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Soyfood Consumption Patterns: Effects of Product Attributes and Household Characteristics

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Effects of perceived attributes of soyfoods on the consumption patterns for six different soyfood products are evaluated. Perceived attributes include convenience, health benefits, and taste. The soyfood products are tofu, vegetable burgers, soy milk, soy supplements, meat substitutes, and soy cheese. This study uses a 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. A binary-choice model and a zero-inflated negative binomial model (ZINB) are used as empirical specifications to address the zero consumption of soyfood products. Results show that perceived health attributes of soyfood have differential effects across the six soyfood products. Convenience of preparation and consumption as well as taste have strong effects across soyfood products. The study identifies several socio-economic characteristics of consumers that have a significant influence on soyfood consumption patterns. Implications for the food industry are discussed in relation to the differential effects of health attributes and socio-demographic variables.

The crushing of soybeans for animal feed and vegetable oil has been historically the dominant usage of the crop. Although the use of whole soybeans for human food such as tofu, soymilk, and other soyfood products constitutes a small part of 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 at the retail level in 2000. Soyatech Inc. (2004) estimated the sales of soyfood products including tofu, soymilk, soy cheese, energy bars, and meat alternatives to be nearly $4 billion in 2003. These trends highlight the important role of soyfood products in increasing the demand for soybeans at the farm level.

Intake of soyfood products has been shown to have beneficial effects on cardiovascular disease (CHD) risk factors. Zhang et al. (2003) reported a clear monotonic dose-response relationship between soyfood intake and risk of total CHD. Using published data and new research, Messina, Gardner, and Barnes (2000) suggested that the consumption of even ten grams (typical of Asian intake) of isoflavone-rich soy protein per day may be associated with health benefits. Recognizing the health benefits from soyfoods, the 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 consumers' health concerns to the consumption of foods containing dairy products (Jensen 1995; Heien and Wessells 1988) and meat sources (Ward and Moon 1996). Capps and Schmitz (1991) and Rimal, Fletcher, and McWatters (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 concerns have a significant effect on food demand. Jensen (1995) analyzed how consumers' health concerns and decisions lead them to participate in the market for whole-fat milk and found that promotions that emphasize the nutritional benefits of milk could be a useful tool for the dairy industry to increase demand. Many studies evaluating meat demand (Brown and Schrader 1990; Capps and Schmitz 1991) have concentrated on shifts in demand caused by consumers' views of the health benefits or risks 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, Balasabrumanian, and Rimal (2005) reported positive demand effects resulting

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from the perceived health benefits of soyfood consumption but did not delineate the effects across specific products.

This study extends Moon, Balasabrumanian, and Rimal's research by examining whether perceived health benefits affect soyfood consumption decisions differently across six individual soyfood products. In addition to health benefits, other attributes such as convenience of preparation and consumption and taste are included to determine their influence on soy product demand. We use a conceptual model combining Lancaster's characteristics and Fishbein's multi-attribute models (Lancaster 1971; Fishbein 1963) in order to integrate perceived attributes of soyfood into soyfood consumption models. A binary logit model and zero-inflated negative binomial models are developed to identify differences between soyfood consuming and non-consuming households. It is postulated that the attributes of soyfood and socio-economic variables have varying effects on the consumption frequencies 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 in product pricing. Lancaster established an indirect relationship between attributes and consumption behavior. Ladd and Suvannunt (1976) identified two properties from Lancaster's model (Moon, Balasabrumanian, and Rimal 2005): 1) the price of the product is the sum of the of the marginal implicit value of its attributes, and 2) 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:

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

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

Moon, Balasabrumanian, and Rimal (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, as there will not be any effect 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 knowledge of the attributes, credence attributes such as nutrition and food safety have always posed a challenge in terms of objective measurement. Consumers often fail to evaluate these attributes even after consuming the products. These issues are addressed by replacing objectively measured attributes with consumers' perceived attributes of soyfood. Fishbein's multi-attribute 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

