Health Concerns and Consumer Preferences for Soy Foods:
Choice Modeling Approach

Jae Bong Chang
Graduate Research Assistant
Oklahoma State University
Stillwater, OK

Wanki Moon*
Associate Professor
Department of Food and Resource Economics
Korea University
Seoul, Korea

Siva K. Balasubramanian
Harold L. Stuart Professor of Marketing
Stuart School of Business
Illinois Institute of Technology
Chicago, IL 60661

Selected Paper prepared for presentation at the Agricultural &Applied Economics Association Annual Meeting, Milwaukee, WI, July 26-28, 2009.

*Corresponding Author:
Email: wmoon@korea.ac.kr
Tel) 02-3290-3031

Health Concerns and Consumer Preferences for Soy Foods: Choice Modeling Approach

Consumers are increasingly aware of the healthfulness of soy-based foods they consume and take such a health attribute into consideration when making soy food purchasing decisions (United Soybean Board 2007). In recognition of the health-promoting properties of soy foods, the Food and Drug Administration (FDA) allowed in 1999 food companies to use health claims on soy-derived foods containing at least 6.25 grams of soy protein per serving. From a scientific perspective, this decision was based on medical and clinical data showing that 25 grams of soy protein a day significantly lowered both total-cholesterol (TC) and low-density-lipoprotein cholesterol (LDC) in the bloodstream - the two most important modifiable risk factors for coronary heart disease (e.g., Anderson, Johnstone and Cook-Newell 1995). Cardiovascular heart disease is the number one cause of deaths in the U.S. Other clinical research has shown that soy foods provide health benefits relative to osteoporosis and cancer (Messina and Barnes 1995), lowered blood pressure and lowered blood levels of triglycerides.

In response to such scientific and regulatory developments surrounding soy-based food products, research has grown in recent years focusing on consumers' behavior toward soy foods. Specifically, Moon, Balasubramanian, and Rimal (2005) showed that consumers' perceived health benefits of soy foods significantly increase the likelihood as well as frequency of consuming soy foods. Wansink and Chan (2001) disclosed that nutritional knowledge of functional foods was associated with soy consumption, while Wansink, Westgreen, and Cheney (2005) highlighted the role of consequence-related attributes in consumers' soy food consumption decision (i.e., how a given soy food attribute will benefit them).

However, there has been little research assessing and quantifying how much consumers would be willing to pay for such health-promoting attribute of soy foods. It is important to determine and understand how the demand for health-related attributes of soy foods compares to demand for other attributes of soy foods and this issue is increasingly critical to agribusinesses and policy makers in need of research to formulate pricing and marketing strategies and to determine the welfare implications of various food labeling and nutrition policies.

The specific objectives of this research are to: 1) determine which attribute of soy foods (taste, soy protein content, health claim, and price) affects consumers' soy food choices, 2) elicit consumers' preferences for each attribute of soy foods by means of willingness-to-pay (WTP), and 3) compare estimated WTPs using different discrete choice models. To estimate consumers' WTP for each attribute in soy foods from the experiments, two econometric models – the multinomial logit and mixed logit (or random parameter logit) models – were used to fit the choice experimental data. Further, welfare change associated with health claims on soy foods was estimated.

Choice Experiments and Food Preferences

Choice models have emerged as a major tool for assigning economic values on nonmarket goods and services and as an alternative/complement to contingent valuation methods (Adamowicz, Louviere, and Swait1998; Adamovitz and Louviere 2000; Train 2003). Initial applications have focused primarily on environmental goods and services such as preservation of rainforests, Mediterranean, and Baltic Sea (Carlsson and

Martisson 2000; Rolfe, Bennett, and Louviere2000), wetlands (Carlsson et al. 2003), and river management in Western Alberta (Adamowicz, Louviere, and Williams 1994).

Stemming from conjoint analysis in Psychology and Marketing, choice modeling is a stated preference approach that is theoretically supported by McFadden's Random Utility Models. Choice modeling is based on hypothetical scenarios and hence suffers from potential overestimation problems, although some research shows that there is little difference between hypothetical and actual marginal willingness to pay derived from choice experiments (Carlsson and Martinsson 2001; Lusk and Schroeder 2004).

