Determinants of Household Choice of Breakfast Cereals:

Healthy or Unhealthy?

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Abstract

We studied consumer demand for more and less healthy breakfast cereals. Using ACNielsen Homescan database and USDA food nutrition data, we developed three cereal nutrition indexes for each household in the data. In addition to the standard demographic characteristics of households and prices, we included variables representing differences between private labels and national brands. We found that the structure of the industry, through its effect on the product mix produced, affects consumer choice of nutritious foods. Some households buy fewer healthy cereals simply through reluctance to trust private labels. Among all factors expected to influence consumer purchases, the prices appear to have the strongest effect on the healthiness of the choice of breakfast cereals, which is a relatively inexpensive product. Households with children and teens buy less healthy cereals, while older and more educated households make healthier choices.

Keywords: consumer demand, healthy and unhealthy food, breakfast cereals.

Introduction

The U.S. Food, Drug and Cosmetic Act, passed in 1938, made it illegal to use disease-prevention claims in promoting food products. This law was enforced until 1984, when Kellogg began making such claims for their All-Bran breakfast cereals. A list of “Preventive Health Tips from the National Cancer Institute” (NCI) appeared on the All-Bran box and the NCI was also mentioned in All-Bran TV and print ads (Consumer reports, October 1986). The Food and Drug Administration (FDA) decided to permit this promotion. Subsequently, the Nutrition Labeling and Education Act of 1990 provided FDA with specific authority to require nutrition labeling of most foods regulated by the agency and to require that all nutrient content claims (i.e., 'high fiber', 'low fat', etc.) and health claims be consistent with agency regulations. The regulations for nutrition labeling become effective in 1994. The goals of this regulation were to reduce the negative effects of untruthful and exaggerated nutrition claims and to provide consumers with nutrition information at the point of sale. As a consequence of these developments, nutrition claims have became a standard marketing tool for many food products.

However, obesity and other nutrition-related health problem have worsened. According to the American Heart Association, the prevalence of overweight in children ages 6-11 increased from 4.2 percent in 1963-65 to 15.8 percent in 1999-2002. The prevalence of overweight in adolescents ages 12-19 increased from 4.6 percent to 16.1 percent over same period. The obesity in Americans in the age 20-74 increased from 20.6% in men and 25.9% in women during 1988-1994 to 27.6% in men and 33.2% in women during 1999-2002. This suggests that nutrition information provided by food labels and advertising may have limited impact on actual food choice. One reason may be costs, in terms of time and efforts, of gathering and processing the information (Stigler and Becker). Also, it may be that nutrition cannot compete with other factors, such as taste and convenience to which food companies are catering with an increasing array of food products.

Because of these trends, the question of consumer demand for healthy/unhealthy foods is a topic of growing interest in agricultural economics. One of the issues addressed is consumer responsiveness to

nutrition and health information. Most studies have used aggregate commodity data or household food surveys. Brown and Schrader constructed a measure of information on the links between cholesterol and heart disease available to physicians to investigate how this information had affected consumer demand for shell eggs. They analyzed aggregate national consumption and price data and found that the information had decreased per capita shell egg consumption and changed shell egg's own price and income elasticities. Chern, Loehman and Yen applied Brown and Schrader's index to the FDA Health and Diet Survey data and found that the health information resulted in decreased consumption of butter and lard and increased consumption of vegetable oils with less saturated fat. Kinnucan et al. updated Brown and Schrader's index to look at the effects of health information together with advertising on the shifts in U.S. aggregate meat demand from beef to poultry. The health information appeared to be important: the health-information elasticities were larger than price elasticites, while effects of generic advertising were found to be small. The conclusion from these studies is that consumer demand, at least at the aggregate level, is responsive to the health and nutrition information.

A study at the individual level was conducted by Variyam, Blaylock and Smallwood. They used Continuing Survey of Food Intake of Individuals (CSFII) and the companion Diet and Health Knowledge Survey (DHKS) conducted by U.S. Department of Agriculture (USDA) to estimate the effects of fiber-specific information on dietary fiber intake. Fiber helps ward off heart disease, diabetes and may help to lessen chances of developing colon cancer. Variyam, Blaylock and Smallwood measured information using survey questions on fiber content of foods, attitude toward consuming fiber-rich foods, and awareness of fiber-health links. Their results confirmed the positive influence of nutrition information on fiber intake and highlighted the enhancement effect of the education on the level of information.

In this study we use a commercial data set to examine household demand for more healthy/less healthy breakfast cereals. For a focus on nutrition, cereal is an excellent product to study. It is one of the largest grocery categories, purchased by nearly all households. More important, it contains products of widely varying nutritional quality. On the one hand, many cereals are important sources of whole grains and

fiber, which are generally agreed to be a preventive for digestive cancers and chronic heart diseases. On the other, there are highly sweetened cereals, which many view as junk food and as potentially contributing to obesity and type-II diabetes, especially among children. These characteristics are well-publicized: cereal marketing makes especially frequent use of health claims. Thus, consumers have a relatively high knowledge of the health aspects of various cereals.

