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Impacts of Sociodemographic Variables on the Implicit Values of Breakfast Cereal Characteristics

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The implicit values of nutrient and nonnutrient characteristics of breakfast cereal were estimated using the 1987–88 household portion of the USDA's Nationwide Food Consumption Survey data. The effects of sociodemographic variables on cereal characteristic values were also estimated. The conceptual framework of the hedonic price model, used for food products, has traditionally focused on the nutritional characteristics of these products. This framework was extended to incorporate nonnutritional characteristics. Findings indicate that consumers' sociodemographic characteristics significantly affect the implicit values of both nutritional and nonnutritional cereal characteristics. Results generally met with prior expectations.

Key words: breakfast cereal, hedonics, implicit values, nutritional and nonnutritional food characteristics, sociodemographic variables

Introduction

The American public has become increasingly concerned with the issues of diet-related health problems and food safety. These concerns underscore the present need for an understanding of consumers' preferences and values of food characteristics. To design successful products, producers and food processors need to know consumers' implicit values of the characteristics of specific food items.

Hedonic price theory gives economists the necessary conceptual framework to investigate this research topic and to estimate consumers' implicit values of product characteristics. Data generated by the U.S. Department of Agriculture's (USDA's) 1987–88 Nationwide Food Consumption Survey (NFCS) provides the information base for estimating values of both nutrient and nonnutrient food characteristics. Breakfast cereals were selected for this study because they have apparent nonnutrient food characteristics (e.g., texture, flavor), well-labeled nutrition information, and contain nutrient supplements. In the past, breakfast cereals were criticized for supplying "empty calories"—meaning that many cereals had a high sugar content, but few vitamins and minerals. A reaction to this criticism led to the vitamin-fortified cereals which are common today. Increased emphasis is now placed on low-fat diets. In response to this demand, cereal companies have reduced the fat content of cereal products, particularly among the granola cereals.

In a study on consumer demand for nutrients in food, Morgan found that the breakfast cereal a consumer prefers depends on the nonnutrient characteristics. These

characteristics include the type of grain, cereal texture, and the addition of sugar, nuts, and fruit. There is frequently a tradeoff between nutrient quality and the "taste" characteristics of the product. For example, some cereals contain added fat to enhance both the taste and texture of the product, but the added fat decreases nutrient quality. Knowledge of the implicit values of these characteristics is needed to achieve a tradeoff that will maximize consumer satisfaction.

In this study, we estimate implicit values of both nutrient and nonnutrient characteristics of breakfast cereals using data from the 1987–88 USDA Nationwide Food Consumption Survey. The implicit values of the characteristics of a product are expected to vary from consumer to consumer. Therefore, our analysis also estimates the impacts of sociodemographic variables on the implicit values of the nutrient and nonnutrient characteristics of breakfast cereals.

The current hedonic model cannot explicitly quantify discrete nonnutrient food characteristics (Lenz; Lenz, Mittelhammer, and Shi). Thus the hedonic framework is extended here to model nonnutrient food characteristics.

Hedonic Price Model

The theoretical model developed by Lancaster assumes that consumers purchase a group of commodities for the utility-bearing characteristics contained in those commodities. Thus household purchasing decisions are characterized as choices by households of a group of products perceived to maximize the utility obtained from their characteristics, subject to the budget constraint. Lancaster assumed that characteristics are objective and are the same for all consumers, but the utility derived from these characteristics can vary among consumers. He also assumed linear relationships between the amounts of characteristics and quantities of goods, and a nonnegative utility for each characteristic. In the mid-1970s, Lancaster's model was extended so that it could be applied to food (Ladd and Suvannunt; Ladd and Martin; Ladd and Zober). Ladd and colleagues relaxed some of the restrictive assumptions of Lancaster's model. Ladd and Suvannunt did not assume a linear relationship between nutrients and food quantity, and nonnegative utility for every product characteristic. However, they did assume that utility depends only on the total amount of characteristics and not on their distribution among commodities.

The hedonic model is specified at a homogeneous market good level with one price, while real-world data are often at some aggregate level. With household survey data, the information is available at an aggregate product level rather than by detailed product brand. In this case, prices and quantities consumed are weighted averages of a number of market goods (specific brands and types).

Lenz, Mittelhammer, and Shi addressed the problem of aggregate commodity groups and developed an aggregate commodity framework. They theoretically demonstrated that the aggregate commodity framework is consistent with the real decision process of households. In this framework, the households' purchasing decisions consist of two stages. In the first stage, households choose the "average" price, the "average" nutrient content, and the quantity of the aggregate commodity which will maximize their utility, subject to the budget constraint. In the second stage, households decide which market goods, and the quantity of each good, will meet the requirements of the first stage.