Choice models have several advantages when compared to contingent valuation methods. First, it explicitly considers all salient attributes associated with a product and can derive marginal value of those attributes as well as overall value for a product. This is consistent with the modern trend in behavioral sciences that appear to be experiencing a paradigmatic shift from the analysis for a whole good to emphasizing attributes/characteristics associated with the good as manifested in Lancaster's characteristics model, Fishbein's multi-attribute model, or hedonic price models. Second, choice model allows testing in consistency given the repeated nature of consumers' choices (Boxall et al.1996). Third, unlike contingent valuation methods that directly ask respondents to express the monetary value of the good under consideration, choice models consider price (cost) as one of the attributes. Therefore, a choice model is less likely to sensitize respondents about the valuation task as much as the CV methods do.

With such advantages in eliciting consumer preferences about nonmarket or new goods (with novel features), choice models are popular to analyze consumers' preferences or trade-offs between salient attributes of food products. For example, Burton et al (2001) and Rigby and Burton (2005) applied choice experiments to analyze consumer preferences for GM foods in the U.K. Lusk, Roosen, and Fox (2003) used similar approach to value beef products from cattle administered growth hormones or fed genetically modified corn. Lusk and Schroeder (2004) examined consumer preferences for beef ribeye steak with differing quality attributes. While this study is the first attempt to value salient attributes of soy-based food products using choice models, previous research (Teratanavat and Hooker2006) has examined consumer preferences for a functional food (tomato juice) fortified with soy proteins, so results from that study might be compared to ours.

Experimental Design, Sampling, and Survey Administration

This study utilized a randomized Choice Based Conjoint (CBC) research design. CBC requires subjects to choose rather than rank or rate products. This approach was popularized by Louviere and Woodworth (1983) by integrating discrete-choice modeling with conjoint analysis (Sawtooth Software 2008). CBC provides a more realistic research setting than other conjoint approaches. This is because respondents are asked to choose one out of several product profiles presented within each of several choice sets, in a manner analogous to actual shopping tasks that consumers' confront in daily life. Most notably, CBC tasks typically include the option of not choosing any of the presented products within a choice set i.e., this is accomplished by including a "No, I do not want to choose any of these" option in the choice set. This design feature accommodates the possibility of market contraction that is often observed when all the alternatives that consumers' face appear unattractive.

As shown in Table 1, our randomized CBC research design analyzed four product categories (soy burgers, soy cheese, soy milk and tofu). It specifically focused on four attributes with three levels each i.e., taste (poor, fair good), price per pack ($2.80, $2.20, and $1.60), protein per serving (6.25 grams, 15.67 grams, and 25 grams), and health claim (No health claim, general health claim, and specific health claim). For the last attribute health claim, the specific health claim highlighted the FDA-approved claim on soy foods with at least "6.25 grams of soy protein per serving may reduce the risk of heart disease." The general claim, on the other hand, merely stated this information without highlighting the FDA approval. These attributes and levels were chosen based on initial interviews with users and prior literature.

Note that the attribute levels are balanced across all four attributes. All four conjoint studies (one for each product category) were targeted at members of the Ipsos-Reid panel. The randomized characteristic of our CBC design included 100 conjoint questionnaire versions for each product category. In other words, these questionnaire versions were computer generated such that each attribute level is equally likely to occur with each level of every other attribute in the product profiles. We chose the randomized CBC approach because the many combinations of attributes and levels included in the questionnaire versions are robust in the estimation of all effects, instead of restricting focus to effects that are research interest. Additionally, the randomized CBC design minimizes problems due to order effects and psychological contexts (Sawtooth Software 2008). For each of the four product categories, the choice experiments involved 12 tasks, with each choice focusing on three profiles and a "No, I would not choose any of these" option.

The above experimental design was administered as an online survey to members of the Ipsos-NPD panel using CBC/HB package from Sawtooth Software.

Of the 400,000 households that participate in this Web panel, a random sample of 3,000 households was selected by Ipsos-NPD such that it was appropriately stratified by geographic regions, income, education, and age to match with the U.S. census. Ipsos-NPD sent e-mail solicitations to these 3,000 households seeking their participation in our survey. Each email contained a unique url (keyed to the respondent-id) that directed recipients to our survey Web site.

