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# Soyfood Consumption Pattern: Effects of Product Attributes and Household Characteristics

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# Soyfood Consumption Pattern: Effects of Product Attributes and Household Characteristics

*Abstract*

Effects of perceived attributes of soyfoods on the consumption pattern for six different soyfood products were evaluated. Perceived attributes included convenience, health benefits, and taste. Six soyfood products were tofu, vegetable burgers, soy milk, soy supplements, meat substitutes, and soy cheese. This study used conceptual model that highlights the role of perceived attributes in a demand model by combining Lancaster's characteristics model with Fishbein's multi-attribute model. Zero-inflated negative binomial model (ZINB) was used as an empirical specification to address the zero consumption of soyfood products. Results show that perceived health attribute of soyfood had differential effects across the six soyfood products. While having a significant effect on other products, it did not influence tofu consumption decision. Convenience of preparation and consumption, and tastefulness had strong impacts consistently across all five types of soyfood products. The study identified several socio-economic characteristics of consumers that had a significant relationship with soyfood consumption patterns. However, these characteristics had varying effects across the six soyfood products. Implications for food industry are discussed in relation to the differential effects of health attributes and socio-demographic profiles.

Key words: health benefit attributes of soyfood, soyfood products, zero-inflated negative binomial model

## Soyfood Consumption Pattern: Effects of Product Attributes and Household Characteristics

Crushing of soybeans for animal feed and vegetable oil has been historically the dominant usage of soybean crop. Although the use for whole soybean for human food such as tofu, soymilk, and other soyfood products constitute a small part of the soybean demand, the total value of soyfood products sold has been increasing in recent years. Henkel (2000) reported that $2.5 billion worth of soyfoods were sold in 2000 at the retail level.. Soytech Inc. (2004) also estimated the sales of soy food products including tofu, soymilk, soy cheese, energy bars, and meat alternatives to be at nearly $4 billion in 2003. These trends further highlight the important role of soyfood products in increasing the demand for soybeans at the farm level.

The farm level demand for soybeans is likely to be adversely affected due to adjustments in diet as consumers start following the recommendations of food guide pyramid. According to Young and Kantor (1999), reduction in total fat intake to the recommended upper limit would sharply decrease consumption of fats and oil such as vegetable oil by 36 percent. This will require a decline of soybean production by 2 million tons to match the domestic demand decrease. Increased usage of soybean for soy food and energy purposes will be necessary to bridge the potential shortfall in the demand for soybean

Intake of soy food products has been shown to have beneficial effects on cardiovascular disease (CHD) risk factors. Zhang et al. (2002) reported a clear monotonic dose-response relationship between soyfood intake and risk of total CHD. Using published data and new research Messina et al.(2000) suggested that the consumption of

even 10 gram (typical of Asian intake) of isoflavone-rich soy protein per day may be associated with health benefits. Recognizing the health benefits from soyfoods, Food and Drug Administration (FDA) has allowed food companies to claim health benefits from soyfood products (FDA, 1999). The American Heart Association has also recommended consumption of soy protein to patients with elevated cholesterol level (Erdman, 2000). There are, however, few studies assessing whether such health benefits and health claims have translated into increased consumption of soyfood products.

Previous studies have related consumer health concern to the consumption habit of foods derived from dairy (Jenson, 1995; Heien and Wessells, 1988) and meat sources (Ward and Moon, 1996). Capps and Schmitz (1991) and Rimal et al. (2001) in discussing health and nutritional factors in food analysis and Yen and Chern (1992) in investigating the impact of nutritional information on demand for dairy products have indicated that consumer health and nutritional concern have a significant effect on food demand. Jenson (1995) analyzed consumers' health concerns and decisions to participate in the market for whole-fat milk and found that promotion using nutritional benefits of milk can be a useful tool for the dairy industry to attract market participation. Many studies evaluating meat demand (Brown and Schrader, 1990; Capps and Schmitz, 1991) have concentrated on shifts in demand caused by consumers' view of the health implications of eating meat. However, little is known about the relationship between the U.S. consumer's perceived benefits of soyfoods and soyfood product consumption patterns. Moon et al. (2005) reported positive effects of perceived health benefits of soyfood on consumption frequency of soyfood as a whole without delineating the effects across specific products. Our study extends their research by examining whether

perceived health benefits impact soyfood consumption decisions differentially across six individual soyfood products. In addition to health benefits, other attributes such as convenience of preparation and consumption and tastefulness are included. We use conceptual model combining Lancaster's characteristics and Fishbein's multiattribute models in order to integrate perceived attributes of soyfood into soyfood consumption models. Zero-inflated negative bionomial models are developed to differentiate soyfood consuming from non-consuming households. It is postulated that attributes of soyfood and socio-economic variables have varying effect on the consumption frequency across six soyfood products.

## Conceptual and Empirical Models

*Conceptual Model*

The traditional demand equation derived from the utility maximization framework does not explain the role of product attributes in influencing the market demand for the products. The theory of consumer demand by Lancaster (1971) was the first attempt in explaining the role of product attributes. According to Lancaster, attributes of goods and services combined with activities give rise to characteristics that are directly related with consumers' demand (Pendleton and Shonkwiler, 2001) Therefore, Lancaster established at least an indirect relationship between attributes and consumption behavior. Ladd and Suvannunt (1976) identified two properties from Lancaster's model (Moon et al., 2005): a) the price of the product is the sum of the of the marginal implicit value of its attributes, and b) household income, and level of attributes and price of a product influence consumer demand. The second property was applied by Van Ravenswaay and Hoehn (1991) and Baker and Crosbie (1993) to analyze consumer preferences for food safety.

Following them, our study specifies the demand equation for a soyfood, Y, for consumer, i:

(1) $$Y_i = Y_i\,(P_1, \mathbf{P}, m, \mathbf{T}).$$

Where $P_1$ is the price of a soyfood, **P** is the vector of prices of related goods, m is consumer's income, and **T** is a vector of non-price attributes of a soyfood.

