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# Perceived Health Benefits and Soy Consumption Behavior: Two-Stage Decision Model Approach

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A two-stage decision model is developed to assess the effect of perceived soy health benefits on consumers' decisions with respect to soy food. The first stage captures whether or not to consume soy food, while the second stage reflects how often to consume. A conceptual/analytical framework is also employed, combining Lancaster's characteristics model and Fishbein's multi-attribute model. Results show that perceived soy health benefits significantly influence both decision stages. Further, consumers' negative perceptions regarding soy (unappetizing taste and inconvenience) have a substantially greater impact on soy consumption behavior than their perceptions about soy health benefits. This finding carries significant implications for the soy industry. Additionally, this health benefit perception mediates the effect of general health-related factors such as knowledge, motivation, and awareness on soy consumption behavior. Our results also underscore the importance of current FDA-regulated health claims in stimulating consumer demand for soy foods.

*Key words:* health benefits from soy food, Lancaster's characteristics model, multi-attribute model, two-stage decision model

## Introduction

In recent years, policy makers and academics have focused considerable attention on the impact of health information on consumers' food/dietary choices. Public policy officials need to know how health information alters food consumption behavior in order to effectively educate people about diet-disease links. Yet, academic researchers have focused mainly on quantifying the effect of health information on health behaviors in general (e.g., Grossman, 1972, 1976; Kenkel, 1991; Moorman and Matulich, 1993) and food/dietary choices in particular (e.g., Putler and Frazao, 1991; Jensen, Kesavan, and Johnson, 1992; Variyam et al., 1999; Chern, 2002).

This analysis examines whether the perceived health benefits from soy proteins influence the consumption of soy foods. Over the past decade, clinical research has demonstrated that soy foods provide various health benefits relative to chronic diseases such as osteoporosis, heart disease, and cancer. For example, Messina and Barnes (1995) found that the intake of soy foods produced anti-carcinogenic effects on breast

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and prostate cancers. Research has also shown that individuals who consume 25 grams of soy protein a day may significantly lower their blood cholesterol (Anderson, Johnstone, and Cook-Newell, 1995). In 1999, the Food and Drug Administration (FDA) recognized such health benefits by allowing food companies to use health claims on soy-based foods containing at least 6.25 grams of soy protein per serving (i.e., one-fourth of the recommended daily intake of 25 grams).[1]

Our research goal is to assess the impact of health benefits and related health claims on the development of the soy food market. Specifically, we examine whether consumers' perceptions of health benefits from soy foods impact two decisions: (*a*) whether to consume soy foods (the soy market-participation decision), and (*b*) how often to consume (the consumption-intensity decision). Heckman's sample selection model is used to jointly estimate regression equations representing these two decision stages.

A key advantage of the two-stage decision model is that the same set of explanatory variables may be included in the two related equations, while the framework allows the flexibility for each variable to impact the two decisions differently. For example, the two-stage model specification can accommodate any of four roles for the perceived soy health benefit construct: (*a*) it exerts a strong and positive influence on both decisions, thereby raising both market penetration (more new consumers) and consumption (more intake among existing consumers); (*b*) it significantly influences only the decision whether or not to consume soy foods, while having no impact on how often to consume; (*c*) it does not increase the probability of consuming soy foods, but motivates soy users to increase their soy intake; and (*d*) it has no impact on either decision.

We conceptualize the link between soy-related health benefits and soy consumption behavior using Lancaster's (1971) characteristics model and Fishbein's (1967) multi-attribute model. Other attributes analyzed include taste, convenience, and the price of soy foods. Simulation analyses are used to illustrate the impact of perceived taste and convenience (relative to health benefits) on soy consumption behavior. We anticipate that general health-related factors such as health knowledge, motivation, and nutritional awareness may influence perceived soy health benefits and/or soy consumption behavior. More specifically, we hypothesize that the health benefit construct mediates the effects of general health-related factors on soy consumption behavior.

## Previous Studies

Evidence indicates that increased knowledge and awareness of diet-disease links motivate consumers to reduce their intake of fat and cholesterol. For example, Brown and Schrader (1990) found consumers' knowledge about the role of cholesterol in heart disease caused a significant drop in shell egg consumption. Chern, Loehman, and Yen (1995) illustrated two beneficial consequences from the growing availability and awareness of health information: a stimulated demand for vegetable oils and a decrease in the intake of butter and lard.

Other researchers have focused attention on the marketing impact of using health claims on food products. Historically, FDA policy banned health claims on food products

[1] The approval was in response to a petition filed by Protein Technologies International (PTI), a Dupont Business, in May 1998. The FDA approved the following health claims: "25 grams of soy protein a day as part of a diet low in saturated fat and cholesterol may reduce the risk of heart disease."

prior to 1985. However, the breakfast cereal industry began using health claims on its products to showcase the link between dietary fiber intake and the lowered risk of colon cancer. This prompted a review of FDA policy on health claims that eventually lifted the ban. The subsequent proliferation of carefully regulated health claims on food products has produced several positive outcomes.

Ippolito and Mathios (1993) show that health claims significantly enhanced consumer knowledge about the fiber-cancer relationship, thereby increasing consumption of fiber-rich cereals. In a subsequent study, Ippolito and Mathios (1995) found additional support for the role of health claims: the consumption of fats and saturated fats decreased faster after 1985 when compared to the 1977–85 period. More recently, Mathios (1998) showcased the dysfunctional consequences associated with the elimination of health claims. Since cooking oils contain more fats than the threshold deemed acceptable, the Nutrition Labeling and Education Act (NLEA) of 1994 disallowed health claims for this food category. Previously, cooking oils lower in saturated fats and higher in monounsaturated fats were shown to be superior to other oils from a heart-health perspective. Using supermarket scanner data, Mathios (1998) found that consumers shifted purchases toward cooking oils higher in saturated fat and lower in monounsaturated fat in the post-NLEA environment. Finally, Balasubramanian and Cole (2002) argue that consumers are more likely to purchase nutritionally desirable packaged foods if they tout health claims.