More than 1,300 households returned the completed questionnaire, yielding a response rate of about 47 %. The on-line survey elicited socio-demographic information including respondents' age, education, income, household size, geographic regions, marital status and ethnic background. Nearly 91 % of the respondents were whites, significantly under-representing Asians (1.8 %) and African Americans (2.8 %) in our sample, when compared to the U.S. census in 2000 (whites=75.1 %, Asians=3.6 %, Blacks=12.3 %). Income category under $30,000 was 25.8 %, while of the representation of categories $30,000~$75,000 and $75,000 ~higher were 53 % and 21.2 %, respectively when compared to the U.S. census in 2000 (35 %, 42 %, and 23 %, respectively). Therefore, the share of respondents representing the middle income category is moderately over-represented. About 32 % of the survey respondents had a bachelor's or higher degree, compared to 24.4 % of the US census. About 33 % of respondents resided in the South, followed by Midwest (24.3 %), West (23.4 %), and Northeast (19 %).

The number of respondents for each study follows: 333 (soy burgers), 317 (soy cheese), 340 (soy milk), and 321 (tofu). The research design was efficient for each product category studied (efficiency ranged between 0.97 and 1.00 per Kuhfeld, Tobias, and Garratt 1994).

Methods and Procedures

Econometric Model Specification

In the experiments, each individual answered twelve discrete-choice questions for each soy food product described by multi-attribute. Based on the random utility model of McFadden (1974), the consumer *i*'s utility of choosing option *j* is defined by

(1) $U_{ij} = V_{ij} + \varepsilon_{ij}$,

where V_{ij} is the deterministic indirect utility function and ε_{ij} is a stochastic portion. In particular, the systematic portion, V_{ij}, is assumed as a linear function of taste, soy protein, health claim, and price and can be expressed as(2)

$$\begin{aligned} V_{ij} &= \alpha_j + \beta_1 GTaste_{ij} + \beta_2 FTaste_{ij} + \beta_3 Protein_{ij} \\ &+ \beta_4 SClaim_{ij} + \beta_5 GClaim_{ij} + \delta Price_{ij} \end{aligned},$$

where α_j is an alternative specific constant that represents individual *i*'s utility for option *j* relative to "none" option, β_n is the marginal utility for *n*th attribute and δ is a marginal utility of income. $GTaste_j$ is a dummy variable that equals to 1 if alternative *j* is good taste, $FTaste_j$ is a dummy variable that equals to 1 if alternative *j* is fair taste, $Protein_j$ is an explanatory variable representing soy protein contents, $SClaim_j$ is a dummy variable that equals to 1 if alternative *j* has a specific health claim and $GClaim_j$ is a dummy variable that equals to 1 if alternative *j* has a general health claims. Assuming the stochastic component is an independently and identically distributed Type I extreme value, the standard multinomial logit model (MNL) yields the probability of individual *i* choosing alternative *j*, which can be outlined as

$$(3) \qquad \text{Prob}\{j \,\text{is chosen}\} = \frac{e^{V_{ij}}}{\sum_{k=1}^{J} e^{V_{ik}}}.$$

The MNL assumes that all consumers in the sample have identical preferences for the attributes of soy foods, where utility coefficients in equation (2) are identical across subjects. The random parameter logit (RPL) model relaxes such preference homogeneity and allows that individual tastes vary in the population. Such heterogeneity is implemented by specifying the utility coefficients as

$$(4) \qquad \beta_i = \overline{\beta} + \sigma v_i,$$

where $\overline{\beta}$ is the population mean and σ is the standard deviation of the distribution of the coefficient β_i around the mean, and v_i is an independent standard normal variable. In this application, all coefficients of attributes, except price, were assumed as random and independently normally distributed in the population. The probability that consumer *i* chooses alternative *j* becomes

$$(5) \qquad \text{Prob}\{j \,\text{is chosen}\} = \int \frac{e^{V_{ij}}}{\sum_{k} e^{V_{ik}}} f(\boldsymbol{\beta}_i) d\boldsymbol{\beta}_i,$$

where $f(\boldsymbol{\beta}_i)$ is the normal density of $\boldsymbol{\beta}_i$. Because equation (5) contains a multi-dimensional integral, the simulated maximum likelihood approach is employed to estimate parameters (Train 2003, pp 240~260).