Moon et al (2005) indicate that two issues need to be addressed when including attributes of soyfoods in a demand model. First, whether consumers are knowledgeable about attributes of soyfood. There will not be any impact of beneficial attributes of soyfood on the demand for soyfood, if consumers are unaware of the link between soyfood consumption and positive health effects. Second, even if consumers have the knowledge of the attributes, credence attributes such as nutrition and food safety have always posed a challenge in terms of objectively measuring them. Consumers often fail to evaluate these attributes even after consuming the products. These issues are addressed by replacing objectively measured attributes by consumers' perceived attributes of soyfood. Fishbein's multiattribute model (Fishbein, 1963) represents a valuable approach in examining the relationship between consumers' product knowledge in terms of their perceived attributes of soyfood and their attitude toward consuming soyfood. Symbolically, Fishbein's multiattribute model can be written as

(2) $$A = \sum_{t}^{n} \beta_t X_t$$

where A is the attitude toward a soyfood; $X_t$ is the strength of the belief that the soyfood possesses an attribute *t*; $\$_t$ is the evaluation of attribute *t*; and *n* is the number of salient attributes of a soyfood. The model therefore proposes that attitudes toward a soyfood product is based on the summed set of beliefs about the soyfood product's attributes weighted by the evaluation of these attributes. The evaluations ($\$_t$) and the belief ($X_t$) are obtained from survey responses, and used for the calculation of the overall attitude toward a product. Assuming that the beliefs about the existence of expected attributes of soyfood products influence consumers' attitude about the products, hence, their consumption, we can replace T in (1) by *A* to obtain a soyfood demand model:

(3) $$Y_i = Y_i (P_1, \mathbf{P}, m, \boldsymbol{A}).$$

Consumers' perceived attributes of soyfood products can have twofold effects. The first effect is on the probability of the participation in the soyfood market. The second effect is on the intensity of consumption (e.g., quantity or frequency) among those who are already market participants. Following the two effects of soyfood attributes, a two-step empirical demand model for a soyfood product is postulated:

(4) $$\Pr(Y_i>0) = g(P_1, \mathbf{P}, m, \boldsymbol{A}, \gamma_1)$$

(5) $$(Y_i|Y_i>0) = \cdot(P_1, \mathbf{P}, m, \boldsymbol{A}, \gamma_2)$$

where $Y_i$ is the frequency of soyfood product consumed during a specific time by consumer *i* and $\gamma_1$ and $\gamma_2$ are the disturbance terms. Equation (4) represents a probability of participation in soyfood product markets, while equation (5) represents the level of consumption given the participation.

An individual is a non-participant in the soyfood market when three is no potential consumption despite changes in relative prices, income or other constraints: i.e.,

the zero consumption among non-participants is due to unacceptable taste or other unfavorable attributes of soyfood products. Unfavorable attribute perception may cause temporary or permanent non-consumption (Lin and Milon, 1993.) Alternatively, a potential participant is merely consuming at zero quantity due to unfavorable prices and income, or temporarily unacceptable attribute perception. Any favorable change in prices, income and perceived attributes will increase the quantity of consumption. Largely, there are three separate empirical specifications of the above postulated consumption problems found in the literature.

The first is the tobit model which assumes that everyone is a market participant. In this model, zero purchases are simply standard corner solutions. The second is the Heckman type specification which does not allow for corner solutions (Blaylock and Blisard, 1993; Jensen, 1995). (comment: CD model arises when we assume zero correlation between the first and second stages) Hence, the decision is either to participate or not to participate. Once a household participates in the soyfood product market, it will have positive purchase levels. The third and most flexible model is also known as Cragg's "double hurdle" model (Jensen, 1995; Blaylock and Blisard, 1993; Haines, Guilkey, and Popkin, 1988). This model makes a distinction between market participation and zero purchases. According to this model, a zero purchase level may mean either nonparticipation in the market or non purchase due to relative price, income, and product attributes. Double hurdle model is the most general and can accommodate tobit and Heckman models as special cases (Jensen, 1995). There are two hurdles in this model a consumer must pass before a positive consumption of soyfood products takes place: be a potential consumer and actually consume soyfood products. The two-step

decision making framework is incorporated in the empirical model specification that uses count data for the dependent variables.

*Empirical Model Specification*

Variables that count the number of times something happens are often modeled using count data models such Poisson and Negative Binomial models. For example, factors affecting how frequently a person visited the doctor (Cameron and Trivedi, 1986), how frequently members of the House of Representatives switch parties (King, 1988) and the number of police arrests in a fixed period (Land, 1992.). In our study, Zero-Inflated Negative Binomial (ZINB) Model (Mullahey, 1986; Greene, 1997; Long, 1997) is used as an empirical model to analyze above discussed soyfood consumption behavior. This model is selected based on two merits: (i) it incorporates the framework of double-hurdle process discussed above, and (ii) it takes into account the potential over-dispersion of the consumption frequency.

Let $Y_i$ represent the consumption of a soyfood product by an individual *i* in terms of number of times in a month. Thus, $Y_i$ takes on integer values ranging from 0 to any positive value. Following Folz et al. (2000), let z represent a binary indicator of regime 1 (z=0) and regime 2 (z=1), and let P* represent the outcome of the generalized Poisson (negative binomial) process in regime 2. The observed consumption frequency of soyfood products, $Y_i$, is zXP*. A ZINB model for soyfood consumption, therefore, is:

(6) $\Pr(z_i = 0) = F(w_i, \gamma)$

(7) $\Pr(Y_i=j \mid z_i=1) = e^{-\mu_K} \frac{\mu_i^j}{j!}$,

Where F (.) is a cumulative probability distribution function with a logistic distribution, the parameter $\mu_i$ is determined by a linear combination of perceived attributes of soyfood

products and socio-economic characteristics of consumers($\ln \mu_i = \beta' x_i$ $\varepsilon_i = \ln \lambda i + \text{in } u_i$), $\beta$ and $\gamma$ are parameter vectors to be estimated, w and x are covariates representing the explanatory variables in the soyfood consumption models. The exponential of disturbance term $\varepsilon_i$ (i.e., $u_i$) is assumed to have a gamma distribution. The probability density function for the observed random variable ($Y_i$ ) is

$$\Pr(Y_i=j) = \Pr(z_i=0) + (1 - \Pr(z_i=0)) \cdot f(Y_i = j), \quad (8)$$

Where the distribution of $Y_i$ conditional on $x_i$ and $u_i$, $f(Y_i = j \mid x_i \text{ and } u_i) = e^{-\lambda u_i}(\lambda_i u_i)^j / j!$. The log-likelihood is[1]

$$\ln L = \sum \ln(\Pr(Yi = j)).$$

## Survey Design and Data Collection

A nationwide on-line survey of 3,000 households was conducted. Households were randomly selected from the database of 400,000 households who make up Ipsos-NPD marketing research panel. The selection process was appropriately stratified to ensure that the demographic characteristics of the sample households that corresponded with the 2000 U.S. census. Sample households were sent e-mails soliciting information regarding their soy-consumption pattern and household characteristics. Each e-mail included a unique URL (keyed to the respondent's ID) to direct the respondent to the survey website.

