Information Cost and Consumer Choices of Healthy Foods

Xiaoou Liu
School of Agricultural Economics and Rural Development
Renmin University of China
Beijing, China

Rigoberto A. Lopez
Department of Agricultural and Resource Economics
University of Connecticut
CT, USA

Chen Zhu[1]
School of Economics and Management
China Agricultural University
Beijing, China

Selected Paper Prepared for Presentation at the
2014 American and Agricultural Economics Association Annual Meeting
Minneapolis, Minnesota, July 27-29, 2014

Abstract

This paper explores how lowering consumer search costs based on labeling formats affects the probability of choosing healthy foods. We propose a theoretical model of the links between information costs and consumer choices of healthy foods and empirically test the ensuing propositions with scanner data from ready-to-eat breakfast cereals (RTEC). Based on a natural experiment with changes in labeling for otherwise identical products, we apply an alternative-specific conditional logit model to approximately 1.13 million observations derived from Nielsen Homescan weekly purchases data matched to advertising and product nutritional and labeling data. Empirical results confirm the theoretical propositions that more convenient labeling significantly increases the probability of a healthier product being chosen. We also find that consumers with a higher volume of RTEC purchases are more sensitive to information cost reductions. Overall, the use of front-of-package labels is effective in inducing consumers to select healthier RTEC products.

[1] Corresponding author: Chen Zhu at zhuchen@cau.edu.cn. Xiaoou Liu is Associate Professor, Rigoberto Lopez is Professor, and Chen Zhu is Assistant Professor at the indicated institutions.

Information Cost and Consumer Choices of Healthy Foods

1. Introduction

Consumer food choices depend in part on awareness of nutritional health content. There is extensive empirical evidence that detailed and complicated labeling often leads consumers to ignore nutrition information (Todd and Variyam, 2008). There are a number of potential explanations for this, from consumers simply being unable to process a nutrition information format (Levy and Fein, 1998; Berning, Chouinard and McCluskey, 2008) or preferring shorter labels at the front of the package (Williams, 2005; Wansink, Sonka and Halser, 2004; Grunert and Wills, 2007) to imposing high information costs (Kiesel and Villas-Boas, 2013). This paper proposes a theoretical model to explain how information costs are linked to consumer choices of healthier foods, and empirically tests the ensuing propositions with scanner data from ready-to-eat breakfast cereals (RTECs) based on the introduction of front-of-package (FOP) labeling. The authors take advantage of/make use of a natural experiment in which RTEC companies introduced FOP labeling while maintaining the mandatory Nutrition Facts Panel on the back of the package for selected products. By subjecting the reduction in information cost from FOP to a format test, this paper contributes to the economic literature on labeling, and links labeling information to consumer search costs and the probability of consumers choosing healthier foods.

Our theoretical model assumes that rational consumers search for food brands with a reservation level of how healthy a brand to purchase. Therefore, they will terminate a search once they realize the information cost of the next search exceeds its expected gain. From the resulting search equilibrium condition, comparative statistics indicate that decreasing the search cost of acquiring and processing nutrition information raises the reservation level for food healthiness, resulting in a higher likelihood of choosing healthier food. Moreover, when the information cost is large relative to the amount purchased (high average cost of information), consumer choices are more sensitive to changes in information costs.

We tested these hypotheses/propositions using scanner data from the U.S. RTEC market. This market provides a good case study for two reasons. First, RTEC products provide a wide array of choices with respect to nutritional content and healthiness, which has important health implications for public policy, particularly for children.[2] Second, consumer choices in the RTEC market have been examined extensively in previous work (e.g., Nevo, 2001), allowing for comparison and validation of consumer choices within the context of FOP introduction and healthy RTEC choices. Furthermore, in 2007, without altering nutritional contents and continuing to use the standard Nutrition Facts Panel on the back of the package (Zhu and Huang, 2014), the top two RTEC manufacturers (Kellogg and General Mills) adopted FOP labels that were found to significantly reduce information costs. In this natural experiment, the effects of FOP were isolated within the same company brands over time and in relation to the brands of competing companies (Quaker Oats and Post) that did not