Researchers can focus on the first stage when estimating the hedonic price function, since the "average" information on price, nutrient, and nonnutrient food characteristics is adequate to estimate implicit values of characteristics. In this framework, consumers' choices for the average price and nutrient content should be restricted to a convex, feasible set defined by the prices and nutrient contents of the individual market goods. In Lenz's framework, nonnutrient characteristics are not explicitly specified, but are represented by the commodity shifters and a vector of sociodemographic variables.

This investigation extends the framework of Lenz by explicitly modeling the nonnutrient food characteristics. Specifically, we quantify the relationship between average price of the aggregate commodity (breakfast cereals) and the average "content" of nonnutrient characteristics. It is assumed that households value a particular non-nutrient characteristic equally within a food group. For example, *ceteris paribus*, a particular processing type (say puffed) is valued equally among various cereal products. We hypothesize that households choose the bundle of market goods with the discrete nonnutrient characteristics which maximize their utility. For example, utility-maximizing households choose cereal products which give them the optimal amount of puffed and flaked cereals in the aggregate commodity (all breakfast cereals).

The household food-purchasing decision problem is to choose average prices, average nutrient levels, percentages of goods which supply average nonnutrient wants, and quantities of aggregate commodities. If food is weakly separable from nonfood, and food characteristics are valued differently across food groups, the household food-purchasing decision becomes:

$$\begin{aligned}
 (1) \quad & \max U_f(N_1, \dots, N_g; NN_1, \dots, NN_g; H), \\
 & \text{s.t.: } P'X \leq E_f, \\
 & N_i = f_i(X_i), \\
 & NN_i = g_i(X_i), \quad i = 1, \dots, g,
 \end{aligned}$$

where $U_f(\cdot)$ is the subutility function for food, N_i is a vector of nutrient quantities contained in food group i , NN_i is a vector of nonnutrient characteristics contained in food group i , H is a vector of household characteristics, P is a vector of prices for food, X is a vector of quantities of each food, X_i is a vector of quantities of food commodities in food group i , and E_f is the level of household food expenditures. The first constraint is the household budget constraint. The second is the nutrient production function for nutrients from the i th food group. The third is the production function for nonnutrient food characteristics from the i th food group. In addition, the above optimization problem is constrained so that the hedonic price function is consistent with rational household purchasing decisions and the aggregate nature of the data. (For a more detailed discussion, see Lenz, Mittelhammer, and Shi.)

Maximizing the utility function yields the hedonic price function which decomposes the price of a commodity into the implicit values of the characteristics. It can be expressed as:

$$(2) \quad P_{ij} = [(\partial U_f / \partial N_i) \lambda^{-1}]' b_{ij} + [(\partial U_f / \partial NN_i) \lambda^{-1}]' \alpha_{ij},$$

where P_{ij} is the price per pound of commodity j in food group i , λ is the marginal utility of food expenditures, $[(\partial U_f / \partial \mathbf{N}_i)]$ is a vector of the marginal utility of nutrients in food group i , and $b_{ij} = (\partial \mathbf{N}_i / \partial X_{ij})$ is a vector of nutrient contents per pound of commodity j in food group i . The bracketed term, $[(\partial U_f / \partial \mathbf{N}_i) \lambda^{-1}]$, is a vector of marginal implicit values of nutrients in food group i . It is a vector of the monetized values of the marginal utilities with respect to the i th food group nutrient attributes. This is represented by the ratio of the marginal utility of the nutrients in the i th food group to the marginal utility of money (food expenditure). The term $[(\partial U_f / \partial \mathbf{NN}_i) \lambda^{-1}]$ is a vector of implicit prices for the nonnutrient characteristics in group i , and $\alpha_{ij} = (\partial \mathbf{NN}_i / \partial X_{ij})$ is a vector of proportions which measures the nonnutrient contents of commodity j in food group i . Since the nonnutrient characteristics are discrete variables, a specific entry in α_{ij} represents that proportion of X_{ij} possessing a particular nonnutrient characteristic.

Because the implicit values are not directly observable, the relationship between the implicit values and the sociodemographic variables cannot be directly estimated. To solve this problem, the implicit values are specified as functions of the sociodemographic variables.

The implicit value of the characteristic is hypothesized to follow the law of diminishing marginal utility. That is, the marginal utility of a characteristic declines as more of that characteristic is consumed. Therefore, the implicit values are specified as functions of the corresponding quantities. In addition, it is hypothesized that the implicit value of a nutrient from cereals can be different from the implicit value of the same nutrient in other foods.

