berkeley, 2000.

———. *Discrete Choice Methods with Simulation.* London/New York: Cambridge University Press, 2003.

Wansink, B. "How Do Front and Back Package Labels Influence Beliefs About Health Claims?" *J. Consumer Affairs* 37,2(2003):305–316.

Wansink, B., S. T. Sonka, and C. M. Hasler. "Front-Label Health Claims: When Less Is More." *Food Policy* 29(2004):659–667.

West, G. E., B. Laurue, C. Gendron, and S. L. Scott. "Consumer Confusion over the Significance of Meat Attributes: The Case of Veal." *J. Consumer Policy* 25(2002):65–88.

Williams, P. "Consumer Understanding and Use of Health Claims for Foods." *Nutrition Science and Policy* 63,7(2005):256–264.

Wirthgen, A. "Consumer, Retailer, and Producer Assessments of Product Differentiation According to Regional Origin and Process Quality." *Agribus.: An Internat. J.* 21,2(2005):191–211.

Yiridoe, E. K., S. Bonti-Ankomah, and R. C. Martin. "Comparison of Consumer Perceptions and Preference Toward Organic versus Conventionally Produced Foods: A Review and Update of the Literature." *Renewable Agr. and Food Systems* 20,4(2005):193–205.

Zarkin, G. A., and D. W. Anderson. "Consumer and Producer Responses to Nutrition Label Changes." *Amer. J. Agr. Econ.* 74,5(1992):1202–1207.