---

[2] Children's RTEC products score low in terms of nutrition quality. Reedy and Krebs-Smith (2010) identify children's cereals as a top source of added sugar in children's diet. Harris et al. (2009) report that cereal brands marketed to children have 85% more sugar, 65% less fiber, and 60% more sodium than adults cereals. Therefore, FOP nutrition labels may bring substantial public health benefits, given their potential to help busy parents make smarter choices and encouraging manufacturers to develop healthier products.

adopt the FOP system.[3]

We used an alternative-specific conditional logit model to implement the empirical analysis, drawing on the Neilsen homescan data for RTECs in 2006-2008. This dataset contains consumers' choices, product information, and consumers' demographic characteristics over 20 RTEC brands from the top four manufacturers. The sampled consumers were selected from 16 designated metropolitan areas in the United States. To control for potential price endogeneity, we employed the control function approach developed by Petrin and Train (2010).

Empirical results confirmed our hypotheses/propositions. We found that FOP labels increase the likelihood that healthier RTEC products will be chosen by consumers. To compare responses of heterogeneous consumers, we used two sub-samples based on the amount purchased. We find that in RTEC market, consumers with higher volume purchases are more sensitive to the information search cost reduction.

2. A Conceptual Model of Consumer Search

Let a nutrition indicator $h_i \sim [-1,1]$ denote the degree of healthiness associated with food product brand i with a marginal distribution function given by *f(h)* and a cumulative density function *F(h).* Assume further that consumers always prefer a healthier food product *ceteris paribus* and that when a consumer searches for a

---

[3] Kellogg's adopted an FOP labeling system "Nutrition at a Glance," based on the European Guidelines. Daily Amounts system, while General Mills used a similar "Nutrition Highlights," as shown on the right-hand side in Figure 2. Both labeling systems display summarized nutrition information for calories, saturated fat, sodium, and sugar on the front of package. The information includes total amount of each nutrient per serving and a percentage of recommended daily intake values.

product, the only cost of searching is that of acquiring and processing nutrition information.

In this model, consumers adopt a sequential search strategy. After reading a brand's nutrition information, a consumer evaluates whether to continue to search or stop and accept the current brand. A consumer stops searching and finalizes the purchase when the information cost becomes too high to proceed to another search.

Assume a consumer who has just evaluated a brand with healthy level *x*. The expected gain from an additional search, denoted by $G(\mathrm{x})$, is given by

$$G(x) = \beta\int_{x}^{1}(h-x)f(h)\mathrm{d}h\,, \tag{1}$$

where β is the quantity purchased, *f(h)* is the distribution of *h* for all brands in the consumer's choice set.[4] Integrating over x,

$$G(x) = \beta[F(h)(h-x)|_{x}^{1} - \int_{x}^{1} F(h)\mathrm{d}h] = \beta[1-x-\int_{x}^{1} F(h)\mathrm{d}h], \tag{2}$$

where $G'(x) = \beta\big(F(x)\big) - 1) < 0$, which indicates a diminishing marginal return to searching. The higher the nutrition level h of the current brand, the lower the expected gains from further search, and when the current indicator *x* is sufficiently high, the expected gain from an additional search falls below the cost of the search.

In practice, as consumers have heterogeneous preferences regarding *h,* and the *h* yield of the next search is not known with certainty, consumers have a reservation level of *h* = *h** defined by the equilibrium condition

$$G(h^*) = \beta[1-h^*-\int_{h^*}^{1} F(h)\mathrm{d}h] = c\,, \tag{3}$$

[4] Our partial equilibrium model only concerns the behavior of consumers. We treat the quantity purchased β as a parameter rather than a variable because β is jointly decided by both consumers' and firms' behavior in a general equilibrium model (Silberberg and Suen, 2001).

where c is the marginal information cost. If x is below the reservation healthiness level h^*, the search continues. Otherwise the consumer stops searching.