The implicit value of the t th nutrient characteristic is specified as:

$$(3) \quad [(\partial U_f / \partial n_t) \lambda^{-1}] = a_{ot} + \sum_k a_{tk} H_k + c_{1t} n_{1t} + c_{2t} n_{2t},$$

where $[(\partial U_f / \partial n_t) \lambda^{-1}]$ is the implicit value for nutrient t in cereals; H_k is the k th household sociodemographic variable; n_{1t} and n_{2t} are the intakes of nutrient t from cereals and noncereal food, respectively; and a_{ot} , a_{tk} , c_{1t} , and c_{2t} are parameters. Implicit value is assumed to be a linear function of sociodemographic variables and nutrient intake. Note that $n_t = n_{1t} + n_{2t}$, and that n_t is an element of \mathbf{N} , where \mathbf{N} is a vector of nutrients from all food.

Similarly, the implicit value of the r th nonnutrient cereal characteristic can be expressed as:

$$(4) \quad [(\partial U_f / \partial nn_r) \lambda^{-1}] = \beta_{or} + \sum_k \beta_{rk} H_k + \delta_r QC_r,$$

where $[(\partial U_f / \partial nn_r) \lambda^{-1}]$ is the implicit value of the r th nonnutrient cereal characteristic; nn_r is the r th element of the nonnutrient characteristic vector from cereals; QC_r is the quantity of consumed cereals with the r th nonnutrient cereal characteristic; and β_{or} , β_{rk} , and δ_r are the parameters. Here, implicit values of the nonnutrient characteristics are assumed to be linear functions of the sociodemographic variables and nonnutrient characteristics.

By dropping the food group subscript i , changing the upper-case "N" and "NN" to lower case in equation (2), and substituting equations (3) and (4) into equation (2), we obtain the following hedonic price function specific to breakfast cereals:

$$(5) \quad P_j = \sum_t (\alpha_{ot} + \sum_k \alpha_{tk} H_k + c_{1t} n_{1t} + c_{2t} n_{2t}) b_{jt} \\ + \sum_r (\beta_{or} + \sum_k \beta_{rk} H_k + \delta_r QC_r) \alpha_{jr},$$

where b_{jt} is the content of nutrient t in the j th cereal commodity, and α_{jr} is a proportion of the j th cereal commodity having the r th nonnutrient cereal characteristic. Equation (5) now contains various interaction terms between cereal characteristics and socio-demographic variables. Estimates of the coefficients of these interaction terms show the impact of the sociodemographic variables on the implicit values of breakfast characteristics as specified in equations (3) and (4).

Empirical Studies

Implicit values of food characteristics for breakfast cereals have been estimated by Morgan, and by Stanley and Tschirhart. Morgan estimated the implicit values of both nutrient and nonnutrient characteristics in breakfast cereals. In her model, price was regressed against the nutrient contents of cereal products and a set of dummy variables representing the nonnutrient characteristics (processing types and types of principal grains). Data used in Morgan's study were obtained from state purchasing agents. Price information from state purchasing agents is not at the retail level. To assess consumers' implicit valuation of food characteristics, it is more appropriate to use consumer survey or retail data.

Stanley and Tschirhart estimated a cereal hedonic price function by using data from three large supermarkets. Both nutrient and nonnutrient cereal characteristics are included in their model. They estimated the hedonic model through a Box-Cox transformation technique based on the argument that the functional form of a hedonic price function cannot be specified on theoretical grounds. Although this technique allows researchers to obtain the best-fit hedonic price function, the benefits of flexibility and the goodness of fit are not without costs. Cassel and Mendelsohn listed several reasons why it may not be appropriate to use the Box-Cox technique to determine the functional form of the hedonic price function: (a) this functional form does not necessarily yield more accurate estimates of the implicit prices of the product characteristics, (b) the nonlinear transformation leads to complex estimates of slopes and elasticities and makes it difficult to interpret the results, and (c) the Box-Cox form usually leads to an increase in the number of parameters in the model, and hence the efficiency of the parameter estimates are reduced. Consequently, Stanley and Tschirhart's approach was not adopted in this study.

The two studies noted above did not estimate the effects of household sociodemographic variables on the implicit values of the nutrient and nonnutrient characteristics. This analysis will examine the impacts of the sociodemographic variables on consumers' implicit valuation of food characteristics.

Empirical Model Specification

Nutrients included in the model were energy, protein, fat, dietary fiber, calcium, iron, vitamin A, vitamin C, and a principal component of the highly correlated B vitamins.