Taken together, these studies illustrate the positive impact of health information on consumer behavior over time. They indicate that such information is critical to educate consumers about diet-disease links. Note that these studies sought to analyze aggregate behavioral change over time. In contrast, our study focuses on cross-sectional (individual) differences in the access to health information and the impact of such information on behavior.

A cross-sectional analytical perspective is insightful because of individual differences in using health information, especially in terms of health knowledge, motivation, information access, and information processing ability. Several studies have examined whether such cross-sectional differences account for behavioral variations in food choice or nutritional intake. For example, Variyam, Blaylock, and Smallwood (1998) reported that the greater the nutrition knowledge, the lower the intake of dietary cholesterol. Variyam et al. (1999) found that the health knowledge of mothers had a significant impact on the quality of diets consumed by their children.

Paradoxically, however, despite the excitement in the scientific community about the health-promoting characteristics of soy protein, few researchers have studied the impact of soy health benefits on soy consumption behavior. To our best knowledge, Wansink and Chan (2001) and Wansink, Westgren, and Cheney (2005) are the only notable exceptions. They relate beliefs about soy to intentions to consume soy, and actual soy consumption. These descriptive survey-based studies suggest soy consumption is more likely when individuals are aware of soy attributes that are personally relevant. More specifically, individuals are more likely to consume soy foods when they possess attribute-related knowledge and consequence-related knowledge (i.e., how a given soy food attribute will benefit them). In contrast, our research relies on widely accepted theoretical and empirical evidence from economics and marketing research to systematically investigate key variables that influence two decisions: (*a*) whether or not to consume soy, and (*b*) how much to consume, if the decision in (*a*) is to consume soy. Our

study also provides valuable insights about the impact of perceived soy health benefits on soy food consumption behavior.

## Conceptual and Empirical Models

The traditional utility maximization framework fails to shed light on the role of a product's attributes in collectively shaping its market demand, but a framework developed by Lancaster (1971) in a related domain offers valuable insights. Specifically, Lancaster's characteristics model proposes that utility is derived from the characteristics of the goods. Ladd and Suvannunt (1976) extended Lancaster's model in their consumer goods characteristics model (CGCM) to identify two properties: (*a*) the price of a product is a sum of the marginal implicit value of its attributes, and (*b*) consumer demand for a product is influenced by the level of its attributes as well as price and income. The first property gave rise to hedonic price models (e.g., Unnevehr and Bard, 1993; Espinosa and Goodwin, 1991). The second property was modified by Van Ravenswaay and Hoehn (1991) for the single-product case and applied by Baker and Crosbie (1993) to evaluate consumer preferences for food safety. We rely on this modified CGCM model to derive the soy food demand function ($Y$) for a consumer $t$:

$$Y_t = Y_t(\mathbf{C}, P_1, \mathbf{P}, m). \tag{1}$$

Equation (1) states that consumers' purchasing decisions for a soy food are determined by its price ($P_1$), a vector of prices of related goods ($\mathbf{P}$), income ($m$), and a vector of its other (nonprice) characteristics ($\mathbf{C}$).

The CGCM model appears more realistic than conventional demand models that ignore the impact of product attributes on market demand. Nevertheless, the CGCM model raises two issues: (*a*) whether the attributes are objectively measurable, and (*b*) whether consumers are knowledgeable about such attributes. The first issue may be problematic particularly for credence products, defined as goods whose attributes cannot be objectively evaluated even after consumption (e.g., a patient with a surgically implanted stent in her carotid artery cannot realistically evaluate the stent's quality or efficacy). With respect to the second issue, consumers are less likely to know about certain attributes, particularly those that lack search properties. For example, soy-based foods possess a nutritional attribute (isoflavones) that reduces the risk of coronary heart disease. Although the level of the isoflavones can be measured objectively, consumers may or may not be aware of the link between isoflavones and reduced risk of heart disease. When consumers are ignorant about this link, the level of isoflavones has no impact on the demand for soy foods.

For these reasons, perceived attribute levels are more appropriate determinants of soy food consumption behavior than objectively determined attribute levels. Specifically, Fishbein's multi-attribute model serves as an ideal conceptual framework linking consumers' perceptions of soy attributes to their behaviors and attitudes (Fishbein, 1967; Ajzen and Fishbein, 1980). Equation (2) expresses the multi-attribute model in a concise form:

$$Attitude_t = \sum \beta_i A_i. \tag{2}$$

The model posits that a consumer's attitude toward an object is a function of (*a*) the importance of the attributes ($\beta_i$) associated with the object, and (*b*) beliefs ($A_i$) that the object possesses those attributes.

Assuming consumers' attitudes toward soy foods are related to soy consumption, we substitute **A** with **C** in soy demand equation (1) to obtain:

$$Y_t = Y_t(P_1, \mathbf{A}, \mathbf{P}, m). \tag{3}$$

Now equation (3) represents a conceptual model that integrates the CGCM with consumers' perceptions of such characteristics. Parameters associated with the vector **A** are equivalent to the importance of attributes ($\beta_i$) in equation (2). The integrated model can be viewed as a special case of equation (1) which is more appropriate for studying experience or credence goods.

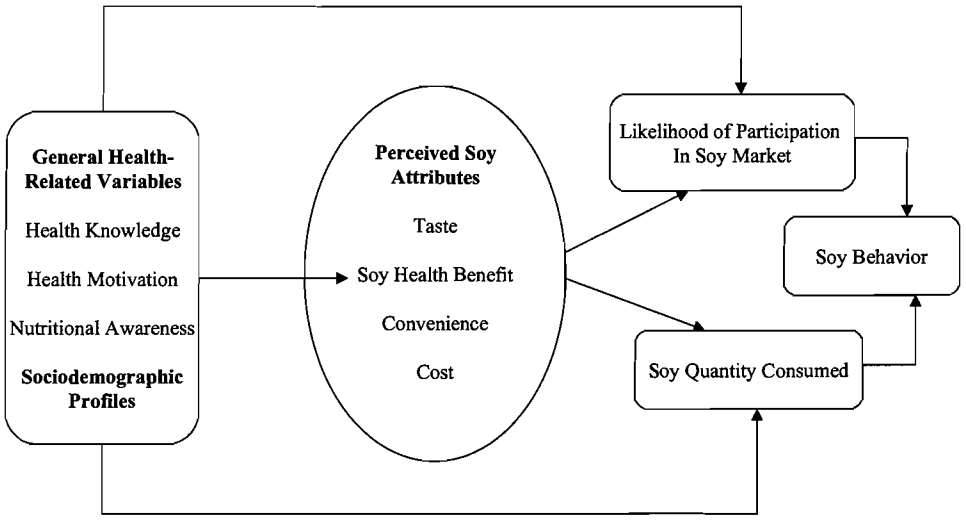
### *The Mediating Role of Perceived Soy Health Benefits*