Solving (3) for h^*, and differentiating with respect to c, one obtains

$$\frac{\partial h^*}{\partial c} = \frac{1}{\beta[F(h^*) - 1]} < 0. \qquad (4)$$

Thus, the lower the information cost, the higher the reservation healthiness level. Restricting the consumer to conducting one product search at a time, the expected duration of a search is:[5]

$$E(duration) = \frac{1}{1 - F(h^*)} \quad . \qquad (5)$$

Thus, a higher h^* implies a longer duration of searching. We summarized the implications from equation (4) and (5) in the following proposition:

Proposition 1: Decreasing the health information search cost c increases a consumer's reservation level of product healthiness h^* as well as the intensity of searching. Both of these increase the probability that consumers will choose a healthier product.

We further analyzed how heterogeneous consumers respond differently to changes in health information search costs. Again, solving (3) for h^* and differentiating with respect to β, we obtained $\frac{\partial h^*}{\partial \beta} = -\frac{c}{\beta^2[F(h^*) - 1]}$.> 0. (6)

To this end, we focused on differentiation with respect to the volume of purchases. Differentiating (4) with respect to β and using (6), we obtained:

[5] 1-$F(h^*)$ is the probability that a consumer successfully finds a satisfactory healthy brand with a healthiness level, equal or greater than h*. Thus, 1/(1-F(h*)) is the expected number of attempts to find a healthiness level equal or greater than h^*. For simplicity we call it expected duration of the search to indicate intensity or number of attempts.

$$\frac{\partial^2 h^*}{\partial c \partial \beta} = -\underbrace{\frac{1}{\beta^2\,[F(h^*)-1)}}_{>0}\;\underbrace{\left\{\frac{1-f(h^*)}{\beta^2[F(h^*)-1]^2}\;\frac{c}{\beta}\right\}}_{<0} \tag{7}$$

Thus, the sign of $\frac{\partial^2 h^*}{\partial c \partial \beta}$ is undetermined because the sign in brackets determines the sign of the expression. When the average information search cost (*c/β*) is relatively high, that is, $\frac{c}{\beta} > \frac{[F(h^*)-1]^2}{f(h^*)}$, then $\frac{\partial^2 h^*}{\partial c \partial \beta} < 0$, resulting in a higher negative responsiveness to changes in information cost. Otherwise, $\frac{\partial^2 h^*}{\partial c \partial \beta} > 0$, resulting in a lower degree of responsiveness to changes in information cost. We summarized the results in the following proposition.

Proposition 2: Given a distribution of reservation product healthiness indicators, when the average information search cost per unit purchased is relatively high ($\frac{c}{\beta} > \frac{[F(h^*)-1]^2}{f(h^*)}$), consumers who purchase more are more sensitive to changes in information search costs.

Next, we turn to test these theoretical insights using changes in nutrition labeling in the RTEC market as a proxy for changes in information cost. A maintained premise is that easier, more convenient labeling lowers the nutrition information search cost. To this end, we exploit a natural experiment in which two RTEC companies introduced FOP labeling for selected products while maintaining conventional labeling in other products. Furthermore, other companies did not follow suit.

3. Empirical Procedures

We combined three proprietary datasets: RTEC household purchases, RTEC product-level weekly advertising exposure, and RTEC package information from January 2006 to December 2008.

The first dataset is Nielsen Homescan data. The data track purchases of RTECs for a panel of 13,985 households across the 16 Designated Market Areas (DMAs) in the United States.[6] The purchases for at-home consumption include buying at big box retailers, grocery stores, convenience stores, automatic vending machines and on-line retailers. For each purchase, the dataset reports time and location of the purchase, price and quantity, product characteristics, such as brand and package size, and demographic characteristics of buyers. The second dataset, from Nielsen Media Research, provides brand level TV advertising exposure on a weekly basis for each DMA, measured in gross rating points (GRPs).

The third dataset is product package information from the Mintel Global New Products Database (GNPD), which provides detailed product listings for 245 categories of food, drink, and other grocery store items since 1996. Product listings are collected by Mintel based on product reformulations, new product introductions, new product packaging, and new product varieties.