Willingness-to-Pay and Welfare Changes Associated with Health Claims

Willingness-to-pay estimates determine the dollar amount that would make consumers indifferent between having one package of soy food and having "nothing." In general, WTP estimate to obtain soy food alternative *j* is simply calculated as the ratio of attribute coefficient to the price coefficient, - α_j / δ, where α_j is the alternative specific constant for soy food *j*. In our framework, soy foods are determined by various levels of attributes, and similarly, WTP for one unit change in the attribute is calculated by dividing the coefficient of attribute by the price parameter. For example, WTP of one gram increase in soy protein is simply $-\beta_3/\delta$. Marginal WTP for a change in the level of attributes can be calculated as $(\beta_j-\beta_k)/\delta$. The utility of the levels "poor" for taste and "no claim" for health claim were normalized to zero for identification. With fixed price coefficients, the WTP for each attribute in the RPL has the same distribution as the attribute (i.e., normal distribution). To calculate the 95% confidence intervals on WTP, we utilize the parametric bootstrapping approach proposed by Krinsky and Robb (1986). In particular, for the RPL, a sample of 1,000 individuals was created for each of the 1,000 draws associated with the coefficients and covariance matrix of the estimated model. For each simulated individual, the mean WTP was calculated.

In addition to WTP estimates, to determine the welfare impact of health claims on soy foods, we follow Louviere, Hensher, and Swait (2000) and welfare changes in the conventional MNL can be measured as follows

(6) $$CV = -(\beta_{price})^{-1}\left[\ln \sum_i e^{V_i^0} - \ln \sum_i e^{V_i^1}\right]$$

where CV represents compensating variation, β_{price} is the marginal utility of income, V^0 is initial utility level without health claims, and V^1 is utility after incorporating claims on health benefits. In the RPL, however, the coefficients are random and the expected measure requires integration over the distribution of the coefficients around the population mean. As such, the welfare change for the RPL is

$$(7) \qquad E(CV) = \int CV\, f(\hat{\boldsymbol{\beta}}_i) d\boldsymbol{\beta} = \int \left\{ -(\hat{\beta}_{price})^{-1} \left[\ln \sum_i e^{\hat{V}_i^0} - \ln \sum_i e^{\hat{V}_i^1} \right] f(\hat{\boldsymbol{\beta}}_i) d\boldsymbol{\beta} \right\}.$$

The expected measure is estimated through simulation by taking the average of repeated draws from $f(\boldsymbol{\beta}_i)$. Assuming constant price coefficients ensure that the expected welfare computation shown in equation (7) is simplified.

Results

A nationally representative random sample size of 317-340 U.S. consumers participated in the web-based choice experiments for each soy food. Table 2 presents the estimates of the MNL model for each soy-derived food. The null hypothesis that all parameters are zero is rejected by the likelihood ratio test (p-value <0.01) for all four models. For each soy-food product, all attribute parameters have expected signs including negative price coefficient and are statistically significant. The attribute of taste had the strongest impact on consumer's choices across all four soy-based food products, while protein content was the least influential attribute. The alternative specific constant for "None" indicates the utility of the "none of these" alternative relative to choosing "buying" options. The option "None" had a positive sign across the four types of soy food products. The positive sign for "None" implies that, in general, people have negative attitude or perception toward soy foods.

Table 3 reports results for the mean and standard deviation estimates for the RPL model. Consistent with the results of the MNL model, all mean coefficients for attributes are positive and statistically significant at 5% or lower levels and coefficients for price are negative, meaning consumer utility decreases with increasing price.

The estimated standard deviations of coefficients for all attributes in soy foods are statistically significant, except for health claims on soy burgers, indicating preference heterogeneity indeed exists among subjects and there is a structural advantage in employing the RPL specification. The standard deviations for protein content are larger than mean coefficients for soy burgers, soy cheese, and tofu and virtually identical for soy milk, suggesting that U.S. consumers are extremely heterogeneous in their preferences for soy protein content attribute. This result is likely to reflect that there are wide variations in perceptions about soy protein between consumers who can link soy protein with isoflavones and those who may not. Large standard deviations for "None" option imply that although consumers overall have a negative perception about soy-based foods associated with a lower likelihood of soy food consumption, very few people who might perceive health benefits of soy in the respondents chose "Buying soy food" options. Results reveal people have strong concern about good taste for all the four soy foods we considered, followed by fair taste for soy burgers and cheese and specific health claim for soy milk and tofu, respectively. However, consumers expressed relatively less preference for protein content in soy foods. Preferences for health claims on soy foods are similar across the four products.