In this study we examine the effect of prices, household structure, and purchase behavior on the healthiness of household cereal choice. We used the ACNielsen Homescan database, consisting of all retail food purchases and prices paid by 7195 US households during 1999. The database also contains households' demographic characteristics. As explained below, we developed three cereal nutrition indexes for each ACNielsen household based on their cereal purchases and nutrition contents of various cereal brands. This was used as the dependent variable in a regression on prices, measures of household structure, income, education and purchase behavior represented by the percent of household's purchases in all retail food categories that were (i) private label, and (ii) bought on a deal. The last two variables were included to capture a unique aspect of the study. We consider the possibility that the structure of industry, through its (possibly incidental) effect on the product mix produced, can affect consumer choice of nutritious foods. The cereal industry is composed of a small number of national brand producers, a fringe of small producers, and a very large number of private labels. While each of these groups produces cereals of all types, there are some possibly important differences in the mix of healthy/unhealthy cereals. For example, the fringe group has several firms specializing in "natural" cereals, a large number of which would be classed as healthy by most criteria.

What is of particular interest here is differences between private labels and national brands. Cereals that are viewed as healthy tend to be basic whole grain types, with simple formulas and non-proprietary names, like raisin bran, oatmeal, and shredded wheat. Less healthy cereals tend to be sweetened and made with more complex formulas using refined grains and added flavorings. They also have proprietary names.

These product differences makes private label more competitive for healthy cereals, which will affect their product mix.

If we classify brands in ACNielsen data by the percent of sugar and fiber in their weight, the sugar content of "other" (other than major brands) branded products is the lowest, reflecting their concentration in adult-type whole grain products. But this group is closely followed by private labels, with average sugar content much below that of all the major manufacturers. For fiber, private label actually has a higher content than does the "other" group.

By this classification, then, we find that private label cereals as a group are among the healthiest, and generally superior to the national brands. As a consequence, consumers who are not reluctant to buy private label products will for that reason tend to purchase healthier cereals. This is the reason we included the private label variable. The "bought on a deal" variable is used to measure the national brand prone consumer. Price reductions, especially with coupons, are used extensively by national cereal brands, but seldom by private labels. Thus, heavy coupon users will tend to buy national brands, and hence, on average, less healthy cereals. These two consumer types are evidently reasonably distinct, for we found the correlation between private label and bought on a deal variables to be virtually zero.

The paper is organized into six sections. Section two provides review of the literature devoted to different aspects of demand for breakfast cereals and links between consumer health and breakfast cereals consumption. Section three describes methodology and datasets used in the analysis. Section four is devoted to explanatory variables used in the analysis. Section five presents results, and section six is the conclusion.

Previous breakfast cereals studies[1]

[1] Breakfast cereals is a very interesting food category. It attracts not only demand economist, but also the attention of industrial organization economists. See, for example, Schmalensee, Connor, Price and Connor, and Reimer.

Several hedonic pricing models have studied cereals. These include Morgan, Metzen and Johnson; Shi and Price; Stanley and Tschirhart. The empirical content of hedonic models is under debate because the content may be just a consequence of arbitrary functional forms (Ekeland, Heckman and Nesheim) and may be subject to endogeneity problems. This may explain why these cereal studies often yielded implausible results, such as negative valuation of fiber and positive valuation of sugar content by consumers.

Binkley and Eales conducted an exploratory study on how prices of breakfast cereals, demographic variables and health characteristics of consumers affect the consumer choice between high fiber and low fiber breakfast cereals. Specifically, they looked at relationship between high fiber cereal consumption and incidents of mortality by digestive cancer. Their work was motivated by Armstrong and Doll who found that cereal consumption is negatively associated with every type of cancer considered, with the association especially pronounced for digestive cancer. Several data sources were used, including: Sales Area Marketing, Inc (SAMI) data on product sales, National County Mortality Data File of the National Center for Health Statistics, and food composition data from USDA Continuing Household Survey data base. Five Kellogg's cereals were considered. All-Bran, a product rich in fiber, was least price and expenditure elastic, implying that All-Bran consumers viewed this product as something "necessary". Healthy life style, measured by consumption of total and high fiber breakfast cereals, had a negative relationship with incidents of mortality from digestive cancer. Finally, there was evidence that consumers in markets with high mortality rates due to digestive cancer were motivated to buy cereals with very high fiber content. Overall, the conclusion of this study is that choice of food is governed not only by price considerations, but also dietary characteristics and it is important that consumers are aware of these characteristics and their effects on health.