The component includes vitamin B6, vitamin B12, thiamin, niacin, and riboflavin. Nutrient characteristics are continuous variables. To keep the model simple and to reduce multicollinearity, fat was not broken down into its various components. The nonnutrient cereal characteristics include type of grain; type of processing; presence of additives such as sugar, fruit, chocolate, and nuts; some convenience measures such as variety pack and type of hot cereal; and whether or not the cereal was enriched with vitamins. These nonnutrient cereal characteristics would be measured by discrete dummy variables for individual cereal items, but for aggregate commodities they are measured as a proportion.

Sociodemographic variables hypothesized to explain the differences in consumers' implicit values of nutrient and nonnutrient characteristics are (a) age composition of the household, (b) education level of the household meal planner, (c) ethnic composition (background) of the household, (d) urbanization (residence location of household), (e) meal preparer working status (i.e., working outside the home), and (f) occupation of the household head. The major factor underlying these hypothesized relationships is that preferences for characteristics are affected by the types of food to which we are exposed (Price et al.). These preferences then directly translate into differing valuations of the food characteristics. Another factor is that nutrition education affects food patterns. A third factor is a difference in nutritional requirements among different age groups.

Food preferences change with age. We are born with a preference for milk. After birth, we first consume bland foods with tastes similar to milk. We basically prefer familiar tastes and textures. Gradually, we are exposed to a wider range of foods with different tastes and textures. We learn to appreciate those tastes and textures associated with positive feelings and experiences. Many breakfast cereals are designed specifically for children. Children generally prefer more highly sweetened products than adults. Activity and growth lead to nutritional requirements changing with age.

The ethnic composition effects stem directly from the above concept of exposure. Different ethnic groups are exposed to different foods. In addition, ethnic composition can measure lactose intolerance. The education effects stem from two sources: (a) persons with different education levels are exposed to different types of foods, and (b) education level is expected to be related to nutrition knowledge.

Degree of urbanization is also related to exposure to different types of food. Persons in urban areas are exposed to a greater variety of food through a larger selection of restaurants. The meal preparer working outside the home is hypothesized to directly affect characteristic valuations through household production theory; that is, foods requiring less preparation will have more value to these households. Working outside the home also exposes the person in charge of food preparation to a different set of foods. Occupation is related to both caloric requirement and exposure to different foods. Blue collar workers are hypothesized to require more calories than others, and thus should give higher values to food energy.

Per capita household food expenditure was also included in the model. Assuming food to be weakly separable from nonfood, household food expenditure measures the effect of the income constraint. At a given level of income, it also measures the preference for higher priced food. Households that purchase higher priced food are hypothesized to prefer those breakfast cereal characteristics which are higher priced.

In order to measure the declining value of a characteristic with increasing consumption of a characteristic (the law of diminishing marginal utility), the quantity of the specific characteristic was included as an explanatory variable. In addition, the log of per capita household food expenditures, the log of household size, the type of store at which food was purchased, and region and zone location of the household were added as noninteractive variables to control for variations in price.

The Data

The data set was taken from the results of the 1987–88 USDA Nationwide Food Consumption Survey. This data set has been criticized for possible bias due to a high nonresponse rate and an underrepresentation of some groups. In this study, we include several variables which measure the characteristics of the underrepresented groups so that the bias in the regression coefficients should be minimal.

The data were screened to eliminate households that did not report essential information such as the occupation of the household head. Nonhousekeeping households were also eliminated since these households would have abnormal home food consumption patterns due to very few meals eaten at home. In addition, the data were screened for price outliers. The price variable plays a crucial role in a hedonic price analysis. It is important to assure the observed price variation is reflecting the “genuine” variation caused by the product characteristics and relevant sociodemographic variables of the households. Household survey data often include extreme price values due to abnormal circumstances. Retail store specials and purchases at unusual locations result in prices that have extreme values. Measurement or recording errors during the survey also cause price outliers. Although the number of outliers is usually small relative to the sample size, their presence can substantially distort the parameter estimates (Huber).

The conventional method for outlier detection usually defines an observation as an outlier if its magnitude is two or three standard deviations above or below the sample mean. With this method, outliers can inordinately affect the results of outlier detection; that is, the effects of these outliers can be so large that some outliers can be masked during the detection process (Huber). A robust outlier detection method originally proposed by Huber was used in this study. By down-weighting their effects on the parameter estimates used to detect outliers, this method is insensitive to the presence of outliers. Approximately 5% of the sample observations were eliminated because of the price outliers. (For further details, refer to Shi.)