The estimates for WTP for attribute and marginal WTP for four soy foods from each of the models estimated are reported in table 4. Results indicate WTP for protein content is very similar across soy foods from the MNL and RPL. For example, consumers are willing to pay $0.03 for 1gram increase in soy protein in soy cheese and

$0.04 in tofu from both MNL and RPL models. However, marginal WTP to exchange soy food with different taste is, in all four products, is varied between models. For example, people are willing to pay for soy burgers that taste good around $7.8 for MNL, but $5.8 for RPL. For RPL model, marginal WTP estimates from poor to good taste ranges from $3.90 for cheese to $5.75 for soy burgers. Further, marginal WTP for good taste relative to poor taste is almost twice compared to marginal WTP for fair taste relative to poor taste for all four soy foods. Marginal WTP to exchange soy foods with different levels of health claim is, in most cases, similar across model. For example, marginal WTP to exchange soy cheese with no claim for general and specific claim is $1.08 and $1.15 for MNL and RPL, respectively. These estimates indicate that consumers are considerably more sensitive to changes in taste than in levels of health claim.

The findings in table 4 suggest, for the RPL model, there is no significant difference in WTP for "good taste" between soy burgers and tofu. However, WTP for "good taste" of soy burgers is significantly greater than soy cheese and soy milk. In contrast, estimated WTP for "general and specific health claim" on soy cheese is lower than soy burgers, soy milk, and tofu. These estimates show that consumer preferences differ across the four types of soy food products.

To explore the impact of introducing health claims on consumer welfare, we consider the welfare changes by comparing whether "health claims" on soy foods is included as one attribute of soy foods. The welfare measures for the specific type of claim for health benefits from the MNL model of table 1 provide estimates for average consumers of 1.65, 1.15, 1.80, and 1.54 for Soy burgers, cheese, milk, and tofu, respectively. Table 5 reports the mean and 95% confidence intervals for the estimates of welfare change from the RPL model. Confidence intervals are calculated using bootstrapping method with 10,000 replications computing equation (6) and approximated equation (7) by taking average values. In general, introducing health claims on soy-based foods produces a gain for average consumers. In particular, consumers who purchase soy milk obtain larger gain than any other products. However, there is no difference in consumer surplus values between two different levels of health claim.

Conclusions

We used choice experiments to shed light on consumer preferences for various attributes (in particular, health-related) associated with soy-based food products. Both multinomial logit (MNL) and random parameter logit (RPL) models were estimated to examine potential heterogeneity across individuals in their preferences for soy-based food products. Standard Deviation parameters in the RPL models are highly significant, indicating that individuals have widely varying preferences for soy-based food products. The heterogeneous preferences are to be expected given the low market penetration rate (about 15 %) of soy foods in the U.S. Additionally, while majority of the U.S. population has negative perceptions about soy foods, some segments of the population are accepting soy foods particularly in response to the health-promoting attributes of soy foods.

Given that soy foods possess health-promoting attributes that offer the promise of reducing heart-related chronic diseases, this study attempted to estimate marginal and total willingness to pay for four salient attributes including Taste, Price, Soy Protein, and Health Claims. Some major findings from the estimated models include:

i. Respondents in the experiments attach the highest value to Taste. This result supports the finding by Moon et al (2005) that perceptions about Taste exerted the strongest impact on consumers' decisions with respect to whether to participate in soy food market and how often to consume.

ii. Consumers were least willing to pay for Soy Protein content, a finding that suggests that they may not know that soy proteins contain isoflavones that have the potential to prevent cardiovascular diseases.

iii. Consumers did not place any additional value on the specific health claim relative to the general health claim, as revealed by the small magnitudes of the marginal willingness to pay between them. In other words, consumers were not willing to pay more for the specific health claim and the phrase of "FDA approval" was not of any additional value them. Consistent with this result, Moon et al (2009) showed that the impact of FDA health claim did not differ from that of general health on consumers' behavioral intentions (willingness to consume soy foods).

iv. The positive sign associated with "None" implying negative perceptions about soy foods is consistent with existing consumers' sentiments toward soy foods in the US market, thereby attesting to the validity of the choice experiments reported here.

References

Adamowicz, W., J. Louviere, and M. Williams. 1994. "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities." *Journal of Environmental Economics and Management* 26:271-92.