More than 1400 households completed the survey, yielding a response rate of approximately 47%. The variables included in the survey and their explanations are listed

[1] For more detail on the model specification see Folz et al., 2000.

in Table 1. The online survey elicited consumption frequency per month for six types of soyfood products: tofu, vegetable burgers, soy milk, soy supplements, meat substitutes, and soy cheese. Consumer' perceived attributes were measured using a Likert scale of 1 to 7, 1 representing strongly disagree and 7 representing strongly agree (see Table 1 for question wordings used to measure perceptions). Perceived attributes of soyfood included convenience in food preparation and consumption, health benefits, tastefulness, and inexpensiveness. Household characteristics of respondents included age, gender and education level of the respondents, household income, household size, number of children in the household, and ethnic background of the household.

## Results and Discussion

*Consumption Frequency of Soyfood Products*

Sample households reported consumption frequency of six soyfood products per month. Table 2 presents the proportion of households reporting non-zero consumption, mean frequency of consumption per month among all households and among the subset of households reporting non-zero consumption. As shown in the table, 36.37 percent of the households in the sample consumed at least one type of soyfood product per month. Tufu, vegetable burgers, and meat substitutes were the popular type of soyfood products. Average consumption frequency across all types of soyfood products was nearly six times in a month among all households, and nearly 16 times among the subset of the households with only positive (greater than zero) consumption frequency. Soy supplements and soy milk were the most frequently consumed soyfood products among those households who were already in the soyfood market.

*Perceived attributes of soyfood*

Health benefits, convenience in preparation and consumption, tastefulness, and inexpensiveness were the four major perceived attributes of soyfood considered in the study (Table 1). These attributes were measured using a seven-point rating scale (1=strongly disagree, 7= strongly agree). Tests were conducted to evaluate the internal consistency of statements under each category. In addition, mean tests were conducted to evaluate the difference in the perceived attributes between those who were consuming soyfood products and those who were not.

Beneficial health attributes were measured using four independent statements relating to soyfood's ability to a) reduce cholesterol level in blood; b) act as an antioxidant; c) retain bone mass; and d) help women during menopause. A test was conducted to evaluate the internal consistency of the four statements. The computed test statistic showed that the four statements had a high level of consistency (Cronbach's $\alpha = 0.85$) in measuring the health benefits of soyfood (Table 3). A composite health benefits index was created by summing up the reported scores for each statement and dividing by four. There were statistically significant difference (P-value $<0.05$) in perceived health benefits of soyfoods between households who consume soyfood products and those who do not. Households who consume soyfood products had more favorable perception of health attributes (mean score of composite index = 4.99) of soyfoods than those who do not (mean score of composite index = 4.37.)

Perceived convenience attributes were measured using three different statements relating to convenience in preparation and consumption of soyfood. These statements

also showed a high level of consistency (Cronbach's $\alpha = 0.74$) in measuring perceived convenience of soyfood. A composite convenience index was created by summing up the reported scores for each of the statements and dividing by three. The results showed that soyfoods were generally perceived to be inconvenient (mean value of composite index = 3.32 compared to 4 = neither agree nor disagree that soyfoods are convenient.) There were statistically significant difference (P-value <0.05) in perceived convenience attributes of soyfoods between households who consume soyfood products and those who do not. Households who do not consume soyfood products clearly disagree that soyfoods are convenient to prepare and consume.

Perceived taste of soyfood was measured using a statement, "I like the taste of soy-base foods." Households generally disagreed that soyfoods were tasteful. Those who consumed soyfoods were statistically different (P-value <0.05) from those who did not in terms of their reported perception of tastefulness of soyfoods.

Finally, the price effects on the consumption frequency for soyfood products were measured using a statement, "Soyfood are inexpensive." Although households disagreed that soyfoods were inexpensive (mean = 3.24), those who did not consume soyfoods were likely to disagree more than those who consumed. Dahr and Foltz (2004) reported that the mean price of soy milk per gallon was more than $8 compared to the $3 for skim/low fat milk. Prices of soyfood products may have been an obstacle in increasing participation in soyfood market.

Consumers' knowledge of health is likely to be associated with their food consumption habit. Krebs-Smith et al., (1995), concluded a strong association between health knowledge and increased intakes of fruit and vegetable. In our study, a health

knowledge variable was computed using respondents' reported health knowledge regarding nutrients intakes and health consequences. Respondents were asked to match 11 nutrients (i.e., sodium, calcium, vitamin A, protein, vitamin C, iron, vitamin D, carbohydrates, saturated fat, potassium, and dietary fiber) with appropriate health consequences (i.e., high blood pressure, strong bones, healthy eyes, amino acids, development of anticancer mechanism in the body, oxygen, absorb calcium, conversion to sugar and fueling the body, cardiovascular disease, and balancing sodium). Each correct match was given a score of 1. Respondents with more than eight correct matches were considered to be knowledgeable, hence, assigned a value of one. Those with eight or less correct matches were assigned zero. More than 50% of the respondents were knowledgeable about the relationship between nutrients intakes and health consequences. There was a statistically significant difference in health knowledge (P-value $<0.05$) between those who consumed soyfoods and those who did not. More than 65% of the soyfood consumers were knowledgeable about the relationship between nutrients intakes and health consequences compared to only 50% among non-consumers.

*Socio-economic characteristics and soyfood consumption*

Socio-economic characteristics included respondent's age, gender, education, household income, household size, number of children in the household, ethnic background of the household. The average age of a respondent was 45 years. The difference in age between soyfood consumers and non consumers was not significant.

Although female respondents were the majority in the subgroup that consumed soyfoods compared to the subgroup that did not consume soyfoods, the difference was not statistically significant. An average soyfood consumer was more educated and had more household income than the non-consumer. The percentage of white respondent in the soyfood consuming subgroup was 95% compared to 89% in the non-consuming subgroup. The soyfood consuming households were smaller in size and had fewer children than non-consuming households.

*Regression Results and Product-wise differences*

Tables 4a and 4b report the results from the product-wise analysis using regression models. The dispersion parameter (Alpha) and zero-inflation model parameter (Tau) across all soyfood products are statistically significant at P-value of less than 0.05. Therefore, the choice of ZINB models was consistent with the consumption behavior for each of the soyfood products. Perceived health benefit index had a statistically significant effect in all soyfood products except tofu. That is, consumers who perceived beneficial health attributes in soyfood products were more likely to participate in the soyfood market as well as increase consumption frequency. This result is consistent with previous studies addressing the impact of health information on food choices (Jensen, 1995; Ippolito and Mathios, 1993; Capps and Schmitz, 1991;Brown and Schrader, 1990.) Figure 1 simulated the impact of perceived health attributes of soyfoods on consumption frequency for six soyfood products. It clearly shows that beneficial health attributes were more important for soy milk and soy supplements than products like tofu. For example, those who strongly disagreed that soyfoods possessed any beneficial health attribute were

likely to consume soy milk less than 5 times a year (0.40x12) compared to 18 times a year (1.5*12) among those who strongly agreed. The perceived health attributes had least impact on tofu consumption. The average frequency of tofu consumption was nearly 6 times a year among those who strongly disagreed that soyfood had health benefits compared to 8 times a year among those who strongly agreed. This result indicates that consumers do not select tofu because of the health benefits of soy proteins, but likely because of other reasons such as eating habits and customs.