Aside from these studies is the work by Ippolito and Mathios. They evaluated whether the policy change in 1985, that allowed food manufacturers to explicitly link diet to disease risks in advertising and labeling, led to improved consumers food choices, or had "…confused consumers sufficiently to slow improvements in diet that would otherwise occur…" During the 1978 -1984 period the evidence of a link

between reduced cancer rates and high fiber diets and corresponding educational programs was growing. At the same time health claims by manufacturers were prohibited and, as a result, Ippolito and Mathios found there were no increases in high-fiber cereals consumption. However, when health claims through labeling and advertising by manufacturers were allowed in 1985, the consumption of high in fiber cereals increased, as well as number of new high fiber cereals produced. An analysis of food consumption patterns revealed that large differences in high fiber cereals consumption among demographic groups, existing prior to the use of health claims, diminished after the change in information policy. This leads to the conclusion that producers' claims are more effective in reaching consumers and influencing their behavior than government educational campaigns and other information sources. The authors attributed this to the fact that government information is usually distributed in very general form, while producers' advertising ties nutrition characteristics of specific product to consumer health.

Data and methodology

The Homescan database contains many product categories, four of which are cereals: ready-to-eat, hot, natural and granola, and wheat germ. In the database, there were 1 888 635 purchases from those categories, conducted by 6 998 households. 197 households bought no breakfast cereal. Using primarily the USDA food nutrition data base but also other sources (including cereal boxes), nutritional contents for each brand purchased were obtained. Major cereals appear directly in the USDA data. For others we either used alternative sources or matched them with USDA cereals. The total number of cereals identified as different by their nutrition content is 451.

We are interested in "healthiness" of the breakfast cereal consumption of each household and in drivers of the choice between healthy and unhealthy breakfast cereals. Knowing the nutrition content of each breakfast cereal purchased and recorded in the ACNielsen database, we calculated the nutrition content of the breakfast cereal "bundle" bought by each household during 1999. We separated "healthy" and "unhealthy" cereals "bundles" by three criteria: (1) sugar content; (2) fiber content; and (3) by a healthiness

index based on rating developed by Consumer Reports Magazine which is based on protein, sugar, fiber, fat, and sodium. The Consumer Reports Magazine rating of most popular in the US breakfast cereals is provided in table 1. Using these ratings and regression analysis, we developed a CU index for every household in the ACNielsen data. Specifically, we regressed the ratings in table 1 on the protein, sugar, fiber, fat, and sodium content of each breakfast cereals. The results of the regression are shown in table 2. The weights that we used to calculate the index for each household are shown in the coefficient column. Note that high (positive) marks are assigned to protein and fiber and low marks (negative) to fat, sugar and sodium.

The distribution of the healthiness of breakfast cereals consumed during 1999 is shown in table 3 and Figures 1-3. Sugar and fiber indices are calculated as percent of weight of all breakfast cereals bought during 1999. The distributions of CU and sugar indices are pretty symmetric, while fiber index is skewed to the left suggesting that some households are biased toward rich in fiber breakfast cereals compare to the rest of the sample.

The three measures of the healthiness of consumer choice of breakfast cereals were used as the dependent variable in a regression on measures of income, education, household structure, purchase behavior and prices. That is, we implemented three regressions where independent variables are the same, but the dependent variables are different: fiber index, sugar index and Consumer Reports index.

Explanatory variables

All variables definitions and expected effects on the dependent variables are provided in the table 4.

The first group of the explanatory variables is demographic characteristics constructed from the information in the ACNielsen database. Among demographic variables, only income per household member is treated as continuous and the others are dummy variables.[2] Our expectation about the effect of income variable on the healthiness of consumed breakfast cereals is mixed. Higher income may be a proxy for better access to and knowledge about the nutrition content of food. However, Variyam, Blaylock and Smallwood found that as

[2] In the ACNielson database, the household income variable is given by intervals. For example, $12 000 - $14 999, $15 000 – $19 999 and so on. Income per household member is calculated as the mean point of the interval divided by size of household.

income increased, households reduce fiber consumption. This may be because higher-income individuals may view rich in fiber products as inferior, or high income individuals have high time costs of obtaining the nutrition information. We expect education to have a positive effect on the healthiness of breakfast cereals because it should give a better ability to gather and process information about nutrition and to distinguish between truthful and exaggerated nutrition claims.

We expect older people to choose cereals rich in fiber because of negative association between high-fiber foods consumption and cancer. We expect that younger people are more taste than nutrition oriented and choose less healthy cereals. The presence of children in the age of 6-17 should reduce healthiness of the household breakfast cereal bundle because they tend to judge foods solely on taste, and for many brands targeted towards children half the cereal is sugar. The presence of female head in the household should improve healthiness of the choice because females have been found to be more concerned about nutrition and health issues. If female head does not work, she may spend more time on household menu planning and pay even more attention to nutrition. We included race and Hispanic variables to capture possible cultural differences (Variyam, Blaylock and Smallwood). Regional dummy variables are included to capture variations due to similar reasons, but also to overcome consequences of the error component specification of the model. We will address this issue below.