Anderson, J.W., B.M. Johnstone, and M.A. Cook-Newell. 1995. "Meta-Analysis of the Effects of Soy Protein Intake on Serum Lipids." *New England Journal of Medicine* 333:1715-16.

Blamey, R. K., J. W. Bennett, J. J. Louviere, M. D. Morrison, and J. Rolfe. 2000. "A Test of Policy Labels in Environmental Choice Modeling Studies." *Ecological Economics* 32:269-86.

Carlsson, F. and P. Martinsson. 2001. "Do Hypothetical and Actual Marginal Willingness to Pay Differ in Choice Experiments? Application to the Valuation of the Environment." *Journal of Environmental Economics and Management* 41:179-92.

Carlsson, F., P. Frykblom, and C. Lilijenstolpe. 2003. "Valuing Wetland Attributes: Application of Choice Experiments." *Ecological Economics* 47:95-103

Lusk J. L. and T. C. Schroeder. 2004. "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Beef Steaks." *American Journal of Agricultural Economics* 86:467-82.

Messina, M., and S. Barnes. 1995. "The Role of Soy Products in Reducing Risk of Cancer." *Journal of National Cancer Institute* 83:541-46.

Moon, W., S.K. Balasubramanian. 2005. "Perceived Health Benefits and Soy Consumption Behavior: Two-Stage Decision Model Approach." *Journal of Agricultural and Resource Economics* 30:315-32.

Rolfe, J. and J. Bennett, and J. Louviere. 2000. "Choice Modelling and Its Potential Application to Tropical Rainforest Preservation." *Ecological Economics* 35:289-302.

Train, K. E. *Discrete Choice Methods with Simulation*. Cambridge, UK: Cambridge University Press. 2003.

United Soybean Board. 2007. *Consumer Attitude about Nutrition 2007*, 14th Annual National Report. http://www.soyconnection.com/health_nutrition/pdf/ConsumerAttitudes2007.pdf

Wansink, B., and N. Chan. 2001. "Relation of Soy Consumption to Nutritional Knowledge." *Journal of Medicinal Food* 4:145-50.

Wansink, B., R.E. Wesgren, and M.M. Cheney. 2005. "Hierarchy of Nutritional Knowledge that Relates to the Consumption of a Functional Food." *Nutrition* 21:264-68.

Table 1. Attribute/Level Information from Experimental Design

Attribute	Attribute Levels
Taste	Poor
	Fair
	Good
Soy protein	6.25 grams per serving
	12.50 grams per serving
	25.00 grams per serving
Health claim	No health claim
	General health claim
	Specific health claim
Price	$1.60
	$2.20
	$2.80

Table 2. Multinomial Logit Model Estimates by Soy-based Food

Attribute	Variable	Burgers	Cheese	Milk	Tofu
Taste	Fair	1.323*[b]	1.461*	0.950*	1.271*
		(0.119)[c]	(0.129)	(0.113)	(0.117)
	Good	2.902*	3.038*	2.664*	2.865*
		(0.109)	(0.120)	(0.100)	(0.107)
Protein	Protein per serving	0.015*	0.016*	0.019*	0.017*
		(0.003)	(0.004)	(0.004)	(0.003)
Health claim	General	0.563*	0.654*	0.613*	0.602*
		(0.067)	(0.071)	(0.070)	(0.068)
	Specific	0.616*	0.695*	0.755*	0.687*
		(0.067)	(0.070)	(0.069)	(0.068)
None[a]		2.991*	2.766*	2.944*	2.816*
		(0.171)	(0.179)	(0.167)	(0.170)
Price	Price per pack	-0.374*	-0.606*	-0.420*	-0.447*
		(0.054)	(0.057)	(0.055)	(0.054)
Log-likelihood		-3932.4	-3644.1	-3892.6	-3810.4
Number of observations		3996	3804	4080	3852

[a] Effect estimated relative to options
[b] One asterisk (*) denotes values that are statistically significant at the 5% level or lower.
[c] Numbers in parentheses are standard errors.