Consumers with knowledge of links between food nutrition and health were more likely to consume soyfood products than those without such knowledge. However, as discussed above such relationship was supported by the sample data for soyfood in general. There were disparity in terms of health knowledge and consumption across soyfood products. Soyfood products such as soy supplement and soymik are consumed by consumers who are generally more concerned about health issues; hence make special efforts in gathering information and buying specialized health foods. The regression results show that while knowledge of links between nutrition and health had positive and significant influence on soymilk and soy supplement consumption, it had no effect on other types of soyfood products.

Consumers who agreed that soyfood products were convenient and tasteful were likely to consume more frequently than those who disagreed. This was true across all soyfood products. Attributes such as convenience and tastefulness had greater effects on consumption frequency than the health attributes. The estimated coefficients for convenience and taste across the products were larger than those for health benefits.

Perception of convenience in preparation and consumption was most important for vegetable burgers and least important for soy cheese (Figure 2). This finding confirms the finding by Kilcast et al. (1996) that convenience in preparation consumption can increase the consumption of fruits and vegetables among the low vegetable consumers. Soyfood products that incorporate convenience in preparation and consumption (e.g., frozen products) were likely to be better accepted by non-participant or low frequency consumers.

Tastefulness was essential to increase consumption frequency for all soyfood products (Figure 3). Role of tastefulness in stimulating consumption of tofu, vegetable burgers, and meat substitutes was greater than that of convenience. It played particularly important role in increasing consumption frequency for soy milk. An average consumer was likely to consume soy milk less than 5 times a year if s/he strongly disagreed that it was tasteful compared to nearly 40 times a year if s/he strongly agreed that it was tasteful. Other studies have shown importance of taste in selecting food items. Acceptance of soy yogurt was found to be significantly lower than traditional milk yogurt primarily due to taste factor among college students in northern Louisiana (Wu et al., 2005). Rimal and Fletcher (2000) reported that attitudes toward in-shell peanuts was influenced by attributes such as fat, taste, and healthiness and that taste were the only attribute influencing consumer purchase decisions. According to Glanz, et al. (1998), taste and costs are of more importance to American consumers while selecting food than nutritional concerns. It is, therefore, important to promote soyfood products as being tasty and convenient in addition to being nutritious.

Although most soyfood products are expensive, prices were not very important for soyfood buyers. In the case of soy milk, "inexpensive" may have been associated with inferior quality, hence, had negative effect on consumption frequency. Just the opposite result was found for soy supplements. Frequency of consumption for soy supplement was likely to increase if consumers perceived that soyfoods were inexpensive.

Socio-economic characteristics of households including household income, household size and number of children in the household had varying effects on soyfood consumption frequency across products. Households with higher income were likely to buy tofu more frequently than those with lower income. Although household income did not play significant role for the rest of the soyfood products, some of the income effects may have been captured in the results relating household size with consumption frequency. For example, consumption frequency for soy milk and soy supplements decreased as the size of the households increased. That is, household food budget is further constrained with additional member in a household, thus reducing the expenditures on soyfood products. Households with children were likely to consume soy milk more frequently than those without children. In addition to household characteristics, respondents' characteristics played significant role in consumption frequency for soyfood products.

While older respondents were likely to consume tofu less frequently, soy milk, soy supplement and soy cheese were likely to be more popular among older population. Soyfood products except vegetable burgers were largely gender neutral. Women respondents were likely to consume vegetable burgers less frequently than men. Respondents' education level had positive effect on all soyfood products except soy

supplements and soy cheese. The biggest effect was on tofu (**$**=0.110) followed by meat substitutes (**$**=0.104), soy milk (**$**=0.088) and vegetable burgers (**$**=0.075). Previous studies have reported the role of education on food choices. Grossman and Kaestner (1997) reported a positive relationship between education and health. A person with more education is better able to maintain a healthy life than a person with less education. Better education enhances the access to nutrition information, thus increase the likelihood of nutritional considerations while making food selections. Nayga (1997) also found a significant positive relationship between education and a main meal planner's perceived importance of nutrition in food shopping. Race may be another individual characteristic associated with the variation in soyfood consumption. White respondents were likely to consume tofu and soy milk less frequently than non-white respondents. Asians are likely to account for such ethnic disparity in soyfood consumption between two ethnic groups in this study.

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## Summary and Implications

The study evaluated the effects of perceived attributes of soyfoods on the consumption pattern for six different soyfood products including tofu, vegetable burgers, soy milk, soy supplements, meat substitutes, and soy cheese. Lancaster's characteristics model was combined with Fishbein's multi-attribute model to develop a soybean demand function that included perceived attributes of soyfood. Zero-inflated negative binomial model (ZINB) was used as an empirical specification to address zero consumption of soyfood products. It was postulated that consumers' soyfood consumption decisions

included first, whether or not to consume, and second, how often to consume. The results of the study have important implications for soyfood industry.

Our study examined the effects of perceived health benefits on individual soy food products rather than on aggregate soyfood, thereby extending the research by Moon et al (2005). The motivation was that perceived health benefits may influence consumers' decisions differentially across individual soy food products. The estimation results clearly showed that soyfood specific health attributes were not equally important across six soyfood products. For example, while soy milk consumers were strongly influenced by perceived health attributes, tofu consumers did not take into account health attributes. There were other critical attributes to stimulate the consumption of soyfood products. Although sales of soyfood products are increasing, overwhelmingly large percentage of Americans avoid soyfood due to unfavorable perceptions about taste and convenience. In this study, consumers who agreed that soyfood products were convenient and tasteful were likely to consume more frequently than those who disagreed. This was true across all soyfood products. It is, therefore, important to promote soyfood products as being tasty and convenient in addition to being nutritious. Soyfood industry needs to invest on food technology to make soyfood products taste better. In addition, consumers prefer food products to be convenient to plan, shop, prepare, cook and clean (Jaeger and Meiselman, 2004). Selection is an important part of convenience. Presently soy milk, meat alternatives, tofu, and energy bars account for two-third of soyfood sales. The soyfood industry needs to introduce and promote new products in meal replacement as well as snack food categories.