This study focuses on four salient attributes of soy foods: price, taste, convenience, and health benefit. Therefore, vector **A** in equation (3) includes consumer perceptions of these four attributes. It must be recognized that the perceived soy health benefit is an endogenous construct which is potentially influenced by other health-related factors and demographic profiles. More specifically, we hypothesize that the perceived soy health benefit is influenced by (*a*) general consumer knowledge about the health consequences of various nutrients (health knowledge), (*b*) consumer motivation to seek nutritious foods (health motivation), (*c*) consumer awareness of the role of dietary choices in preventing diseases (nutritional awareness), and (*d*) demographic profiles including age, education, ethnic background, income, and gender.

If this hypothesis is true, health-related variables and demographic characteristics may directly impact soy food consumption and/or indirectly influence soy food consumption via the perceived soy health benefit construct. To succinctly capture these interdependent relationships among variables, we propose that the perceived health benefit construct mediates the effects of health knowledge and motivation, nutritional awareness, and demographic profiles on the two decision stages discussed earlier—i.e., whether to consume soy (soy market-participation decision) and how often to consume (consumption-intensity decision).

Figure 1 depicts the relationships among perceived attributes, general health-related variables, and soy consumption behavior. Soy consumption behavior is represented by two endogenous decisions: market participation and consumption intensity. These two decisions are influenced by perceived attributes, general health-related variables, and sociodemographic profiles. Further, figure 1 shows that the perceived soy health benefit construct mediates the impact of several constructs (general health knowledge, motivation, nutritional awareness, and sociodemographic variables) on soy consumption behavior.

We test this mediating hypothesis using the following four criteria adapted from Judd and Kenny (1981) and Baron and Kenny (1986): (*a*) the perceived soy health benefit (mediator) has a statistically significant impact on soy consumption decisions; (*b*) health knowledge, motivation, nutritional awareness, and sociodemographic profiles (predictors) significantly influence soy consumption decisions; (*c*) these predictors exert a significant




Source: Adapted from Baron and Kenny (1986).

**Figure 1. Mediating role of perceived soy health benefits in determining soy consumption behavior**

influence on the perceived soy health benefit construct; and (*d*) the effects of these predictors are either diminished or no longer significant when the perceived soy health benefit construct is controlled for in the soy behavioral equations (perfect mediation occurs if the predictors have no effect when the mediator is controlled).[2] These criteria require the estimation of the following four separate regression models:

- MODEL A. *Soy Consumption Behavior = f(Perceived Soy Health Benefit, Perceived Price, Taste*, and *Convenience*).
- MODEL B. *Soy Consumption Behavior = f(Health Knowledge, Health Motivation*, and *Nutritional Awareness*; *Age, Education, Income, Ethnic Background*, and *Gender*).
- MODEL C. *Perceived Soy Health Benefit = f(Health Knowledge, Health Motivation*, and *Nutritional Awareness*; *Age, Education, Income, Ethnic Background*, and *Gender*).
- MODEL D. *Soy Consumption Behavior = f(Perceived Soy Health Benefit, Price, Taste*, and *Convenience*; *Health Knowledge, Health Motivation*, and *Nutritional Awareness*; *Age, Education, Income, Ethnic Background*, and *Gender*).

A comparison of estimated parameters across models A through D can help determine whether the perceived soy health benefit construct mediates the effects of other health-related variables on the two decision stages.

[2] When the effects of predictors and mediator are estimated in the same equation (such as model D in our case), the model may suffer from the multicollinearity problem, resulting in reduced power in the test of model coefficients. Baron and Kenny (1986) suggest researchers should consider both the significance of the coefficients and their absolute size. In our case, the computed conditional index number is less than 15, indicating that multicollinearity is not a problem.

*Two-Stage Decision Models*

A relatively small proportion of U.S. consumers use soy-based food products on a regular basis. Wansink, Sonka, and Park (2001) underscore the importance of categorizing consumers into heavy, light, and nonuser groups when analyzing soy food consumption. Our study uses the two-step decision approach to properly address nonusers as well as users.

Two-step decision models commonly refer to double-hurdle and first-hurdle dominance models (Cragg, 1971; Jones, 1989). The double-hurdle model allows zero values to represent either optimal continuous consumption decisions (i.e., corner solutions) or discrete decisions to avoid soy foods (i.e., nonparticipants in soy market or nonusers). In contrast, the first-hurdle dominance model differentiates between users and nonusers—i.e., zero values indicate only nonusers. Because we measure soy consumption behavior as monthly consumption frequency aggregated over six different soy-based food products, zero values from our survey denote nonusers, thereby attesting to the appropriateness of the first-hurdle dominance model to fit our survey data.