Table 3. Estimates of Random Parameter Logit Model by Soy-based Food

Attribute	Variable	Burgers	Cheese	Milk	Tofu
Mean Parameter					
Taste	Fair	1.542*[b]	1.612*	0.978*	1.209*
		(0.195)[c]	(0.201)	(0.183)	(0.223)
	Good	4.522*	4.639*	3.854*	5.077*
		(0.290)	(0.272)	(0.240)	(0.296)
Protein	Protein per serving	0.021*	0.034*	0.037*	0.039*
		(0.007)	(0.007)	(0.006)	(0.008)
Health claim	General	1.147*	1.289*	1.351*	1.260*
		(0.106)	(0.123)	(0.119)	(0.137)
	Specific	1.227*	1.359*	1.518*	1.528*
		(0.105)	(0.119)	(0.120)	(0.138)
None[a]		5.003*	4.318*	4.000*	2.224*
		(0.513)	(0.400)	(0.363)	(0.371)
Price	Price per pack	-0.787*	-1.189*	-0.880*	-1.024*
		(0.083)	(0.091)	(0.085)	(0.095)
Standard Deviation Parameter					
Taste	Fair	0.989*	1.439*	1.482*	1.857*
		(0.184)	(0.232)	(0.215)	(0.253)
	Good	2.499*	2.405*	2.722*	2.302*
		(0.258)	(0.236)	(0.233)	(0.158)
Protein	Protein per serving	0.051*	0.066*	0.036*	0.087*
		(0.008)	(0.008)	(0.007)	(0.009)
Health claim	General	0.272	0.716*	0.455*	1.076*
		(0.269)	(0.166)	(0.169)	(0.159)
	Specific	0.244	0.603*	0.427*	0.843*
		(0.208)	(0.162)	(0.146)	(0.124)
None		7.439*	7.509*	7.683*	10.861*
		(0.704)	(0.639)	(0.587)	(0.760)
Log-likelihood		-2005.7	-1980.0	-2029.2	-1845.8
Number of observations		3996	3804	4080	3852

[a] Effect estimated relative to options
[b] One asterisk (*) denotes values that are statistically significant at the 5% level or lower.
[c] Numbers in parentheses are standard errors.

Table 4. Willingness-to-Pay for Attributes by Econometric Models and Soy-based Food

	Multinomial Logit Model				Random Param	
Willingness-to-pay for	Burgers	Cheese	Milk	Tofu	Burgers	Cheese
1 gram increase in Soy protein	$0.04 [0.02,0.06] [a]	$0.03 [0.01,0.04]	$0.05 [0.03,0.07]	$0.04 [0.02,0.06]	$0.03 [0.01,0.04]	$0.03 [0.02,0.04]
Fair taste vs. poor taste	$3.54 [2.61,5.17]	$2.41 [1.88,3.15]	$2.26 [1.60,3.30]	$2.84 [2.13,3.93]	$1.96 [1.49,2.63]	$1.36 [1.04,1.77]
Good taste vs. poor taste	$7.77 [6.07,11.0]	$5.01 [4.18,6.24]	$6.34 [5.03,8.69]	$6.40 [5.15,8.59]	$5.75 [4.74,7.29]	$3.90 [3.33,4.66]
General health claim vs. no claim	$1.51 [1.05,2.18]	$1.08 [0.81,1.41]	$1.46 [1.04,2.06]	$1.35 [0.97,1.86]	$1.46 [1.14,1.88]	$1.08 [0.86,1.33]
Specific health claim vs. no claim	$1.65 [1.17,2.39]	$1.15 [0.88,1.49]	$1.80 [1.34,2.49]	$1.54 [1.14,2.11]	$1.56 [1.23,2.04]	$1.14 [0.93,1.41]

[a] Numbers in brackets are 95% confidence intervals determined via Krinsky-Robb parametric bootstrapping method.

Table 5. Welfare Change from Introducing Health Claim by Soy-based Food: Random Parameter Logit Model

Health Claim		Burgers	Cheese	Milk	Tofu
General	Upper 95% confidence interval	2.66	2.41	2.80	3.45
	Mean	1.47	1.09	1.55	1.24
	Lower 95% confidence interval	0.39	-0.18	0.35	-0.91
Specific	Upper 95% confidence interval	2.65	2.30	2.93	3.27
	Mean	1.58	1.45	1.74	1.50
	Lower 95% confidence interval	0.68	0.03	0.61	-0.20

Note: The welfare values are calculated using 10,000 replications from the estimated population distribution under assumption that the price of each product is $2.5, fair taste, and 15 grams of protein/serving.