Empirical Results

The hedonic price function (5) was estimated using a nonlinear (SYSNLIN) procedure in SAS. The hedonic model is linear in parameters, and hence it can be estimated using a linear procedure. However, equation (5) has numerous interaction terms. In order to use a linear procedure (in SAS) to estimate this model, all interaction terms must be manually created. With a nonlinear procedure, such as SYSNLIN in SAS, we can directly specify the model without manually creating the interaction terms. Since heteroskedasticity problems in cross-sectional modeling are expected, the White

Table 1. Predicted Implicit Nutrient Values in One Pound of Breakfast Cereal Simulated for Selected Sociodemographic Profiles

Nutrient	No. of Simulations	Mean Value	Standard Deviation	Minimum Value	Maximum Value	% of Profiles Positive
Energy	104	0.7235	0.2464	0.3752	1.2605	100
Protein	26	0.0723	0.0234	0.0365	0.1225	100
Fat	39	-0.0439	0.0396	-0.1064	0.0366	15
Calcium	104	0.1135	0.0505	0.0275	0.2247	100
Iron	26	0.0362	0.0423	-0.0129	0.1215	73
Vitamin A	26	-0.0274	0.0591	-0.1455	0.0425	54
Vitamin C	104	-0.0973	0.0850	-0.3280	0.0145	13
Fiber	13	-0.0086	0.0245	-0.0425	0.0277	46

heteroskedasticity-corrected covariance matrix was used in hypothesis testing (White). Thus the parameter estimates are consistent, but not asymptotically efficient.

The initial specification of the model included 270 parameters, most of which are associated with the interaction terms. A joint test of all interaction terms showed significance at the 0.01 level. Other joint hypothesis tests of groups of variables (Wald tests) were performed using the 0.10 level of significance to eliminate extraneous interaction terms. This resulted in a model with 105 variables. The fact that over one-half of the interaction terms were eliminated from the initial specification of the model seems extreme. However, the profession's understanding of how household sociodemographic variables affect the implicit valuation of cereal characteristics is limited. Economic theory provides little guidance in choosing these variables. Therefore, many variables could be insignificant.

Nutrient Characteristics

Before discussing the effects of sociodemographic variables on values of the characteristics, it is useful to examine the overall implicit values of the various nutrients. The implicit value of each nutrient is a function of the sociodemographic variables. Implicit values were computed for selected combinations of household sociodemographic types. These combinations form sociodemographic profiles. For energy, fat, calcium, and vitamin C, 104 profiles were used. For protein, iron, and vitamin A, only 26 profiles were used since fewer sociodemographic variables significantly affected these nutrients. The implicit value of a specific nutrient for a given sociodemographic profile was computed by multiplying the marginal implicit value of the nutrient by the average nutrient content per pound of cereal. Due to space limitations, only the mean, standard deviation, and the range of the specific values are reported here (table 1). In addition, the percentages of the values which were positive are given. The reader is reminded that nutrient characteristics are continuous variables. This means that the implicit values are not relative to some excluded group.

Values for energy, protein, and calcium were positive for all profiles (table 1), with energy having the highest mean value. This implies that the primary purpose of eating breakfast cereals is to provide the energy needed after the usual 8–14 hours without

eating. Iron was positive for 73% of the profiles. The values for fat and vitamin C were negative for at least 85% of the profiles. The negative value for fat was expected since dietary guidelines have recommended reduction of fat in the U.S. diet (USDA/U.S. Department of Health and Human Services 1980, 1985). The negative value for vitamin C was not expected. However, breakfast cereals are not considered to be a good source of vitamin C, which could explain a near-zero value. The negative value may stem from vitamin C content being correlated with characteristics not included in the model. The values for fiber and vitamin A were approximately half positive and half negative, which implies an overall value near zero. While the near-zero value for fiber was not expected, this result perhaps reflects the fact that the USDA dietary guidelines have not placed as much emphasis on fiber as on fat. The estimates for nonnutrient characteristics show bran cereals to be positively valued. Bran cereals may be considered to be a good source of fiber, or they may be considered to have a positive health value not related to fiber. Bran cereal may also have a positive taste component. This suggests that there is imperfect knowledge concerning the health value of fiber in breakfast cereal. If so, this may signal the need for better education on the benefits of fiber in breakfast food. The near-zero value for vitamin A may have resulted because consumers do not consider breakfast cereals to be a good source of this vitamin.

The relationships between nutrient intake and sociodemographic variables are summarized according to the type of sociodemographic variable (table 2). The first two variables, nutrient intake from cereal and nutrient intake from other foods, measure the decline in the implicit nutrient values as the nutrient intakes increase (table 2, I). Diminishing values were significant for all nutrients.