To calculate prices, we first defined “most healthy” and “least healthy” cereals as cereals in the upper quartile and lower quartile, respectively, of the distribution of CU or fiber index. For the sugar index the definition is the reverse. ACNielsen lists all prices paid by households and we could simply take these prices. However, consumers with low search costs and access to many outlets can exercise some control on prices paid, generating potential endogeneity. To avoid this endogeneity problem, we proceeded as follows. In the ACNielsen data, all US territory is divided into 52 markets. For each breakfast cereal in each market we calculated volume-weighted average price. That is, households in the same market are assigned the same price for a particular breakfast cereal. Such structure of the data may lead to error-component model (Moulton and Randolph). If errors actually follow an error components specification, then the use of ordinary

least square can lead to seriously biased standard errors and test statistics. Therefore, it is important to test for the presence of error components. We conducted this test and found no evidence of error-component problem. However, this was true only when the models included the regional variables discussed above. The private label and "deal" variables were calculated as the percent of all purchases in the entire data base (not just cereals) that were private label and deal, respectively. This was computed for every household.

Results

The results of the regression analysis are presented in table 5. The results for the three measures of healthiness are very similar for all variables. The higher income per household member has significant positive effect on the healthiness of breakfast cereals choice: income variable enters the CU index equation and fiber equation with a positive sign and the sugar equation with a negative sign. Given that education variable is also included in the model, the income is most likely a proxy for better access to nutrition information. The education variable is also highly significant and has a positive effect on CU and fiber indices and negative effect on sugar index, as expected. Compared to young households, older households buy healthier breakfast cereal.[3] The same is true for middle age household, but the difference is smaller. Households with children in the age from 6 to 12 and from 13 to 17 buy less healthy breakfast cereals, but presence of very young children have no effect. The 6 to 12 age group is likely to be the group most susceptible to advertising, and highly advertised cereals are often very high in sugar. We tested if better education in the families with children influences the choice of breakfast cereals, expecting to find that educated parents would buy more healthy food for themselves and especially for their children. For this test, we added interactions of education variable with babe, youth and teen variables to the model. However, these variables did not have any significant effect on the healthiness of breakfast cereals.

The presence of a female head does not have any effect on the choice in all three models. However, households with only a male head choose less healthy cereals compared to households where only female

[3] White race young household living in central region is our reference group.

head or both heads are present, at least in terms of CU index. As expected, female heads not employed outside the home make better choice of breakfast cereals. Interestingly, effect of the male head being not employed is also positive and even stronger. This may suggest that males, if they have time to shop, are more careful shoppers than females. The effect of Hispanic ethnicity is not significant. Black and oriental households choose lower in fiber breakfast cereals. The results for Hispanic and black households is very similar to what is found by Variyam, Blaylock and Smallwood.

The private label variable enters all three models as expected: the effects on CU index and fiber index are positive, and the effect on sugar index is negative. However, the effect on fiber index is not significant, suggesting that the health advantage of private labels mainly involves low sugar. The special price or deal variable has a significant negative effect on the healthiness of the choice as expected. Branded cereals in the aggregate tend to be less healthy, perhaps because of an emphasis on taste features.

The sign and large magnitude of the price of more and less healthy breakfast cereals reveal that the choice of breakfast cereal, which is a relatively inexpensive product, is sensitive to price. In the markets where less healthy cereals are more expensive, consumers choose more healthy cereals. That is, there is significant substitution effect. In fact, consumers pay extra when the manufacturer adds the sweetener. Sugar costs about 35 cents a pound in the store. In the box of cereal such as Honey Smacks, the cost of sugar is four times larger (Consumer Reports). We found that the average prices are higher for unhealthy cereals than for healthy in all markets, when the healthiness is measured by CU index, and in 47 of 52 markets when the healthiness is measured by the fiber or sugar indexes.

Conclusions

In this study we examined the effect of prices, household structure, and purchase behavior on the healthiness of household breakfast cereal choice. We created three measures of the healthiness: an overall nutritional quality index, a fiber index and a sugar index. Households with children and teens buy less healthy cereals, while older households make healthier choices. More educated households and higher income households

also choose healthier cereals. Reasons for the latter are not obvious, since some of the cheapest cereals fall in the healthy group. (However, many natural and multigrain cereals tend to be high-priced.) Our explanation for this positive relationship between income and healthiness of the choice is the higher income serves as a proxy for better access to nutrition information. The private label and bought on deal variables were both significant with expected signs. This suggests that nutrition profiles can differ simply due to different shopping behavior. Evidently some households buy fewer healthy cereals simply through reluctance to trust private labels.

Strikingly, among all factors expected to influence consumer purchases, the prices appear to have the strongest effect on the healthiness of the choice of breakfast cereals, relatively inexpensive product. As price of less healthy cereals increases, consumers choose more healthy breakfast cereals. In the same time, the price increase of more healthy cereals leads to less healthy choice. These suggest that prices are important: as more healthy cereals become less expensive, more households would buy them. This is especially important, for one oft-mentioned policy choice is to tax less healthy food products and /or to subsidize those viewed as healthier. Our results provide evidence that such policies may be effective.