The decision-making mechanism of the double-hurdle model is expressed as follows:

$$Y_t = \begin{cases} Y_t^* & \text{if } Y_t^* > 0 \text{ and } D_t > 0 \\ 0 & \text{otherwise,} \end{cases} \tag{4}$$

where

$$Y_t^* = \mathbf{X}_t\beta + \varepsilon_t \text{ and } D_t = \mathbf{Z}_t\theta + \nu_t.$$

The actual observed consumption of soy food is $Y_t$, and $Y_t^*$ is a latent variable representing the optimal level of soy consumption. $D_t$ is a binary (one or zero) discrete variable that reflects the soy market-participation decision. A vector of explanatory variables ($\mathbf{X}_t$) impacts the consumption decision, while $\mathbf{Z}_t$ is a vector of variables explaining the decision to participate. Both $D_t$ and $Y_t^*$ must simultaneously be greater than zero to observe positive $Y_t$, with the zeros indicating either optimal consumption decisions (corner solutions) or discrete decisions. When the error terms in equation (4) follow a bivariate normal distribution, the double-hurdle model is represented by the likelihood function below (Blundell and Meghir, 1987; Jones, 1989; Blisard and Blaylock, 1993):

$$\begin{aligned} L = {} & \prod_0 \left[1 - \Pr(D_t = 1)\Pr(Y_t^* > 0 \mid D_t = 1)\right] \\ & \prod_1 \Pr(D_t = 1)\Pr(Y_t^* > 0 \mid D_t = 1)\Pr\left[Y_t^* \mid Y_t^* > 0, D_t = 1\right]. \end{aligned} \tag{5}$$

A special case of the double-hurdle arises when there are no corner solutions, with all zero observations signaling that the household does not consume soy food products, thus leading to specifications commonly noted as the first-hurdle dominance model (Jones, 1989; Blisard and Blaylock, 1993). The statistical counterpart to the first-hurdle dominance model is the sample selection model which differs from equation (5) in that only $D_t$ needs to be greater than 0 to observe positive $Y_t$. The first-hurdle dominance decision rule for soy consumption is represented with the likelihood:

$$L = \prod_0 \left[1 - \Pr(D_t = 1)\right] \prod_1 \Pr(D_t = 1)\Pr\left[Y_t^* \mid D_t = 1\right]. \tag{6}$$

Equations (5) and (6) differ in two components: $\Pr(Y_t^* > 0 \mid D_t = 1)$ is equal to one, and $\Pr[Y_t^* \mid Y_t^* > 0, D_t = 1]$ is reduced to $\Pr[Y_t^* \mid D_t = 1]$. These two differences clearly establish that once having decided to enter the soy market, no corner solutions are observed. The log-likelihood function corresponding to equation (6) is shown below (Davidson and MacKinnon, 1993):

$$\ln L = \sum_0 \ln\left(1 - \Phi(\mathbf{Z}_t\theta)\right) + \sum_1 \ln\left\{\phi(Y_t - \mathbf{X}_t\beta)/\sigma\right\} \sum_1 \ln\left\{\Phi\{\mathbf{Z}_t\theta + \rho(Y_t - \mathbf{X}_t\beta)/\sigma\}/(1 - \rho^2)^{1/2}\right\}. \tag{7}$$

Equation (7) is applied to estimate the four regression models developed earlier. Accordingly, the dependent variable in models A, B, and D will be divided into two stages: (*a*) the soy market-participation decision for all respondents, and (*b*) the soy consumption-intensity decision for respondents who participate in the soy market.

## Survey Design

A survey instrument was designed to elicit information necessary to estimate equation (5) including soy food consumption behavior and perceptions about various attributes pertinent to soy-based foods. The instrument was administered as an online survey to members of the Ipsos-NPD marketing research panel. Of the 400,000 households who participate in this online panel, a random sample of 3,000 households was selected by Ipsos-NPD, with households appropriately stratified by geographic regions, income, education, and age to correspond to the 2000 U.S. Census. Ipsos-NPD sent e-mail solicitations to these 3,000 households seeking their participation in our survey. Each e-mail contained a unique URL (keyed to the respondent's ID) that directed recipients to the survey website.

More than 1,400 households returned the completed questionnaire, yielding a response rate of about 47%. The online survey elicited sociodemographic information including respondents' age, education, income, household size, geographic region, gender, and ethnic background. Nearly 91% of the respondents were white, significantly underrepresenting Asians (1.8%) and African Americans (2.8%) in our sample as compared to the 2000 U.S. Census (i.e., whites = 75.1%, Asians = 3.6%, Blacks = 12.3%). For the survey income categories, 25.8% of respondents reported annual income under $30,000, 53% reported income in the range of $30,000 to $75,000, and 21.2% reported income of $75,000 or higher. The respective percentages for these categories in the 2000 U.S. Census were 35%, 42%, and 23%. Therefore, the share of respondents representing the middle income category is moderately over-represented. About 32% of the survey respondents have a bachelor's degree or higher, compared to 24.4% under the 2000 U.S. Census. Finally, approximately 33% of respondents resided in the South, followed by Midwest (24.3%), West (23.4%), and Northeast (19%).

### *Soy Food Consumption Behavior*

Soy food consumption behavior is defined here as monthly consumption frequency of tofu, soy veggie burgers, soy milk, soy supplements, soy cheese, and meat substitutes. For each of six soy-food products in our study, table 1 presents the proportion of

**Table 1. Soy-Based Food Consumption Behavior of Survey Households: Participation and Frequency**

| Soy-Based Food Item | Proportion of Respondents Reporting Nonzero Consumption (%) | Mean Consumption Frequency, All Observations (times/month) | Mean Consumption Frequency, Nonzero Observations (times/month) |
|---|---|---|---|
| Tofu | 18.63 | 0.79 | 4.17 |
| Soy milk | 12.53 | 1.29 | 10.35 |
| Veggie burgers | 18.48 | 0.70 | 3.76 |
| Meat substitutes | 18.90 | 1.14 | 6.05 |
| Soy supplements | 7.98 | 1.12 | 14.09 |
| Soy cheese | 6.32 | 0.53 | 8.35 |
| Total | 36.30 | 5.57 | 15.31 |

respondents reporting a nonzero frequency of consumption. It also shows the average monthly consumption frequency with and without zero reports included. Meat substitutes, tofu, and veggie burgers exhibited the greatest market penetration, with more than 18% of respondents reporting nonzero levels of consumption, followed by soy milk (12.5%), soy supplements (7.9%), and soy cheese (6.3%). Among soy users, soy supplements and soy milk were most frequently consumed, at 14.09 and 10.35 times per month, respectively. When combined across the six categories, average consumption frequency was 5.57 times per month for the entire sample and 15.31 times per month for the subsample of soy users. More than 36% of total respondents reported they consumed one or more of the six soy food products at least once per month.