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

where A is the attitude toward a soyfood, X_t is the strength of the belief that the soyfood possesses an attribute t; β_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 are based on the summed set of beliefs about the soyfood product's attributes weighted by the evaluation of these attributes. The evaluations (β_t) and the belief (X_t) are obtained from survey responses and are 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' attitudes about the products, and hence their consumption, we can replace **T** in Equation 1 with A to obtain a soyfood demand model:

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

Consumers' perceived attributes of soyfood products can have two effects. The first effect is on the probability of 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:

$$(4)\quad \Pr(Y_i > 0) = g(P_1, \mathbf{P}, m, \boldsymbol{A}, \varepsilon_1)$$

$$(5)\quad (Y_i | Y_i > 0) = \zeta(P_1, \mathbf{P}, m, \boldsymbol{A}, \varepsilon_2)\ ,$$

where Y_i is the frequency of soyfood product consumed during a specific time by consumer *i* and ε_1 and ε_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 participation.

An individual is a non-participant in the soyfood market when s/he is consuming zero amounts of soy products. The zero observation can be divided into two groups: those who will not consume soy products due to unacceptable taste or other unfavorable attributes of soyfood products including soy allergy, and those who are 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 for this second group.

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, the zero-inflated negative binomial (ZINB) model (Mullahey 1986; Greene 1997; Long 1997) is used as an empirical model to analyze soyfood consumption behavior. This model is selected based on three merits: it incorporates the framework of the double-hurdle process discussed above, it is best suited for the count-data nature of the dependent variable in the study (that is, the number of times soy products are consumed within a month), and 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 Foltz, Barham, and Kim (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

$$(6)\quad \Pr(zi = 0) = F(wi, \gamma)$$

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

where F(.) is a cumulative probability-distribution function with a logistic distribution, the parameter μ_i is determined by a linear combination of perceived attributes of soyfood products and socio-economic characteristics of consumers ($\ln \mu_i = \beta' x_i\ \varepsilon_i = \ln \lambda i + \ln u_i$), β and γ are parameter vectors to be estimated, and w and x are covariates representing the explanatory variables in the soyfood consumption models. The exponential of disturbance term ε_i (i.e., u_i) is assumed to have a gamma distribution with mean 1 and variance α (Cameron and Trivedi 1986; Greene 1997). The gamma distribution is chosen to overcome the potential asymmetrical distribution of disturbance. The probability density function for the observed random variable (Y_i) is

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

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

Survey Design and Data Collection

A nationwide online survey of 3,000 households was conducted. Households were randomly selected

[1] For more detail on the model specification see Foltz, Barham, and Kim (2000).

from the database of 400,000 households that make up the Ipsos-NPD marketing research panel. Ipsos-NPD is a marketing research firm operating in the United States and Canada. The firm was hired conduct the market survey. The selection process was appropriately stratified to ensure that the demographic characteristics of the sample households corresponded with the 2000 U.S. census. Sample households were sent emails soliciting information regarding their soy-consumption pattern and household characteristics. Each email included a unique URL (keyed to the respondent's ID) to direct the respondent to the survey website.

More than 1,400 households completed the survey, yielding a response rate of approximately 47 percent. The variables included in the survey and their explanations are listed in Table 1. The online survey elicited consumption frequency per month

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 soymilk 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 of soy products	"Please indicate your agreement with each of these statements (select one for each statements): 1 = Disagree strongly, 2 = Disagree somewhat, 3 = Neither agree nor disagree, 4 = Agree somewhat, 5 = Agree strongly"
Health benefits	
Lowering cholesterol	Soyfoods lower cholesterol level in blood
Antioxidant	Soyfoods act as an antioxidant
Bone mass (osteoporosis)	Soyfoods retain bone mass
Menopause	Soyfoods are good for women during menopause
Convenience	
Convenient	Soyfoods are convenient
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
Sociodemographics	
Age	Respondents' age in years
Gender	1 = female; 0 = male
Income	Household income in thousand dollars
Education	1 = some college education or above; 0 otherwise
Household size	Number of household member
Children	Number of children in the household
Ethnic background	1 if white; 0 otherwise

for six types of soyfood products: tofu, vegetable burgers, soy milk, soy supplements, meat substitutes, and soy cheese. Consumer's perceived attributes were measured using a Likert scale of 1 to 5, with 1 representing strongly disagree and 5 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, and mean frequency of consumption per month among all households and among the subset of households reporting non-zero consumption. As shown, 36.37 percent of the households in the sample consumed at least one type of soyfood product per month. Tofu, vegetable burgers, and meat substitutes were the most popular types 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, and good taste were the three major perceived attributes of soyfood considered in the study (Table 1). These attributes were measured using a five-point rating scale (1 = strongly disagree, 5 = 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 con-

Table 2. Soyfood Consumption Behavior of Surveyed Households.