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Figure 1. Distribution of the constructed CU index of the breakfast cereal consumption in the ACNielsen data, 1999.

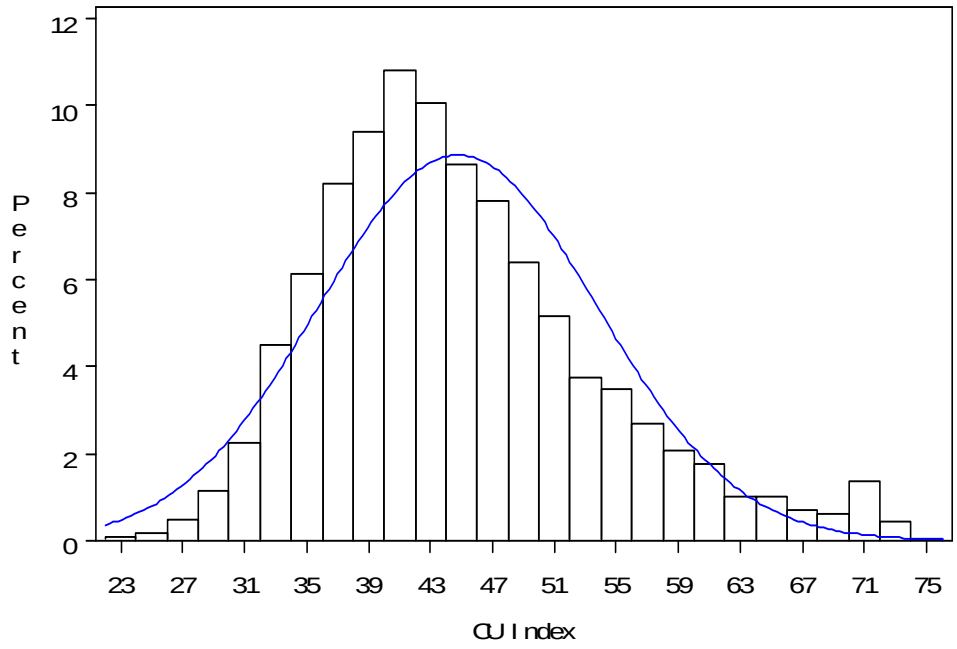

Figure 2. Distribution of the sugar index of the breakfast cereal consumption in the ACNielsen data, 1999.

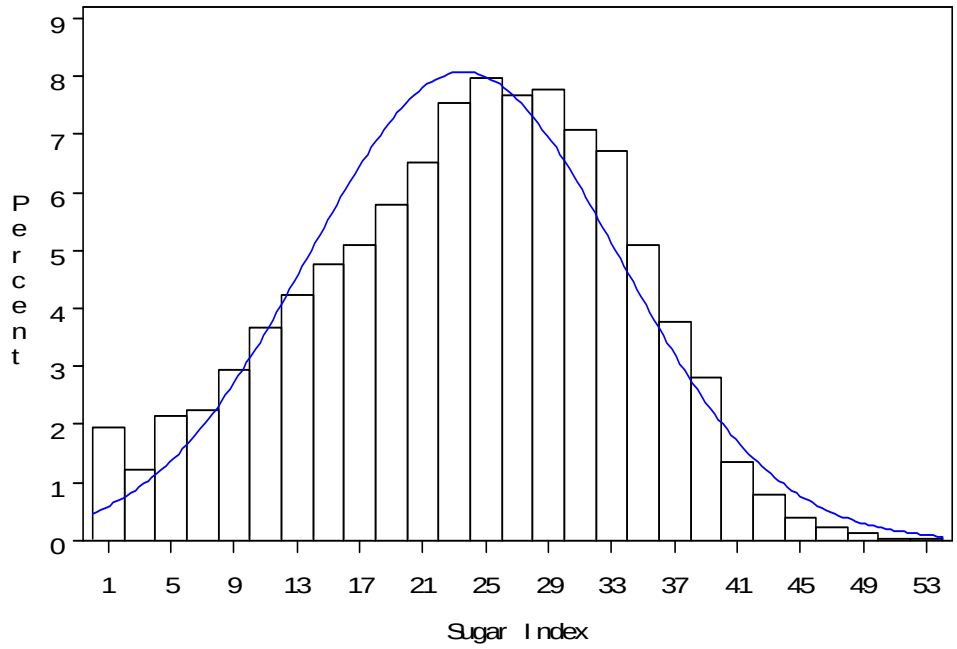

Figure 3. Distribution of the fiber index of the breakfast cereal consumption in the ACNielsen data, 1999.