*Perceived Attributes of Soy-Based Foods*

Four broad attributes of soy food are considered in this study: price, taste, convenience, and health benefits. The survey instrument incorporated questions measuring respondents' perceptions of these attributes. Perceptions about soy health benefits were measured as a composite index (Cronbach's $\alpha = 0.85$) based on responses to the following four statements on a seven-point rating scale (1 = strongly disagree, 7 = strongly agree): Soy foods (*a*) lower cholesterol level in your blood; (*b*) act as an antioxidant; (*c*) help retain bone mass, thereby reducing the risk of osteoporosis; and (*d*) are good for women during menopause. Perceived convenience was measured by the sum of three similarly rated items (Cronbach's $\alpha = 0.74$): (*a*) soy-based foods are convenient, (*b*) recipes for soy-based foods are readily available, and (*c*) I know how to prepare soy-based food products. In addition, perceived price and perceived taste were respectively measured with the statements: "Soy foods are inexpensive," and "I like the taste of soy-based foods."

*General Health-Related Variables*

Given the main focus of our study on the link between perceptions about soy-specific health benefits and soy consumption behavior, we anticipate that general health-related factors are relevant in explaining the variance in perceived soy health benefits and/or soy consumption behavior. Specifically, three such factors (general health knowledge, motivation, and nutritional awareness) are considered here.

The health knowledge construct was measured using an instrument drawn from Moorman and Matulich (1993), who define health knowledge as the extent to which consumers have enduring health-related cognitive structures. In this instrument, respondents were asked to link or match each of 11 nutrients (i.e., sodium, calcium, vitamin A, protein, vitamin C, iron, vitamin D, carbohydrates, saturated fat, potassium, and dietary fiber) with an appropriate health consequence from the following list: high blood pressure, strong bones, healthy eyes, amino acids, anticancer power, oxygen, absorb calcium, conversion to sugar and fueling the body, cardiovascular disease, and balancing sodium. An index of health knowledge was constructed by adding all correct answers for each respondent. Hence, the index ranges from a minimum of 0 (representing no health knowledge) to a maximum of 11 (representing the highest health knowledge).

Health motivation is defined as consumers' goal-directed arousal to engage in preventive dietary health behaviors (Moorman and Matulich, 1993). In our study, health motivation is operationalized specifically in relation to dietary behavior and measured using responses to the following three statements (Cronbach's $\alpha = 0.66$): (*a*) I read nutrition labels on food packages very carefully, (*b*) I consulted a dietitian in the past year, and (*c*) I changed my diet in the past year to reduce the risk of certain diseases. Responses to these items were averaged to obtain an index of health motivation.

Finally, nutritional awareness refers to consumers' awareness of the importance of dietary choices in preventing diseases. This construct was measured with the following eight items (Cronbach's $\alpha = 0.87$): (*a*) I am very concerned about the amount of salt in my diet, (*b*) I eat a lot of fresh fruit, (*c*) I eat a lot of fresh vegetables, (*d*) I am actively trying to consume less fat in my diet, (*e*) I am actively trying to consume less cholesterol in my diet, (*f*) I am very much concerned about linkages between diet and chronic diseases, (*g*) I am very concerned about nutrition, and (*h*) I am concerned about getting enough calcium in my diet. Responses to these statement items were averaged to obtain an index of nutritional awareness. Table 2 provides brief descriptions and summary statistics for all the items/constructs used to estimate our models.

## Results

Models A, B, and D were estimated using Heckman's two-step estimation procedure, because maximum-likelihood (ML) estimation failed to achieve convergence. The ML estimation of equation (7) is usually cumbersome, so the computationally simpler Heckman's two-step technique is often used (Heckman, 1979). Parameter estimates from the two-step procedure are consistent, although not as efficient as ML estimates. Because residuals in the second step of the Heckman's method were heteroskedastic, we used White's heteroskedasticity-consistent covariance matrix estimator. Model C for perceived soy health benefit was estimated by the ordinary least squares (OLS) method. Table 3 presents estimation results for models A through D.

Model A links perceived attributes to the soy-related decision in each of the two stages. Results show that perceptions about health benefits, taste, and convenience have a significant impact on the probability of consuming soy-based food products (first-stage decision on whether to consume) as well as consumption intensity (second-stage decision on how often to consume). Respondents who perceive health-related benefits from soy

**Table 2. Description and Summary Statistics of Variables in Model Estimation**

| Variable | Description | Mean | Std. Dev. |
|---|---|---|---|
| **Perceived Soy Attributes:** | | | |
| ▸ *Health Benefits:* ($\alpha$ = 0.85) | | | |
| Lowering cholesterol | Soy foods lower cholesterol level in blood | 4.75 | 1.32 |
| Antioxidant | Soy foods act as an antioxidant | 4.55 | 1.22 |
| Bone mass | Soy foods help retain bone mass | 4.35 | 1.32 |
| Menopause | Soy foods are good for women during menopause | 4.74 | 1.36 |
| ▸ *Convenience:* ($\alpha$ = 0.74) | | | |
| Convenient | Soy foods are convenient | 3.59 | 1.45 |
| Recipes | Recipes for soy foods are readily available | 3.74 | 1.59 |
| Preparation | I know how to prepare soy foods | 2.64 | 1.77 |
| ▸ *Taste* | I like the taste of soy foods | 3.14 | 1.73 |
| ▸ *Price* | Soy foods are inexpensive | 3.24 | 1.48 |
| **Health Knowledge** | Aggregation of correct answers to 11 nutrition questions | 8.29 | 2.65 |
| **Health Motivation:** ($\alpha$ = 0.66) | | | |
| Nutrition label | I read nutritional labels very carefully | 4.26 | 1.84 |
| Dietitian | I consulted a dietitian in the past year | 1.71 | 1.52 |
| Changing diet | I changed my diet to reduce the risk of certain diseases | 3.29 | 1.94 |
| **Nutritional Awareness:** ($\alpha$ = 0.87) | | | |
| Fresh fruit | I eat a lot of fresh fruits | 4.16 | 1.67 |
| Fresh vegetables | I eat a lot of fresh vegetables | 4.39 | 1.61 |
| Less fat | I actively try to consume less fat in my diet | 4.59 | 1.67 |
| Less cholesterol | I actively try to consume less cholesterol | 4.32 | 1.72 |
| Chronic diseases | I am very concerned about linkages between diet and chronic diseases | 4.57 | 1.63 |
| **Sociodemographics:** | | | |
| Income | 1 = less than \$5,000; 25 = \$250,000 or more | 11.4 | 5.6 |
| Age | Respondent's age in years | 45.3 | 12.54 |
| Education | 1 = grade school<br>2 = some high school<br>3 = high school graduate<br>4 = some college<br>5 = two years of college<br>6 = four years of college<br>7 = some post-graduate<br>8 = post-graduate degree | 5.0 | 1.63 |
| Gender | 1 if male; 0 otherwise | 0.47 | |
| Ethnic background | 1 if white; 0 otherwise | 0.91 | |