The study demonstrated that soyfood market can be segmented based on consumers' socio-economic characteristics including age, gender, education, ethnic background, household income, household size and children in the household. Instead of promoting all soyfood products as a generic product group, they need to be treated as unique products able to meet the needs of specific segment of the food market. For example, tofu is more likely to be preferred by young non-white consumers who are not knowledgeable about the health benefits of soy proteins. In other words, consumers with knowledge about the health benefits of soy food will choose soy milk, soy cheese, or veggie burgers, while avoiding tofu. Moon et al (2005) suggest that health claims approved by the FDA can play a significant role in advertising health benefits of soy proteins. Given our result, tofu is not likely to be influenced by such advertising. Therefore, different marketing strategies such as introduction of new products with improved taste or added convenience are needed to stimulate the consumption of tofu products.

## References

Blaylock, J. and N. Blisard. "U.S. Cigarette Consumption: The Case of Low-Income Women." *American Journal of Agricultural Economics 74*(August 1992):698-705.

Brown, D.J., and L.F. Schrader. "Cholestoral Information and Shell Egg Consumption." *American Journal of Agricultural Economics* 72 (August 1990):548-555.

Baker, G.A. and P.J. Crosbie. "Measuring Food Safety Preferences: Identifying Consumer Segments." *Journal of Agricultural and Resource Economics* 18(1993):227-287.

Capps O.and J.D. Schmitz. "A Recognition of Health and Nutrition Factors in Food Demand Analysis," *Western Journal of Agricultural Economics* 16(1991):21-35.

Cameron, A.C. and P.K. Trivedi. "Econometric Models Based on Count data: Comparision and Application of Estimators and Tests." *Journal of Applied Econometrics* 1(1986): 29-53.

Dahr, T. and J.D.Foltz. "Is Soy Milk? The Economics of the Soy Market" Paper presented at American Association of Agricultural Economics Meeting in Denver, August 1-14, 2004

Department of Health and Human Services, Food and Drug Administration. Food labeling: Health claims, soy protein and coronary heart disease. Federal Register (1999):57700-57733.

Erdman, J.W. "Soy protein and cardiovascular disease. A statement for healthcare professionals from the nutrition committee of the American Heart Association." *Circulation* 102(2000): 2555-2559.

Fishbein, M. "An Investigation of the Relationships Between Beliefs About an Object and Attitude Towards That Object." *Human Relations* 16 (1963): 233-240.

Foltz, J., B. Barham, K. Kim. "Universities and Agricultural Biotechnology Patent Production." *Agribusiness* 16(Winter 2000):82-95.

Glanz, K., M. Basil, E. Maibach, J. Goldberg, and D. Snyder. "Why American eat what they do – taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption." *Journal of American Dietetic Association* 98 (1998):1118-1126.

Greene, W. *Econometric Analysis*. Saddle River, NJ: Prentice Press 1997.

Grossman, M. and R. Kaestner. "Effects of Education on Health," *The Social Benefits of Education*. J.R. Behrman and N.G. Stacey, eds. University of Michigan Press, 1997

Henkel, J. "Soy: Health claims for soy protein, questions about other components." FDA Consumer Magazine May-June, 2000.

Heien D.M., and C.R. Wessells. "The Demand for Diary Products: Structure, Prediction, and Decomposition," *American Journal of Agricultural Economics* 70 (May 1988): 219-228.

Haines, P., D. Guilkey, and B. Popkin. "Modelling Food Consumption Decisions as Two-step Process." *American Journal of Agricultural Economics* 70(August 1988):543-552.

Ippolito, P.M., and A.D. Mathios. "Information, Adversting, and Health Choices: A Study of the Cereal Market." *RAND Journal of Economics* 21(1990):459-480.

Jensen, K. “Fluid Milk Purchase Patterns in the South: Effects of Use of Nutrition Information and Household Characteristics,” *Journal of Agricultural and Applied Economics* 27 (December 1995): 644-57.

Jaeger, S. and H. Meiselman. “Perceptions of meal convenience: the case of at-home evening meals.” Appetite 42(2004):317-325..

Kilcast, D., J. Cathro, and L. Morris. “Practical approaches to increasing vegetable consumption.” Nutrition and Food Science 5(1996):48-51.

King, G. “Statistical models for political science event counts: Bias in conventional procedures and evidence for the exponential Poisson regression model,” *American Journal of Political Science* 32(1988):838-863.

Krebs-Smith, S.M., J. Heimendinger, B.H. Patterson, A.F. Subar, R. Kessler, and E. Pivonka. “Psychological Factors Associated with Fruit and Vegetable Consumption.” *American Journal of Health Promotion* 10 (1995):98-104.

Lancaster, K. *Consumer Demand: A New Approach.* New York: Columbia University Press, 1971.

Ladd, G. W. and V. Suvannunt. “A Model of Consumer Goods Characteristics.” *American Journal of Agricultural Economics* 58(August 1976):504-510.

Land, K.C. “Models for criminal careers: some suggestions for moving beyond the current debate.” *Criminology* 30(1992):149-155.

Lin, C.-T. J. and W. Milon. “Attribute and Safety Perceptions in a Double-Hurdle Model of Shelfish Consumption.” *American Journal of Agricultural Economics* 75(August 1993):724-729.

Long J.S. *Regression Models for Categorical and Limited Dependent Variables* Advanced Quantitative Techniques in the Social Science Series 7 Sage Publications, 1997

Pendleton, L. H. and J.S. Shonkwiler. “Valuing Bundled Attributes: A Latent Characteristics Approach.” *Land Economics* 77(2001):118-129.

Messina, M. C. Gardner and S. Barnes. “Gaining Insight into the Health Effects of Soy but a Long Way Still to Go: Commentary on the Fourth International Symposium on the Role of Soy in Preventing and Treating Chronic Disease**”** *Journal of Nutrition*132 (2002):547S-551S.

Moon Wanki, S.K. Balasubramanian, and A. Rimal. “Perceived Health Benefits and Soy Consumption Behavior: Two-State Decision Model Approach.” *Journal of Agricultural and Resource Economics* 30(2005):31-332.

Mullahey, J. "Specification and testing of some modified count data models." *Journal of Econometrics* 33(1986):341-365.

Nayga, R.M. Jr. "Impact of Sociodemographic Factors on Perceived Importance of Nutrition in Food Shopping." *Journal of Consumer Affairs* 31 (1997):1-9.

Rimal, Arbindra, S. Fletcher, and K. McWatters. "Nutrition Considerations in Food Selection." *International Journal of Food and Agribusiness Review* 13 (2001).