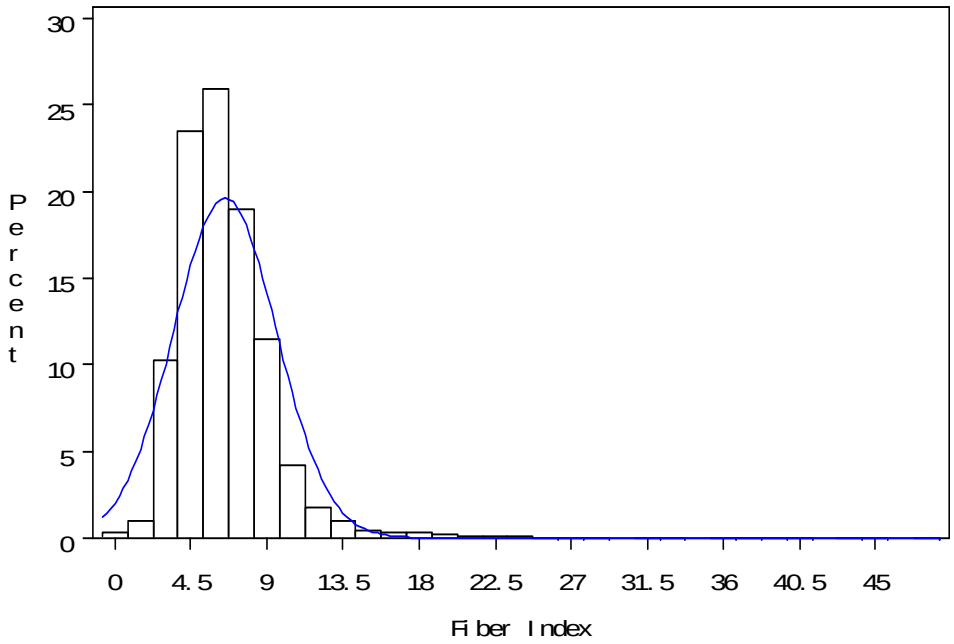
30
25
20
15
10
5
0
Percent
0
4.5
9
13.5
18
22.5
27
31.5
36
40.5
45
Fiber Index

Table1. Nutrition Index for breakfast cereals calculated by Consumer Union and reported in Consumer Report, October 1986, and their nutrition information per 100 grams as reported in USDA food nutrition data.[4]

Brand	Index	Protein, gm	Fat, gm	Sugar, gm	Fiber, gm	Sodium, mg
All-Bran (Kellogg)	60	12.5	3.32	19	32	258
Apple Jacks (Kellogg)	33	3	2	49	3.2	475
Bran Buds (Kellogg)	51	7	2.15	27	43	676
Cap'n Crunch (Quaker Oats)	22	4.35	5.81	43.57	2.5	749
Cap'n Crunch's Crunch Berry (Quaker Oats)	22	4.45	5.65	44.52	2.5	699
Cap'n Crunch's Peanut Butter Crunch	20	7.05	9.15	33.19	2.9	742
Cheerios (General Mills)	51	11	6	4	9	910
Cocoa Krispies (Kellogg)	29	3.4	3.2	45	3.2	613
Cookie-Crisp, Chocolate Chip (Ralston Purina)	27	4	3	42	1.5	594
Corn Chex (Ralston Purina)	40	7	0.9	10.77	2	959
Kellogg's Corn Flakes	44	7	0.8	7	3.5	725
Crackin'Oat Bran (Kellogg)	36	8.3	14.6	31	11.7	286
Kellogg's Bran Flakes	49	10	2	17	17.5	715
Froot Loops (Kellogg)	31	3.4	4.1	47	3.1	471
Frosted Mini-Wheats (Kellogg)	62	9.8	1.6	19.6	10	10
Frosted Krispies (Kellogg)	27	3.4	0.8	40	0.3	726
Golden Grahams (General Mills)	27	5	3.5	35	3	895
Honey Nut Cheerios (General Mills)	27	9	4	35	6	898
King Vitamin (Quaker Oats)	31	6.45	3.56	20.2	3.8	838
Kix (General Mills)	40	6	2	11	3	891
Life (Quaker Oats)	49	9.92	4.38	19.48	6.6	513
Lucky Charms (General Mills)	29	7	3.8	43	5	678
Product 19 (Kellogg)	42	7.7	1.4	13.3	3.3	690
Kellogg's Raisin Ban	38	8.5	2.5	32	11.9	593
Rice Chex (Ralston Purina)	42	6	1	8	1	941
Rice Krispies (Kellogg)	42	6.2	1.3	9.1	0.4	966
Quaker Puffed Rice	67	7	0.9	0	1.4	5
Special K (Kellogg)	53	22.5	1.55	12.9	2.4	721
Corn Pops (Kellogg)	36	3.7	0.73	45.2	0.8	386
Frosted Flakes (Kellogg)	29	3.3	0.52	38	3.2	479
Honey Smacks (Kellogg)	40	6.4	1.85	56	3.7	186
Total (General Mills)	49	8	2.5	17	8	639
Trix (General Mills)	27	3	3.8	44	3	647
Wheat Chex	56	10	2	10	11	891
Wheaties (General Mills)	47	10	3.2	14	10	725
Quaker Puffed Wheat	78	16.26	2.15	1.36	9.4	5
Cinnamon Life (Quaker Oats)	49	8.91	4	26.59	6.2	478
Oh's Honey Graham (Quaker Oats)	18	3.97	7.41	45.07	2.1	600
Sun Country Granola with Raisins	51	11.77	18.02	20.42	5.2	33
Fiber One (General Mills)	67	8	2.7	0	48	429
All-Bran with Extra Fiber (Kellogg)	67	11.3	3.5	0.37	50	475