Soyfood 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.

sistency (Cronbach's α = 0.85) in measuring the health benefits of soyfood (Table 3). A composite health-benefits index was created by summing the reported scores for each statement and dividing by four. There were statistically significant differences (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 a more favorable perception of health attributes (mean score of composite index = 3.83) of soyfoods than did those who do not (mean score of composite index = 3.30.)

Perceived convenience attributes were measured using three statements relating to convenience in preparation and consumption of soyfood. These statements also showed a high level of consistency (Cronbach's α = 0.74) in measuring perceived convenience of soyfood. A composite convenience index was created by summing 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 = 2.48 compared to 3 = neither agree nor disagree that soyfoods are convenient.) There

Table 3. Summary Statistics of Variables Representing Soyfood Attributes and Socio-Economic Characteristics of Respondents.

	All observations		Non-zero consumption		Zero consumption	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Perceived attributes of soy products						
Health benefits (a = 0.85)	3.51	0.89	3.83[A]	0.88	3.30[B]	0.84
Lowering cholesterol	3.66	1.10	3.95[A]	1.09	3.49[B]	1.06
Antioxidant	3.48	1.04	3.77[A]	1.07	3.31[B]	0.97
Bone mass (osteoporosis)	3.31	1.11	3.59[A]	1.17	3.15[B]	1.04
Menopause	3.60	1.11	4.00[A]	1.07	3.37[B]	1.07
Convenience (a = 0.74)	2.48	1.06	3.07[A]	1.37	1.11[B]	0.84
Convenient	2.67	1.23	3.25[A]	1.23	2.32[B]	1.09
Recipes	2.78	1.35	3.22[A]	1.40	2.51[B]	1.25
Preparation	1.99	1.36	2.73[A]	1.55	1.55[B]	1.00
Taste	2.33	1.37	3.27[A]	1.38	1.76[B]	1.01
Sociodemographics						
Age	45.09	12.69	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 ('000)	61.18	40.78	68.38[A]	46.97	57.07[B]	36.15
Education	0.80	0.40	0.89[A]	0.32	0.77[B]	0.42
Household size	2.52	1.25	2.43[B]	1.19	2.58[A]	1.27
Children	0.63	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%.

were statistically significant differences (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. However, it must be noted that perceived convenience in use may not have converted non-users into users. Rather, users of soyfood products find them convenient after using them for some time. This suggests that perception of convenience could be a strong factor to keep users in the market for soyproducts but not necessarily to convert non-users into users.

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

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, and 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 higher household income than the non-consumer. The percentage of white respondents in the soyfood-consuming subgroup was 95 percent, compared to 89 percent 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

Table 4 reports the results from the product-wise analysis using regression models. The results are reported for households' decisions in relation to market participation and frequency of purchase for six soy products consistent with the theoretical explanation above. While parameters associated with market-participation equations were estimated using logit models, those associated with consumption-frequency equations were estimated using zero-inflated negative binomial models. The dispersion parameter (Alpha) and zero-inflation model parameter (Tau) across all soyfood products were statistically significant at P-value < 0.05. Therefore the choice of ZINB models was consistent with the consumption behavior for each of the soyfood products. The perceived health-benefit index had a statistically significant effect on all soyfood products except tofu and meat substitutes. This result indicates that consumers do not select, for example, tofu because of the health benefits of soy proteins, but likely because of other reasons such as taste and convenience. In general, consumers who perceived beneficial health attributes in soyfood products were more likely to participate in the soyfood market and to increase consumption frequency. This result is consistent with previous studies addressing the impact of health information on food choices (Jensen 1995; Ippolito and Mathios 1990; Capps and Schmitz 1991; Brown and Schrader 1990.)