Rimal, A. and S. M. Fletcher. "Influence of Product Attributes and Household Characteristics on Consumers' Attitude and Purchase Pattern of In-shell Peanuts." *Journal of Food Distribution Research* 31(2000): 28-36.

Soyatech, Inc. and SPINS, Co. "Soyfoods: The U.S. Market" (2004)

Van Ravenswaay, E., and J.P. Hoehn. "Contingent Valuation and Food Safety: the Case of Pesticide Residues in Food." Staff paper No. 91-13. Department of Agricultural Economics, Michigan State University, 1991.

Wu, Y., E. Molaison, J. Pope, and S. Reagan. "Attitude and acceptance of soy-based yogurt by college students." Nutrition and Food Science 25 (2005):253-257.

Ward R. and W. Moon. "Changing Attitudes about Fat and Cholesterol: Do They Impact Meat Consumption?," *Choices*, Third Quarter, 40-42 (1996).

Yen, S.T. and W.S. Chern. "Flexible Demand Systems with Serially Correlated Errors: Fat and Oil Consumption in United States," *American Journal of Agricultural Economics* 74 (1992):689-97.

Young, C.E. and L. S. Kantor. "Moving toward the food guide pyramid: implications for U.S. Agriculture." ERS, USDA, Agricultural Economics Report No. 779.

Zhang, X., X. O. Shu, Y. Gao, G. Yang, Q. Li, H. Li, F. Jin and W. Zheng. **"**Soy Food Consumption Is Associated with Lower Risk of Coronary Heart Disease in Chinese Women." *Journal of Nutrition* 133(2003):2874-2878.

**Table 1. Description of variables included in the study**

| Variable | Description |
|---|---|
| Tofu | Consumption of frequency of tofu per month |
| Veggie Burger | Consumption of frequency of veggie burger per month |
| Soy Milk | Consumption of frequency of soy milk per month |
| Soy Supplements | Consumption of frequency of soy supplement per month |
| Meat Substitutes | Consumption of frequency of meat substitute per month |
| Soy Cheese | Consumption of frequency of soy cheese per month |
| **Perceived Attributes Soy Products** | |
| *Health Benefits* | |
| Lowering Cholesterol | Soy foods lower cholesterol level in blood |
| Antioxidant | Soy foods act as an antioxidant |
| Bone mass (Osteoporosis) | Soy foods retain bone mass |
| Menopause | Soy foods are good for women during menopause |
| *Convenience* | |
| Convenient | Soyfoods are convinient |
| Recipes | Recipes that use soy-based foods are readily available |
| Preparation | I know how to prepare soy-based food items |
| *Taste* | I like the taste of soy-based foods |
| *Inexpensive* | Soy-based foods are inexpensive |
| *Health Knowledge* | Binary variable representing health knowledge. 1 = More than 8 correct answers to health questions; 0 otherwise |
| **Sociodemographics** | |
| Age | Respondents' age in years |
| Gender | 1 = female; 0 = male |
| Income | 1 = less than $5,000; 25 = $250,000 or more |
| Education | 1 = grade school; 2 = some high school; 3 = high school graduate; 4 = some college; 5 = two years of college; 6 = four years of college; 7 = some post-graduate; 8 = post graduate degree |
| Household Size | Number of household member |
| Children | Number of children in the household |
| Ethnic background | 1 if white; 0 otherwise |

**Table 2. Soy Food Consumption Behavior of Surveyed Households**

| Soy Food Products | Respondents Reporting Non-Zero Consumption (%) | Mean Consumption Frequency, All Observations ± MSE (Times/month) | Mean Consumption Frequency, Non-Zero Consumption ± MSE (Times/month) |
|---|---|---|---|
| Tofu | 18.64 | 0.78 ± 0.054 | 4.18 ± 0.238 |
| Veggie Burger | 18.49 | 0.70 ± 0.048 | 3.77 ± .213 |
| Soy Milk | 12.54 | 1.30 ± 0.048 | 10.36 ± 0.573 |
| Soy Supplements | 7.98 | 1.13 ± 0.102 | 14.09 ± 0.877 |
| Meat Substitutes | 18.86 | 1.13 ± 0.076 | 5.98 ± 0.323 |
| Soy Cheese | 6.33 | 0.53 ± 0.060 | 8.36 ± 0.717 |
| All | 36.37 | 5.57 ± 0.303 | 15.32 ± 0.735 |

Note: MSE = Mean Standard Error

**Table 3. Summary statistics of variables representing soyfood attributes and socio-economic characteristics of respondents.**

| | All Observation | | Non-zero consumption | | Zero consumption | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| **Perceived Attributes Soy Products** | | | | | | |
| *Health Benefits* (a=0.85) | 4.59 | 1.07 | 4.99[A] | 1.10 | 4.37[B] | 0.99 |
| Lowering Cholesterol | 4.75 | 1.30 | 5.11 [A] | 1.33 | 4.55 [B] | 1.23 |
| Antioxidant | 4.54 | 1.21 | 4.90 [A] | 1.23 | 4.34 [B] | 1.12 |
| Bone mass (Osteoporosis) | 4.36 | 1.31 | 4.70 [A] | 1.42 | 4.17 [B] | 1.20 |
| Menopause | 4.72 | 1.36 | 5.23 [A] | 1.36 | 4.43 [B] | 1.23 |
| *Convenience* (a=0.74) | 3.32 | 1.31 | 4.05 [A] | 1.37 | 2.88 [B] | 1.07 |
| Convenient | 3.60 | 1.46 | 4.28 [A] | 1.39 | 3.18 [B] | 1.34 |
| Recipes | 3.73 | 1.59 | 4.26 [A] | 1.66 | 3.41 [B] | 1.46 |
| Preparation | 2.64 | 1.77 | 3.64 [A] | 1.89 | 2.04 [B] | 1.38 |
| *Taste* | 3.14 | 1.73 | 4.32 [A] | 1.65 | 2.43 [B] | 1.35 |
| *Inexpensive* | 3.24 | 1.49 | 3.58 [A] | 1.51 | 3.04 [B] | 1.44 |
| **Health Knowledge** | 0.55 | 0.60 | 0.65 [A] | 0.48 | 0.50 [B] | 0.50 |
| **Sociodemographics** | | | | | | |
| Age | 45.12 | 12.71 | 45.54 [A] | 12.66 | 44.82 [A] | 12.71 |
| Gender | 0.51 | 0.50 | 0.53 [A] | 0.50 | 0.50 [A] | 0.50 |
| Income | 11.37 | 5.71 | 12.32 [A] | 6.01 | 10.80 [B] | 5.47 |
| Education | 4.95 | 1.62 | 5.36 [A] | 1.68 | 4.77 [B] | 1.60 |
| Household Size | 2.52 | 1.24 | 2.43 [B] | 1.19 | 2.58 [A] | 1.27 |
| Children | 0.62 | 0.97 | 0.54 [B] | 0.90 | 0.68 [A] | 1.00 |
| Ethnic background | 0.93 | 0.26 | 0.89 [B] | 0.32 | 0.95 [A] | 0.22 |

Mean tests were conducted using Tukey process. Means with the same letters are not significantly different at 5%.