[4] Consumer Reports Magazine provides nutrition information of breakfast cereals with corresponding indices. But, nutrition information was provided only for some of the breakfast cereals for which ratings were reported. Moreover, when level of a key component is small, the Magazine reports “trace”, which cannot be used to recover weights assigned to each key nutrient component in the index. For these two reasons, we use USDA food nutrition data as a source of the breakfast cereal nutrition content.

Brand	Index	Protein, gm	Fat, gm	Sugar, gm	Fiber, gm	Sodium, mg
Crispix (Kellogg)	44	6.8	0.8	10.3	0.5	724
Raisin Nut Bran (General Mills)	42	9.39	8	29	9.2	455
FrankenBerry (General Mills)	24	3	2.6	47	0.9	711
Country Corn Flakes (General Mills)	44	6	1.3	8	1.7	877
Count Chocula (General Mills)	27	4	3.6	47	1.8	584
Cocoa Puff (General Mills)	24	4	3.2	47	2.3	571
Cinnamon Toast Crunch (General Mills)	22	5	11	34	4	687
Kaboom (General Mills)	31	9	3.7	20	6	950
Post Natural Bran Flakes	56	9.4	2.2	18.9	17.6	732
Cocoa Pebbles (Post)	27	3.5	4.2	44	1.6	541
Fruity Pebbles (Post)	27	3.6	3.9	44	0.7	584
Alpha-Bits (Post)	29	8.5	4.1	39	4.1	661
Fruit & Fibre (Post)	44	7.1	5.6	29.8	9.7	509
Super Golden Crisp (Post)	42	5.5	1.4	53.9	0	150
Grape-Nuts (Post)	56	10.8	1.9	12	8.7	610
Grape-Nuts Flakes (Post)	49	10	2.9	17.6	8.8	482
Honey-Comb (Post)	29	5.2	2.1	38.3	2.5	743
Post Natural Raisin Bran	40	7.9	1.8	33.4	13.1	611
Post Toasties Corn Flakes	44	6.7	0.1	6.5	4.5	949
Nabisco Shredded Wheat	71	10.4	1.2	0.8	11.5	7
Nabisco Shredded Wheat'N Bran	73	12.5	1.4	1	13.4	5
Nabisco Shredded Wheat Spoon Size	73	10.3	1.1	0.9	11.4	7
Post 100% Bran	58	12.7	2.1	24.4	28.6	417
Bran Chex (Ralston Purina)	51	7	2.5	22	13	657
Uncle Sam (US Mills)	69	15.98	11.6	1.56	20.3	206
Familia Genuine Swiss Muesli (Biofamilia)	56	9.5	6.3	26.2	8.5	50

Table 2. Weights for each component in the CU index.
Dependent variable is Consumer Report Magazine Index.

Variable	Coefficient	Standard Error	t Value	Pr > |t|
Intercept	63.21	2.60	24.28	<.0001
Protein	0.88	0.18	4.89	<.0001
Total lipid (fat)	-0.93	0.15	-6.29	<.0001
Sugars	-0.49	0.04	-12.69	<.0001
Fiber	0.26	0.05	5.41	<.0001
Sodium	-0.02	0.00	-13.92	<.0001

Number of observations	67
Adj R – square	0.94
F statistics	211.41

Table 3. Purchased breakfast cereals Healthiness indices[5]

Healthiness Index	Range	Mean	Std. Dev	Minimum	Maximum
CU	1 to 100	44.76	9.01	22.55	75.44
Sugar	1 to 100	23.58	9.87	0	53.90
Fiber	1 to 100	6.52	3.06	0	48.00

[5] One observation in the database is purchase of buckwheat groats which contains a lot of protein and almost no fat, sugar and sodium. The index for this purchase is greater than 100. We removed this purchase from the further analysis.

Table 4. Variable definitions, their summary statistics and expected effects on the independent variable.