Consumers who agreed that soyfood products were convenient and tasted good were likely to become a soyfood buyer and to consume more frequently than were those who disagreed. This was true across all soyfood products. Attributes such as convenience and taste had greater effects on consumption frequency than did the health attributes. The estimated coefficients for convenience and taste across the products were larger than those for health benefits. Notice that convenience and taste variables were not included in the equation for soy supplements. Perception of convenience in preparation and consumption played the most important role in enhancing market participation for soy cheese, meat substitutes, and tofu. This finding confirms the finding by Kilcast, Cathro, and Morris (1996) that convenience in preparation and consumption can increase the consumption of fruits and vegetables among low-frequency 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.

Good taste was essential to increase market participation and consumption frequency for all

Table 4. Soyfood Consumption: Participation and Consumption Frequency Decisions.

	Tofu		Vegetable burgers		Soymilk	
Variables	PART	C.F	PART	C.F	PART	C.F
Constant	−4.707**	−1.462**	−6.675**	−1.911**	−5.927**	−2.078**
Health Benefits	0.116	0.036	0.355**	0.112**	0.390**	0.219**
Convenience	0.502**	0.297**	0.434**	0.230**	0.425**	0.307**
Taste	0.540**	0.280**	0.596**	0.267**	0.756**	0.422**
Age	−0.013*	−0.009**	0.005	0.000	−0.013*	0.000
Gender	−0.030	0.046	−0.171	−0.127**	−0.042	0.028
Income	0.008**	0.003**	0.000	0.000	0.002	0.001
Education	0.743**	0.336**	0.463*	0.199**	0.214	−0.140
Household Size	−0.025	0.000	0.213*	0.073	−0.267*	−0.119**
Children	−0.097	−0.075	−0.309**	−0.132**	0.251	0.098
Ethnic Background	−0.572**	−0.322**	0.157	−0.060	−0.099	−0.285**
Dispersion parameters						
Alpha		2.236**		2.336**		−7.587**
Zero-inflation model						
Tau		−2.225**		−2.564**		−2.282**

Note: ** = Significance at a<0.05 and * = Significance at a<0.10.
PART = market-participation decisions; C.F. = consumption-frequency decisions.

soyfood products. The role of taste in stimulating participation in the tofu, vegetable burgers, and soy milk markets was greater than that of convenience. Taste played a particularly important role in increasing market participation and consumption frequency for soy milk. A simulated analysis based on the estimated parameters showed that an average consumer was likely to consume soy milk less than five times a year if s/he strongly disagreed that it tasted good, compared to nearly 30 times a year if s/he strongly agreed that it tasted good. Other studies have shown the importance of taste in selecting food items. Acceptance among college students of soy yogurt was found to be significantly lower than traditional milk yogurt primarily due to taste factor in northern Louisiana (Wu et al. 2005). Rimal and Fletcher (2000) reported that attitudes toward in-shell peanuts were influenced by attributes such as fat, taste, and healthiness and that taste was 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 are nutritional concerns. It is, therefore, important to promote soyfood products as being tasty and convenient in addition to being nutritious.

Socio-economic characteristics of households including household income, household size, and number of children in the household had varying effects on market participation and consumption frequency across products. Households with higher income were likely to be tofu buyers and to buy it more frequently than were those with lower income. Interestingly, households with higher income were less likely to be soy cheese buyers compared to low income households. Although household income did not play a significant role for the rest of the soyfood products, some of the income effects may have been captured in the results relating to household size, particularly in relation to consumption frequency.

Table 4. Soyfood Consumption: Participation and Consumption Frequency Decisions (Continued).