Notes: Seven-point ratings of agreement (1 = strongly disagree, 7 = strongly agree) were used to measure perceived health benefits, convenience, taste, and price, health motivation, and nutritional awareness. Alpha ($\alpha$) represents Cronbach's measure of internal consistency.

**Table 3. Soy Food Consumption Behavior of Survey Households: Estimated Parameters of Sample Selection Models**

| | Model A | | Model B | | Model C[a] | | Model D | |
|---|---|---|---|---|---|---|---|---|
| Variable | Param. Estimate | *t*-Ratio | Param. Estimate | *t*-Ratio | Param. Estimate | *t*-Ratio | Param. Estimate | *t*-Ratio |
| **First-Stage, Market-Participation Decision:** | | | | | | | | |
| CONSTANT | -2.858** | -14.025 | -2.215** | -11.096 | | | -3.846** | -11.016 |
| Health Benefits | 0.147** | 3.816 | — | — | | | 0.111** | 2.694 |
| Taste | 0.362** | 12.572 | — | — | | | 0.345** | 11.502 |
| Price | -0.017 | -0.590 | — | — | | | -0.003 | -0.110 |
| Convenience | 0.215** | 5.415 | — | — | | | 0.176** | 4.222 |
| Health Knowledge | — | — | 0.064* | 5.856 | | | 0.024 | 1.488 |
| Motivation | — | — | 0.050** | 6.294 | | | 0.050** | 4.083 |
| Awareness | — | — | 0.025** | 7.016 | | | 0.010* | 1.730 |
| Age | — | — | -0.003 | -1.339 | | | -0.003 | -0.935 |
| Education | — | — | 0.102** | 5.948 | | | 0.082** | 3.198 |
| Income | — | — | 0.041 | 1.155 | | | 0.089 | 1.602 |
| Gender | | | -0.068 | -1.243 | | | -0.046 | -0.544 |
| Ethnicity | — | — | -0.543** | -5.514 | | | -0.222 | -1.397 |
| Log Likelihood | -710.015 | | -1,530.422 | | | | -658.661 | |
| Restricted Log L | -960.374 | | -1,717.857 | | | | -937.243 | |
| $\chi^2$ | 500.718* | | 374.870** | | | | 557.565** | |
| **Second-Stage, Consumption-Intensity Decision:** | | | | | | | | |
| CONSTANT | -104.180** | -4.047 | -88.802 | -1.455 | 15.257** | 10.099 | -96.400** | -3.827 |
| Health Benefits | 4.844** | 3.465 | — | — | — | — | 3.366** | 3.190 |
| Taste | 8.996** | 3.852 | — | — | — | — | 6.828** | 4.002 |
| Price | -1.136 | -1.333 | — | — | — | — | -0.795 | -1.134 |
| Convenience | 8.243** | 5.100 | — | — | — | — | 6.372** | 5.508 |
| Health Knowledge | — | — | 1.359 | 1.125 | 0.561* | 6.957 | -0.365 | -0.876 |
| Motivation | — | — | 1.697* | 1.883 | 0.293* | 4.731 | 1.106** | 3.059 |
| Awareness | — | — | 1.025** | 2.190 | 0.194** | 7.101 | 0.218 | 1.553 |
| Age | — | — | -0.088 | -0.915 | 0.053** | -3.139 | -0.051 | -0.624 |
| Education | — | — | 3.054 | 1.647 | 0.463** | 3.486 | 2.407** | 3.284 |
| Income | — | — | -1.007 | -0.666 | 0.204 | -0.740 | -1.747 | -1.262 |
| Gender | | | 1.465 | 0.635 | 1.678* | 4.029 | 1.893 | 0.949 |
| Ethnicity | — | — | -12.106 | -1.296 | -0.908 | -1.147 | -2.000 | -0.578 |
| LAMBDA | 35.199** | 3.510 | 37.749 | 1.467 | | | 26.397** | 3.451 |
| *F*-Statistic | 31.060** | | 6.060** | | 43.200** | | 13.440** | |
| $R^2$ | 0.224 | | 0.054 | | 0.197 | | 0.253 | |

Note: Single and double asterisks denote significance at $\alpha < 0.10$ and $\alpha < 0.05$, respectively.

[a] Model C estimates perceived soy health benefits.

foods are more likely to participate in the soy market and consume soy foods more often, when compared to those who do not perceive such benefits. Furthermore, respondents who perceive soy foods as tasty and convenient were more likely to participate in the soy market and consume soy foods more often compared to those who do not have such perceptions. Perceived price, however, was not important in explaining either decision.

Model B relates health knowledge, motivation, nutritional awareness, and sociodemographic characteristics to soy consumption decisions. Estimated results show that general health knowledge was a significant determinant of the likelihood of being a soy user. However, health knowledge did not affect consumption intensity. Health motivation and nutritional awareness significantly influenced both decision stages, i.e., market participation as well as consumption intensity. Specifically, the higher the motivation to seek healthy diets and/or the higher the awareness of the importance of diet in one's health, the higher is the likelihood of consuming soy foods. Sociodemographic characteristics also played a significant role in the two decision stages. In particular, respondents with higher education were more likely to participate in the soy market and consume soy foods more often. Racial background was statistically significant—i.e., whites were less likely to participate in the soy market relative to other races (African-Americans, Asians, and Hispanics).