Among the sociodemographic variables affecting the implicit nutrient values, household age composition was the most significant (table 2). Teenagers had the highest energy value, with energy value rating lowest after retirement. These results are consistent with the nutritional requirements for energy. Fat was negatively valued for children less than 18 years of age, but was given a small positive value for those over 18. This positive value is not consistent with nutritional recommendations and points to the need for nutritional awareness on the part of consumers and/or a change in the nutrient content of breakfast cereals that appeal to persons over 18 years of age. Calcium was positively valued by all age groups, but was lowest among retired households. Iron, fiber, and the vitamin B component were positively valued by some age groups but not others. Since these nutrients should be positively valued by all age groups, nutrition awareness and/or changes in the nutrient content of selected breakfast cereals are needed. The negative values for vitamin C and vitamin A for the selected age groups also point to a problem concerning these nutrients in breakfast cereal.

Education level significantly reduced the implicit value of fat, but had no significant influence at the 0.05 level on any of the other nutrients. Ethnic composition of the household did not significantly affect any of the implicit values for nutrients at the 0.05 level. Urbanization significantly affected the value for energy intakes, but none of the other nutrients. Energy value was highest in rural areas. (Additional relationships are shown in table 2.)

Finally, as seen in table 2, per capita food expenditure significantly affected the characteristic values for protein and fiber. The positive effect on protein value may be explained by the fact that households with high food expenditures usually have a high preference for more expensive, high-protein foods.

Table 2. Impacts of Sociodemographic Variables on Nutrient Characteristic Values for Breakfast Cereals

Variable	Coefficient / t-Value		Variable	Coefficient / t-Value	
I. Diminishing Marginal Utility			III. Education Level of Meal Planner		
Nutrient intake from cereal:			Less than high school:		
Fat	-0.02946	-2.63	Iron	0.00013	0.68
Calcium	-0.00027	-2.61	College:		
Iron	-0.00026	-1.97	Protein	0.00055	1.12
Vitamin C	0.00036	3.19	Fat	-0.00156	-1.21
Nutrient intake from other foods:			Calcium	-0.00003	1.22
Energy	-0.00006	-5.43	Vitamin C	-0.00010	-1.27
Protein	-0.00038	-1.41	Beyond college:		
Vitamin C	-0.00004	-2.32	Fat	-0.00307	-2.16
II. Age Composition of Household^a			IV. Ethnic Composition of Household		
Proportion of members age < 11:			Spanish:		
Energy	0.00070	12.16	Energy	0.00004	1.85
Fat	-0.00949	-3.08	V. Urbanization (residence location)		
Calcium	0.00014	2.46	Central city:		
Iron	0.00267	5.06	Energy	-0.00030	-3.00
Proportion of members age 11-18:			Suburb:		
Energy	0.00087	9.20	Energy	-0.00025	-2.75
Fat	-0.00797	-1.83	Vitamin C	0.00007	0.98
Calcium	0.00008	1.50	VI. Meal Preparer Works Outside Home		
Vitamin A	-0.00002	-2.48	Energy	-0.00060	-4.39
Fiber	0.00372	2.48	Calcium	-0.00007	-2.40
Vitamin B component ^b	0.13701	2.92	Vitamin B component ^b	0.01877	2.17
Proportion of members age > 18:			VII. Occupation of Household Head		
Energy	0.00067	13.96	Blue collar:		
Fat	0.00314	1.86	Vitamin A	0.000002	1.29
Calcium	0.00026	7.75	Vitamin C	-0.00017	-1.09
Retired household head:			VIII. Per Capita Food Expenditure		
Energy	-0.00036	-3.38	Protein	-0.00009	3.22
Calcium	-0.00004	-1.10	Fiber	-0.00004	-2.80
Vitamin C	-0.00052	-2.47			
Vitamin B component ^b	0.05296	2.82			

No. Observations = 5,719, Degrees of Freedom = 5,614, $R^2 = 0.59$
 Goodness-of-Fit Measures (Theil's U -statistics): $U^M = 0.000$, $U^S = 0.127$, $U^C = 0.873$, $U^R = 0.000$, $U^D = 1.000$

Notes: Education, occupation, working status, region, urbanization, race, and origin were incorporated into the model using dummy variables. The excluded categories were high school, white collar, not working outside the home, south, nonmetropolitan area, non-Black, and non-Spanish.

^aThe classification of age composition of household was based on the age classification for Recommended Dietary Allowances (RDA) published by the National Research Council.

^bThe first principal component, consisting of vitamin B6, vitamin B12, thiamin, niacin, and riboflavin.