**Table 4a. Soy Food Consumption: Results from Zero Inflated Negative Binomial Count Data Models**

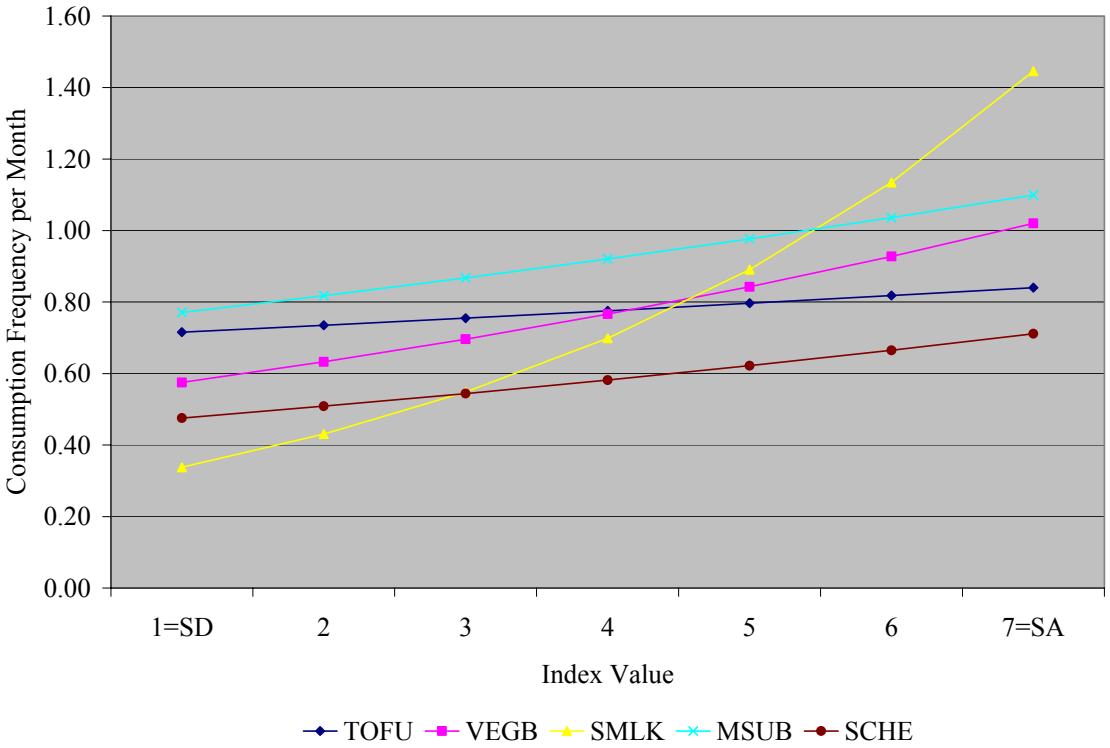
| Variables | Tofu | | Vegetable Burgers | | Soymilk | |
|---|---|---|---|---|---|---|
| | Param. Estimates | t-Ratio | Param. Estimates | t-Ratio | Param. Estimates | t-Ratio |
| Constant | -1.870** | -5.727 | -2.290** | -5.442 | -2.651** | -5.557 |
| Health Benefits | 0.027 | 0.802 | 0.096** | 3.017 | 0.242** | 5.319 |
| Convenience | 0.266** | 6.818 | 0.192** | 5.245 | 0.261** | 5.809 |
| Taste | 0.221** | 7.013 | 0.233** | 6.135 | 0.363** | 7.761 |
| Inexpensive | -0.030 | -1.228 | 0.000 | 0.021 | -0.164** | -4.422 |
| Health Knowledge | 0.005 | 0.082 | -0.058 | -0.963 | 0.242** | 5.319 |
| Age | -0.008** | -3.087 | 0.001 | 0.331 | 0.005** | 2.088 |
| Gender | 0.023 | 0.350 | -0.167** | -2.519 | -0.003 | -0.037 |
| Income | 0.018** | 3.026 | -0.001 | -0.215 | -0.006 | -0.862 |
| Education | 0.110** | 4.888 | 0.075** | 3.124 | 0.088** | 2.839 |
| Household Size | -0.003 | -0.067 | 0.065 | 1.289 | -0.167** | -3.275 |
| Children | -0.057 | -0.971 | -0.113* | -1.789 | 0.177** | 2.680 |
| Ethnic Background | -0.369** | -3.009 | -0.107 | -1.004 | -0.447** | -2.508 |
| Dispersion parameters | | | | | | |
| Alpha | 2.057** | 10.079 | 2.198** | 11.100 | 7.198** | 29.407 |
| Zero inflation model | | | | | | |
| Tau | -2.231** | -6.050 | -2.368** | -5.284 | -2.463** | -7.362 |