	Meat substitutes		Soy supplements		Soy cheese	
Variables	PART	C.F	PART	C.F	PART	C.F
Constant	−6.521**	−2.038**	−6.476**	−2.463**	−9.775**	−2.641**
Health benefits	0.100	0.056	0.739**	0.261**	0.146	0.089*
Convenience	0.532**	0.291**			0.840**	0.305**
Taste	0.530**	0.310**			0.589**	0.233**
Age	0.010*	0.003	0.023**	0.010**	0.017	0.007**
Gender	0.083	−0.021	0.089	−0.130*	0.043	0.037
Income	0.001	0.001	−0.002	−0.001	−0.007**	−0.001
Education	0.821**	0.346**	0.548**	0.059	0.976**	0.188
Household size	0.129	0.002	0.132	−0.082	0.037	-0.059
Children	−0.247*	−0.063	−0.163	0.022	0.034	0.052
Ethnic background	0.258	−0.021	−0.517**	0.213*	0.618	0.244
Dispersion parameters						
Alpha		4.102**		19.696**		10.527**
Zero-inflation model						
Tau		−2.329**		−3.190**		−4.191**

Note: * = Significance at a<0.10; and **=Significance at a<0.05.
PART = market-participation decisions; C.F. = consumption-frequency decisions.

For example, consumption frequency for soy milk decreased as the size of the households increased. It is likely that the household food budget is further constrained with additional members in a household, thus reducing the expenditures on soyfood products. Households with children were less likely to purchase vegetable burgers and meat substitutes than were those without children.

In addition to household characteristics, respondents' characteristics played a significant role in consumption frequency for soyfood products. While older respondents were less likely to be tofu and soymilk buyers, meat substitutes, soy supplements, and soy cheese were likely to be more popular among older population. Soyfood products except vegetable burgers and soy supplements were largely gender-neutral. Women were likely to consume vegetable burgers and soy supplements less frequently than were men. Similar results may be found for regular burgers. Respondents' education level had positive effects on either market participation or consumption frequency for all soyfood products except soy milk. 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 is a person with less education. Better education enhances access to nutrition information, thus increasing 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 were non-white respondents. Asians are likely to account for such ethnic disparity in soyfood consumption between

ethnic groups in this study. Nevertheless, the study uncovered a very interesting consumption tendency for soy supplements: while white consumers were less likely to be soy supplement buyers, once in the market for soy supplements they were likely to consume more frequently than were consumers belonging to other racial groups.

Differences in the prevalence of lactose intolerance across ethnic groups in the United States can further explain the disparity in the consumption of soy-based products reported in the study. According to Vesa, Marteau, and Korpela (2000), the prevalence is 15 percent among whites, 53 percent among Mexican-Americans, and 80 percent among African-Americans. That means a large percentage of non-Caucasian Americans (represented by "non-white" in the study) are lactose intolerant. For those consumers, soy products, including soymilk, have become appropriate substitutes. Therefore, Asian-Americans along with lactose intolerant non-Caucasian whites constitute a market for soy-based products.

Summary and Implications

This study evaluates 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 includes perceived attributes of soyfood. A binary-choice model and a zero-inflated negative binomial model (ZINB) are used as empirical specifications to address zero-consumption of soyfood products. It is postulated that consumers' soyfood-consumption decisions include first, whether or not to consume, and second, how often to consume. The results of the study have important implications for soyfood industry.

This study examines the effects of perceived health benefits on consumption of individual soyfood products rather than of aggregate soyfood, thereby extending the research by Moon, Balasabrumanian, and Rimal (2005). The motivation is that perceived health benefits may influence consumers' decisions differentially across individual soyfood products. The estimation results clearly show that soyfood-specific health attributes are 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. Other critical attributes stimulate the consumption of soyfood products. Although sales of soyfood products are increasing, an 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 tasted good were likely to consume more frequently than were 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. The soyfood industry needs to invest in 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-thirds of soyfood sales. The soyfood industry needs to introduce and promote new products in meal replacement as well as snack food categories.

This study demonstrates that the 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, products need to be treated as unique to meet the needs of specific segments of the food market. For example, tofu is more likely to be preferred by young non-white consumers who are less influenced by the health benefits of soy proteins than by its good taste. Moon, Balasabrumanian, and Rimal (2005) suggest that health claims approved by the FDA can play a significant role in advertising health benefits of soy proteins. Based on our results, consumers of tofu are less likely to be influenced by such advertising. Therefore, different marketing strategies such as the introduction of new products with improved taste or added convenience are needed to stimulate the consumption of tofu products.

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