Nonnutrient Characteristics

Empirical results for nonnutrient characteristics are summarized by first presenting the direct impacts of nonnutrient characteristics on the cereal prices (table 3, I) and then presenting the impacts of the interaction terms between the nonnutrient characteristics and sociodemographic variables (table 3, II-VII). Impacts of the set of sociodemographic variables other than those in the interaction terms are given at the end of table 3 (VIII).

These control variables measure the impacts of sociodemographic variables directly on the prices paid by consumers.

The direct impacts of nonnutrient characteristics reflect consumers' overall implicit valuation for these characteristics relative to the corresponding excluded categories. The excluded groups for variables with more than two categories are listed in table 3 (I). For variables with two categories, the excluded category does not have that characteristic. For example, the coefficient of 1.48285 for the direct impact of variety pack means that, holding other things constant, the consumer would pay \$1.48 more for one pound of variety pack than for a nonvariety pack.

There are significant differences in the implicit values of the different types of grains, the types of processing, additives to the cereals, and the amount of convenience (table 3, I). Variety pack, a measure of convenience, was statistically different from other package forms. The "light" cereals, such as rice and puffed, may be perceived as low calorie. They have relatively high implicit values. Newer cereal types, such as multi-grain and rolled, also have high implicit values. The value of unenriched cereal is higher than for enriched. Most cereal is enriched, and the unenriched variety is a special product appealing to those consumers who do not want artificial supplements.

Interaction terms between the nonnutrient characteristics and the sociodemographic variables measure how the sociodemographic variables affect consumers' implicit values of the nonnutrient cereal characteristics. The hypothesis of a diminishing marginal utility for nonnutrient characteristics was confirmed for two types of processing (puffed and shredded) and for grits (table 3, II). Other nonnutrient characteristics showed little evidence of diminishing marginal utility.

Age composition of the household, education level, ethnic composition, and the meal preparer working outside the home all significantly impacted the implicit values of the nonnutrient characteristics. Two relatively new types of processing, rolled and nugget, were valued less by households with high percentages of adults. Households without children and/or with nonretired heads placed greater value on variety packs. Households with retired heads may have more time for food preparation. Households with children may experience economies of size.

Variety pack and the more convenient forms of hot cereal were more highly valued at higher education levels. However, the meal preparer working outside the home did not show significantly higher values for the convenience measures as was expected. Black households had significantly different values for many of the hot cereals.

Household characteristics and sociodemographic variables also directly affected the overall prices paid for breakfast cereals (table 3, VIII). Households residing in central cities paid higher prices for cereals than the households who resided in suburban areas, while the households in both of these regions paid higher prices than those residing in nonmetropolitan areas (the omitted group). Households with a retired head and/or households with a meal preparer working outside the home paid higher prices for breakfast cereals.

Prices were also affected by household size, the type of store, and per capita food expenditures. Household size is likely measuring the economies which can be obtained by purchasing larger packages, or the purchase of more inexpensive brands by the large household. Households that usually purchase food at discount supermarkets pay a lower price for cereals than others. Per capita food expenditure was positively related to the price paid for cereals. Households with high food expenditures could be purchasing the more expensive, higher quality brands and/or the smaller packages of cereal.

Table 3. Impacts of Sociodemographic Variables on Nonnutrient Characteristic Values for Breakfast Cereals