Variable	Definition	Sample mean and standard deviation	Expected effect on CU index	Expected effect on sugar index	Expected effect on fiber index
Income	Income per household member per year, $1000	25.46 (18.16)	?	?	?
Education	1 if average of education levels of male and female heads of households is at least completed college degree, 0 otherwise	0.34 (0.47)	+	-	+
Old	1 if average age of male and female heads of household is 50 or older, 0 otherwise	0.52 (0.5)	+	-	+
Middle	1 if average age of male and female heads of household is between 35 to 49, 0 otherwise	0.38 (0.49)	?	?	?
Young	1 if average age of male and female heads of household is under 35, 0 otherwise	0.10 (0.30)	-	+	-
Babe	1 if children under 6 years old are present, 0 otherwise	0.1 (0.3)	?	?	?
Youth	1 if children 6-12 years old are present, 0 otherwise	0.16 (0.37)	-	+	-
Teen	1 if children 13-17 years old are present, 0 otherwise	0.15 (0.36)	-	+	-
Male head	1 if male head present, 0 otherwise	0.76 (0.42)	?	?	?
Female head	1 if female head is present, 0 otherwise	0.91 (0.29)	+	-	+
Female head not working	1 if female head is present and do not work, 0 otherwise	0.30 (0.46)	+	-	+
Male head not working	1 if male head is present and do not work, 0 otherwise	0.18 (0.38)	?	?	?
Private label	Ratio of number of private label purchases to total number of purchases[6]	0.18 (0.10)	+	-	+
Special price	Ratio of number of purchases on special prices to total number of purchases[6]	0.28 (0.21)	-	+	-
Unhealthy price	Weighted by volume average price of least healthy cereals in each market	0.63 (0.03)	+	-	+
Healthy price	Weighted by volume average price of most healthy cereals in each market	0.41 (0.03)	-	+	-
Black	1 if black race, 0 otherwise	0.1 (0.3)	?	?	?
Oriental	1 if oriental race, 0 otherwise	0.01 (0.11)	?	?	?
Hispanic	1 if Hispanic origin, 0 otherwise	0.06 (0.24)	?	?	?
South US region	1 if household is in South US region	0.34 (0.47)	?	?	?
West US region	1 if household is in West US region	0.20 (0.40)	?	?	?
East US region	1 if household is in East US region	0.20 (0.40)	?	?	?
Central US region	1 if household is in Central US region	0.25 (0.43)	?	?	?

[6] In these ratios, the denominator is total number of household's purchases in all food categories, not only breakfast cereals, and the nominator is number of private label purchases (or purchases on special prices) in all food categories also.

Table 5. Results of the regression analysis.[7]

Variable	CU index	Sugar index	Fiber index
Intercept	40.31***	28.89***	4.01***
	(2.45)	(2.53)	(0.87)
Income	0.03***	-0.03***	0.02***
	(0.01)	(0.01)	(0.00)
Education	0.81***	-0.87***	0.36***
	(0.25)	(0.27)	(0.09)
Old	5.06***	-6.12***	1.2***
	(0.41)	(0.44)	(0.14)
Middle	2.19***	-2.58***	0.31**
	(0.39)	(0.42)	(0.13)
Babe	-0.81**	0.48	-0.23*
	(0.39)	(0.43)	(0.14)
Youth	-3.22***	3.47***	-0.68***
	(0.33)	(0.36)	(0.11)
Teen	-2.82***	3.22***	-0.53***
	(0.33)	(0.36)	(0.12)
Male head	-0.70**	0.50	-0.12
	(0.29)	(0.31)	(0.10)
Female head	0.45	-0.45	0.05
	(0.42)	(0.45)	(0.15)
Female head not working	1.10***	-1.26***	0.28
	(0.26)	(0.28)	(0.09)
Male head not working	1.38***	-1.47***	0.44
	(0.33)	(0.36)	(0.12)
Private Label	4.05***	-3.30***	0.56
	(1.13)	(1.24)	(0.40)
Special price	-3.26***	3.14***	-0.61***
	(0.52)	(0.57)	(0.18)
Unhealthy price	8.69**	-6.97*	2.41*
	(3.69)	(3.63)	(1.32)
Healthy price	-13.54***	6.88**	-0.27
	(3.70)	(2.87)	(1.47)
South	0.62**	-0.04	0.19*
	(0.32)	(0.35)	(0.11)
West	1.25***	-0.67*	0.17
	(0.36)	(0.39)	(0.12)
East	0.85**	-0.40	0.13
	(0.36)	(0.37)	(0.13)
Black	1.41***	-0.48	-0.89***
	(0.35)	(0.38)	(0.12)
Oriental	0.41	-1.46	-0.62**
	(0.89)	(0.97)	(0.31)
Hispanic	-0.73	0.70	-0.17
	(0.44)	(0.48)	(0.15)
Number of observations	5892	5892	5884[8]
R-square	0.16	0.16	0.12
LM test statistic for the error component	0.41	1.67	0.85

[7] We tested for and did not find any multicollinearity problem in three models.

[8] In this regression smaller number of observations is used because in one market, represented only by 8 households, none of the households bought breakfast cereals that are least healthy according to our definition based on fiber index.