Model C hypothesizes that consumer perceptions of soy health benefits are influenced by their general health knowledge, motivation, nutritional awareness, and sociodemographic characteristics. Estimated results clearly support this hypothesis. Respondents with greater health knowledge, motivation, and awareness are more likely to perceive health benefits from soy foods. Such benefit perceptions also differ across sociodemographic profiles. Specifically, respondents with higher education are more likely to perceive health benefits from soy food. Females and older respondents also tended to see greater health benefits from soy foods.

### *Evaluating the Mediation Hypothesis*

Model D incorporates all sets of variables hypothesized to explain soy food consumption behavior. The results of model D are compared against models A and B to determine whether the perceived soy health benefit mediates the effects of other general health-related variables and sociodemographic characteristics on soy food consumption behavior. Estimated results in model D show that health knowledge has little impact on the probability of participating in the soy market—i.e., the size of effect measurably decreases from $\beta = 0.064$ ($t = 5.856$) in model B, to $\beta = 0.024$ ($t = 1.488$) in model D. This result, when combined with results from models A and C with regard to soy health knowledge, indicates that the effect of general health knowledge on soy food consumption behavior is mediated largely by perceived (soy-specific) health benefits.

In contrast, health motivation is still significant in both market-participation and consumption-intensity equations even after accounting for perceived soy health benefits. The size of this effect in the participation equation barely differs between model B ($\beta = 0.050$, $t = 6.294$) and model D ($\beta = 0.050$, $t = 4.083$), revealing that the direct impact of health motivation on the soy market-participation decision is stronger than the indirect effect via perceived health benefits. In the consumption-intensity equation, the size of impact is reduced from $\beta = 1.697$ ($t = 1.883$) in model B, to $\beta = 1.106$ ($t = 3.059$) in model D. This reduction suggests health motivation exerts an indirect influence on

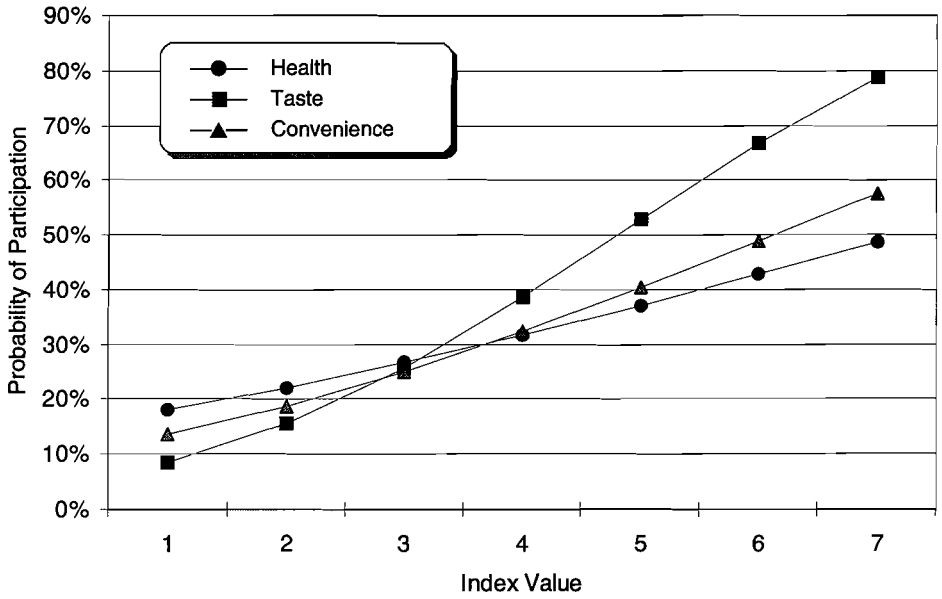
the soy consumption-intensity decision via perceived soy health benefits. Nutritional awareness is significant in both the market-participation and consumption-intensity decisions. Its effect decreases from $\beta = 0.025$ ($t = 7.016$) and $\beta = 1.025$ ($t = 2.190$) in model B, to $\beta = 0.010$ ($t = 1.730$) and $\beta = 0.218$ ($t = 1.553$) in model D, indicating a large portion of the impact of nutritional awareness is channeled through the perceived soy health benefit construct.

The effect of education is significant in model D, although the size of effect decreases from $\beta = 0.102$ ($t = 5.948$) in model B, to $\beta = 0.082$ ($t = 3.198$) in model D in the first stage, and from $\beta = 3.054$ ($t = 1.647$) in model B, to $\beta = 2.407$ ($t = 3.284$) in model D in the second stage. Hence, education is associated with soy consumption decisions directly (i.e., respondents with higher education are more likely to consume soy food simply because of preference for such food) and indirectly via positive correlation with perceived soy health benefits (i.e., respondents with higher education are more likely to consume soy food because they are more knowledgeable of the soy health benefits). The indirect effect of education via perceived soy health benefits in this study suggests that consumers with less education have a disadvantage in gaining access to information about the benefits of consuming soy foods. From the soy industry perspective, this finding highlights the need to target advertising efforts that showcase health benefits at consumers with low education. Further, government agencies related to public health should have a stake in disseminating information on soy health benefits to the public. Effective messages targeted specifically at consumers with an informational disadvantage may alleviate the disparities in soy consumption across consumer groups (Ippolito and Mathios, 1990).

## Discussion, Implications, and Conclusions

The sample selection model results reported in this study establish that perceived soy health benefits affect both the likelihood of market-participation and consumption-intensity decisions. That is, consumers who perceive significant health benefits from soy foods are more likely to participate in the soy market and, when they participate, consume soy foods more often than those with low health-benefit perceptions about soy foods. This result is consistent with both time-series (Brown and Schrader, 1990; Chern, Loehman, and Yen, 1995; Ippolito and Mathios, 1993, 1995) and cross-sectional analyses (Variyam, Blaylock, and Smallwood, 1998; Variyam et al., 1999) focusing on the role of health information in food/dietary choices. While these studies link general health knowledge to food choices, our research differs in that it analyzes the impact of product-specific knowledge (soy health benefits) and important mediators on soy food consumption behavior.