Note: * = Significance at $a<0.10$; and **=Significance at $a<0.05$

**Table 4b. Soy Product Consumption: Results from Zero Inflated Negative Binomial Count Data Models.**

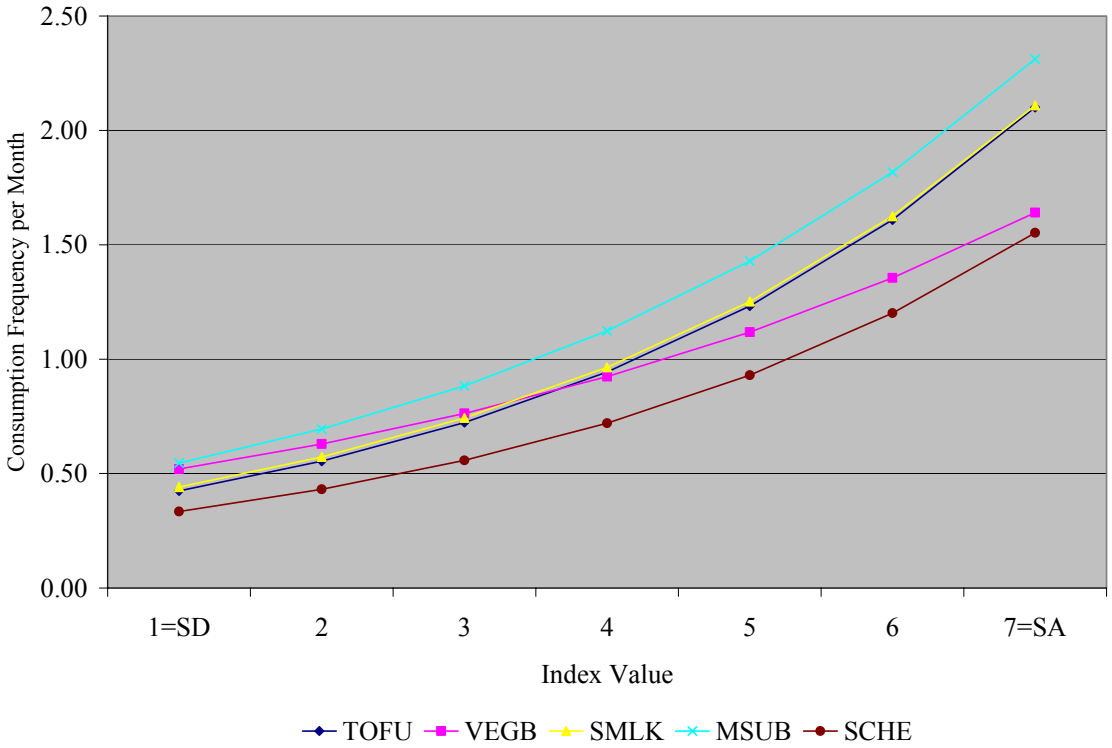
| Variables | Meat Substitutes | | Soy supplements | | Soy Cheese | |
|---|---|---|---|---|---|---|
| | Param. Estimates | t-Ratio | Param. Estimates | t-Ratio | Param. Estimates | t-Ratio |
| Constant | -2.417** | -6.014 | -2.662** | -3.693 | -2.569** | -2.810 |
| Health Benefits | 0.059* | 1.697 | 0.328** | 3.871 | 0.067* | 1.863 |
| Convenience | 0.241** | 6.248 | - | - | 0.256** | 2.815 |
| Taste | 0.261** | 7.524 | - | - | 0.184** | 3.022 |
| Inexpensive | -0.032 | -1.344 | 0.117** | 3.230 | -0.048* | -1.774 |
| Health Knowledge | -0.057 | -0.862 | 0.423** | 3.602 | 0.036 | 0.587 |
| Age | 0.004 | 1.556 | 0.019** | 3.716 | 0.007** | 2.205 |
| Gender | -0.064 | -0.960 | 0.050 | 0.690 | 0.064 | 1.106 |
| Income | 0.001 | 0.134 | -0.007 | -1.558 | -0.003 | -0.707 |
| Education | 0.104** | 4.324 | 0.022 | 1.083 | 0.026 | 1.158 |
| Household Size | 0.009 | 0.184 | -0.075** | -2.243 | -0.074 | -1.279 |
| Children | -0.042 | -0.652 | -0.030 | -0.674 | 0.064 | 0.889 |
| Ethnic Background | -0.082 | -0.567 | -0.023 | -0.377 | 0.211 | 1.500 |
| Dispersion parameters | | | | | | |
| Alpha | 3.765** | 18.827 | 22.404** | 39.274 | 10.117** | 17.218 |
| Zero inflation model | | | | | | |
| Tau | -2.216** | -6.251 | -3.986** | -3.519 | -4.748** | -2.874 |

Note: * = Significance at $a<0.10$; and **=Significance at $a<0.05$



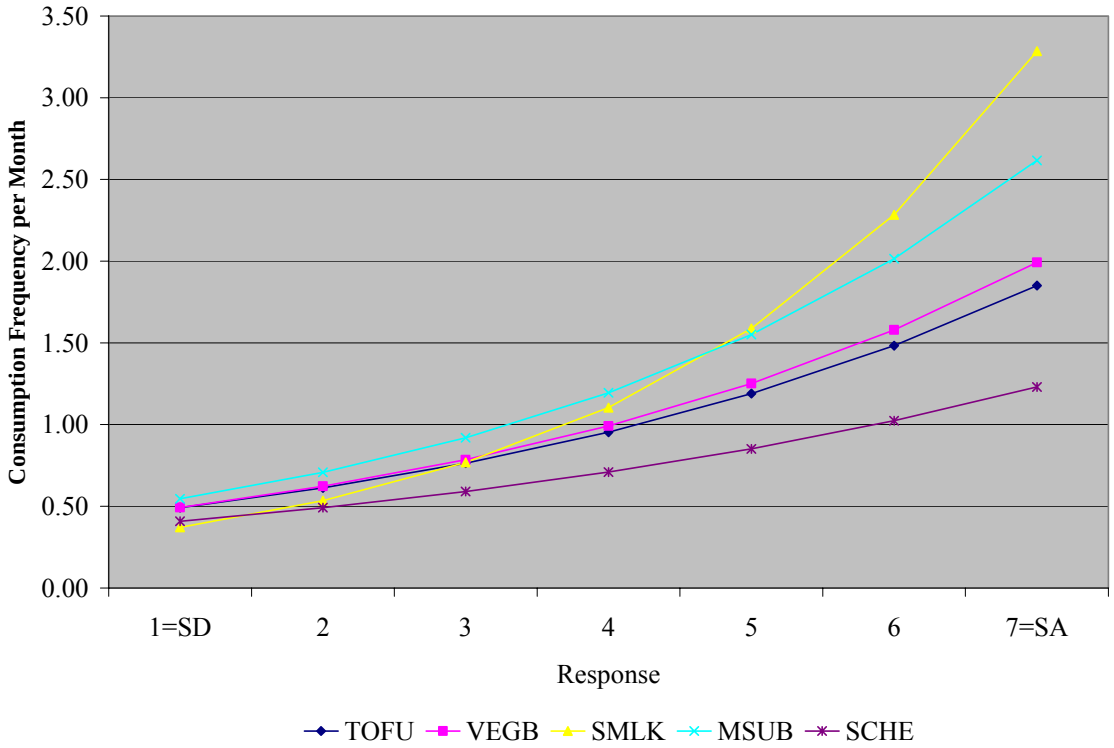

Note: Index Value (1-7 scale); 1 = strongly disagree (SD), 7 = strongly agree (SA)

**Figure 1. Simulated impact of perceived health attributes of soy foods on consumption frequency.**




Note: Index Value (1-7 scale); 1 = strongly disagree (SD), 7 = strongly agree (SA)

**Figure 2. Simulated impact of perceived convenience attributes of soy foods on consumption frequency.**




Note: Index Value (1-7 scale); 1 = strongly disagree (SD), 7 = strongly agree (SA)

**Figure 3. Simulated impact of perceived taste of soy foods on consumption frequency.**