Variable	Coefficient / t-Value		Variable	Coefficient / t-Value	
I. Direct Impact^a			IV. Education Level of Meal Planner		
Variety pack	1.48285	2.69	Less than high school:		
Presweetened	0.18299	8.12	Variety pack	-2.75256	-4.52
Fruits/nuts added	0.16547	6.71	Rice	0.15066	2.57
Type of grain:			College:		
Rice	0.70124	15.15	Variety pack	-0.37747	-0.52
Multigrain	0.53419	9.85	Oats	-0.13741	-3.20
Oats	0.00986	0.16	Nugget	0.16407	1.34
Wheat	0.32659	9.84	Beyond college:		
Bran	0.49550	8.35	Unenriched	-0.27912	-0.80
Corn ^b	—	—	Hot regular	0.23903	2.69
Type of processing:			V. Ethnic Composition of Household		
Puffed	0.56906	12.91	Black:		
Shredded	0.20639	6.09	Variety pack	1.45397	3.44
Nugget	0.91989	4.83	Nugget	0.33826	1.23
Rolled	1.46202	5.59	Unenriched	-0.70358	-3.81
Flaked ^b	—	—	Hot quick	0.12154	2.41
Unenriched	0.70755	4.65	Hot oats	-0.81359	-3.18
Hot cereal	-0.15995	-0.65	Hot wheat	-0.94051	-3.36
Type of hot cereal:			Hot nongrits	0.83419	3.35
Oats	0.76647	3.08	Spanish:		
Wheat	0.74899	2.83	Chocolate added	-0.48542	-0.97
Grits	0.11743	1.60	VI. Meal Preparer Works Outside Home		
Other ^b	—	—	Variety pack	-1.16526	-1.17
Convenience of hot cereal:			Multigrain	-0.92580	-1.54
Regular	-0.91411	-18.05	Bran	-0.17040	-2.91
Quick	-0.91904	-18.73	Nugget	0.23948	1.85
Instant ^b	—	—	VII. Occupation of Household Head		
Chocolate added	0.03496	0.56	Blue collar:		
II. Diminishing Marginal Utility			Multigrain	0.10614	1.69
Quantity of characteristic:			Puffed	-0.05517	-1.26
Variety pack	0.06575	0.42	VIII. Control Variables^c		
Rice	-0.09437	-1.09	Region:		
Puffed	-0.24320	-2.61	Northeast	0.02792	1.76
Shredded	-0.12396	-2.06	West	0.08896	5.26
Grits	-0.25948	-3.17	South ^b	—	—
III. Age Composition of Household			Urbanization (residence location):		
Proportion of members age < 11:			Central city	0.46848	2.79
Oats	0.19637	1.98	Suburb	0.38016	2.50
Proportion of members age > 18:			Rural ^b	—	—
Variety pack	3.33200	3.23	Retired household head	0.67825	3.84
Rolled	-1.21430	-3.83	Meal preparer works outside home	1.07019	4.50
Nugget	-0.43865	-3.83	Log household size	-0.09172	-4.54
Hot oats	-0.59966	-1.94	Nonsupermarket stores	-0.11375	-2.34
Hot wheat	-0.34948	-1.06	Log per capita food expenditure	0.14654	5.05
Hot nongrits	0.26950	0.88			
Retired household head:					
Variety pack	-1.26966	-5.94			
Chocolate added	-0.81660	-3.69			

^a Direct impact of nonnutrient cereal characteristics on prices paid for cereals other than the interaction term between nonnutrient attributes and sociodemographic variables.

^b Denotes excluded dummy variable category where there are more than two categories.

^c Besides the nutrient and nonnutrient components, an additional set of sociodemographic variables was included in the hedonic price function to control the price variation that could not be explained by food characteristics.

Summary and Conclusions

A hedonic price model was developed which allows modeling discrete nonnutrient food characteristics in addition to nutrient characteristics. Inclusion of the nonnutrient characteristics avoids bias from excluded relevant variables. Another major feature of this research was to specify and estimate the effects of sociodemographic variables on the values of the characteristics.

The empirical results for breakfast cereals support the hypothesis that the values of the characteristics are influenced by the sociodemographic variables. Nutrition information programs can be targeted toward groups with low implicit values. Advertising for new cereal products can be targeted toward groups with low implicit values of the characteristics provided by the new product.

The most important nutrient characteristic in terms of its implicit value was energy. Energy value was highest in households with teenagers and lowest in households with retired heads. This finding is consistent with the energy requirements of these age groups.

Fat was negatively valued in breakfast cereals, which is consistent with the recent concerns about excess fat in the American diet. Fat values were lower for households with children and for households with higher education levels. Even though the overall negative value for fat is consistent with good nutrition, the smaller negative values for fat among households without children suggest a need for improved nutrition education among this group.

Protein, calcium, and the vitamin B component were positively valued as well. Calcium values were lowest among retired households and among households with the meal preparer working outside the home, suggesting that these groups should be targeted to receive information about the benefits of calcium in breakfast cereals.

Fiber content was negatively valued overall, but bran was positively valued. Bran was valued either for its perceived fiber content or for its "taste" value. Either interpretation has important implications for additional information on the benefits of fiber in breakfast cereal.

The type of grain and the type of processing had significant impacts on the price of breakfast cereal. Various convenience measures were positively valued, as were additives such as sugar, nuts, and fruit. These nonnutrient characteristics were also significantly affected by selected sociodemographic variables.

Both nutrient and nonnutrient values declined with increases in the consumption of these characteristics. This is consistent with the concept of decreasing marginal utility and with nutritional recommendations. If a nutrient is consumed at a level at or above its recommended level, the nutritional value of that nutrient approaches zero.

It is possible to alter both the nutrient and nonnutrient content of cereals through cereal processing and nutrient fortifications. Therefore, these results can be used to design products with improved taste and nutrient content. Since the implicit values vary among households with different sociodemographic backgrounds, the results can be used to design products for targeting to particular groups. The findings of this study can also be used to educate the general public about the nutritional aspects of breakfast cereal. For example, education programs can be designed to show the benefits of fiber.

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