The estimated role of perceived soy health benefits in our results extends the widely observed importance of health concerns in food choice decisions to the soy market context. At this point, it is useful to assess the extent to which the perceived soy health benefit attribute influences consumers in each of the two decision stages relative to other attributes such as taste and convenience. Using the parameter estimates from the first decision stage, figure 2 shows the simulated impact of the three attributes (health, taste, and convenience) on the probability of participating in the soy market. The probability increases from 20% to 50% as the index changes from a value of 1 ("low perception of health benefit") to a value of 7 ("high perception of health benefit"). Yet,




Note: Index Values (1–7 scale): 1 = strongly disagree, 7 = strongly agree

**Figure 2. Simulated impact of perceived attributes on probability of participation**

figure 2 clearly shows that perceived taste and convenience impact the probability of participating in the soy market more strongly than perceived health benefits. In particular, the probability decreases drastically from 80% to less than 10% when the index of perceived taste changes from a value of 7 ("agree that soy food is tasty") to a value of 1 ("disagree"). When consumers' perceptions about convenience of soy food change from 7 ("agree that soy food is convenient") to 1 ("disagree"), the probability diminishes from about 58% to 12%.

It is also instructive to examine the relative impact of these three attributes on the second-stage decision—the consumption intensity (frequency) of current soy users. When soy users strongly agree that soy food is tasty or convenient (holding other variables constant), their simulated consumption frequency reaches nearly 40 times per month. This contrasts with a frequency of only 23 times a month when consumers strongly believe that soy food offers health benefits relative to chronic diseases.

The relatively stronger impact of perceived taste and convenience over health benefits on soy consumption behavior eloquently highlights the key dynamics in the current soy market. Although this market is growing fast, the majority of consumers appear to avoid soy food because of its perceived unattractive taste and inconvenience. While this result poses a challenge to the soy food industry, biotechnology may offer a promising response. Referring to a set of tools that allow scientists to genetically characterize or improve living organisms, this technology is being used to make soy food taste better, or remove such objectionable flavors as "beany," "grassy," or "bitter" (Kinney, 2003). Further, protein engineering techniques (i.e., proteomics) enable researchers to redesign molecular structures of soy proteins to fit specific properties desired in food products; this approach is being explored to extend the range of applications for soy protein in food (Soper et al.,

2003). Taken together, these emerging technologies may facilitate production of a wide variety of soy-based food products that not only confer multiple health benefits to consumers, but also appetizing taste.

The Food and Drug Administration (FDA) decision to allow health claims for soy foods carries considerable significance for the soy industry.[3] Although such health claims are regulated, this decision officially authenticated the health benefits unique to soy-based foods. It also enabled the soy food industry to devise new marketing strategies touting well-accepted scientific results about the health benefits stemming from soy foods. Our finding that soy-specific health knowledge has a positive and significant impact on soy consumption behavior suggests the dissemination of information about soy-related health benefits via health claims is an effective approach to stimulate demand for soy-based foods. Additionally, findings reported by Wansink, Westgren, and Cheney (2005) also affirm the importance of health claims for soy foods. They found that individuals may not necessarily link the attribute-level knowledge they possess with self-relevant consequences (e.g., health benefits). Therefore, the FDA-regulated health claims for soy products may encourage consumers to establish and reinforce such links.

Consequently, FDA-approved health claims on packaged soy food products represent a major avenue for the industry to inform consumers about soy health benefits (Unnevehr and Hasler, 2000). In making food choices, Balasubramanian and Cole (2002) report that consumers rely more on heuristics (i.e., descriptor terms such as "low fat," or health claims that often appear on packaged foods) than on the comprehensive information in the nutrition panel mandated by the 1994 Nutrition Labeling and Education Act (NLEA). Moreover, Ippolito and Mathios (1991) conclude that health claims in breakfast cereal markets led to significant increases in consumer knowledge of the fiber-cancer relationship. When combined with our findings about perceived soy health benefits, these studies indicate that health claims can be a very significant vehicle to communicate the health benefits of soy. Potentially, health claims can play a significant role in advertising such benefits, thereby serving the interests of both the soy industry and the general public.

In conclusion, our study offers three key messages.

- First, the perceived health benefits of soy consumption mediate the impact of other variables in two consumer-level decisions: whether or not to consume soy, and if so, how much soy to consume. Results clearly indicate that the perceived health benefits from soy diminish the impact of general health knowledge on soy food consumption in the first decision stage (the market-participation decision). Therefore, efforts by the soy industry and public policy officials to stimulate soy consumption must focus on the specific health benefits offered by soy, rather than on improving general health knowledge. Given the impressive scientific research evidence showcasing health benefits that individuals may derive by consuming soy foods, this task does not appear formidable at first glance. However, the effectiveness of consumer education about nutrition often depends on how the message is communicated, rather than what is communicated. As Wansink and colleagues (Wansink and Chan, 2001; Wansink, Westgren, and Cheney,

[3] The FDA undertakes a stringent review of scientific evidence before allowing health claims on food products. To date, the FDA has established only seven allowable health claims, including calcium and a reduced risk of osteoporosis; sodium and an increased risk of hypertension; dietary saturated fat and cholesterol and an increased risk of coronary heart disease; dietary fat and an increased risk of cancer; fiber-containing grain products, fruits, and vegetables and a reduced risk of cancer; soluble fiber and a reduced risk of coronary heart disease; fruits and vegetables and a reduced risk of cancer.

2005) assert, the impact of soy health benefits on soy consumption is enhanced when those benefits are personally relevant. They also argue that the type of consumer knowledge is more important than the amount of consumer knowledge about soy. More specifically, consequence-related knowledge (knowing that specific soy food characteristics are linked to desirable health consequences) may be more important than attribute-related knowledge (knowing that soy foods have specific characteristics). Overall, therefore, the FDA-regulated health claims focusing on the health benefits of soy could play a very useful role in consumer education about soy foods.

- Second, both public policy agencies and the soy industry must endeavor to improve consumers' motivation and nutrition awareness. Our results show that these variables act in conjunction with the health benefit construct in both decision stages.
- Finally, it is important to recognize that less-educated consumers may be disadvantaged with regard to learning about the health benefits of soy. From a public policy perspective, this may require deploying more resources to sensitize such consumers about the health benefits of soy foods.

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