We divided RTEC products into "healthy" and "unhealthy" nutritional quality groups based on their Nutrient Profile Index (NPI) scores. The NPI score reflects food quality assessments and is calculated based on a model developed for the Food Standards Agency (FSA) of the UK (Castetbon, Harris and Schwartz, 2011). Rather than relying on a single nutrient measurement (e.g., sugar), NPI scores take into

[6]The DMAs are: New York, Philadelphia, Detroit, Boston, Washington DC, Baltimore, Atlanta, Miami-Ft. Lauderdale, Hartford-New Haven, Springfield-Holyoke, Chicago, Kansas City, Houston, Los Angeles, San Francisco-Oakland-San Rosa, and Seattle-Tacoma-Bellingham.

account both positive (e.g. protein, fiber, vitamins) and negative (e.g. sugar, sodium, saturated fat) nutrients in the entire nutrient composition, providing a more comprehensive evaluation of the nutritional quality of food products. We created two categories of nutrient quality based on NPI scores: (1) unhealthy (less than 40 points); and (2) healthy (40 points or more).

We focused on a panel of households that were relatively active buyers of RTECs during the sample period, that is, those that purchased RTECs at least 10 times during a total of 152 weeks. The resulting dataset included 3,553 households in 16 DMAs. The estimating sample contained 1,130,900 household-level observations based on 152 weekly periods, 20 national brands of RTEC, and 16 DMA markets. Table 1 lists product characteristics of the 20 RTEC cereal brands.

Figure 1 illustrates the distribution of weekly total volume of RTECs (in ounces) purchased by the sample households. The distribution is asymmetric with a long tail. The 50th percentile purchased 20 ounces per week. To illustrate proposition 2, we split the full sample at the 50th percentile of the distribution into two sub-samples. The first sub-sample included households that purchased 20 ounces or less per week. The rest are included in sub-sample 2.

We used an alternative-specific conditional logit (ASC logit) model to implement the empirical analysis (Greene, 2011; Cameron and Trivedi, 2010). a simple multinomial or conditional logit model, the ASC logit has the major advantage of allowing incorporation of impacts on food choices of both product-level (alternative-specific) characteristics (e.g., price, advertising, nutritional labels) and household-level (case-specific) factors (e.g., age, gender, education).

We first specified consumer utility. Assuming J alternatives in consumers' choice sets, the conditional indirect utility of consumer i from purchasing product $j \in \{1, ..., J\}$ is given by:

$$u_{ij} = \beta x_{ij} + \gamma_j d_i + \epsilon_{ij}, \tag{8}$$

where x_{ij} is alternative-specific product attributes, d_i is a matrix of case-specific variables, such as households' socio-demographic characteristics, and ϵ_{ij} includes variables unobserved by researchers. The conditional probability that consumer i purchases product j can be expressed as:

$$p_{ij} = \frac{exp(\beta x_{ij} + \gamma_j z_i)}{\sum_{r=1}^{J} exp(\beta x_{ir} + \gamma_r z_i)} \tag{9}$$

We used three types of explanatory variables. The first type was product attributes, such as price, TV advertising, dummies for FOP labels, a dummy for healthy product, a dummy for saturated fat, and nutritional contents for three nutrients (sugar, sodium, and fiber). The second type was firm-fixed effect variables, which were used to control for unobserved firm characteristics invariant over time. The first two types of variables were classified as alternative-specific, because they could differ among different products in each choice occasion. The third type was demographic variables, including household size, education background, income, and the age of children. The demographic variables are case-specific because they do not vary for each choice occasion. Table 2 reports the summary statistics for the entire sample.

The major objective of the empirical analysis was estimates of the coefficients of the interaction terms of FOP labels with the healthiness dummy. To test Proposition 1, if the coefficient estimate of the interaction term from the full sample regression is positive, FOP will increase the probability that households will purchase a healthier brand. We can then conclude that reduction in information cost leads households to a better diet choice. To test Proposition 2, if the coefficient estimates of the interaction term from two the sub-samples are different, we can conclude that households with different amounts of purchases respond differently to information cost reduction. If the estimate from sub-sample 1 is smaller than sub-sample 2, the households that purchase more cereals are more sensitive to information cost than those that purchase less.

Price endogeneity can arise from several sources (Train, 2009). Price may correlate with unobserved attributes of a product as well as the marketing practices of the firms. When unobserved attributes are costly for manufacturers, they are expected to be reflected in price and the estimated price coefficient will biased downward. On the other hand, if a store manager applies non-price store promotion activities that researchers cannot observe, the price and media advertising coefficients can be overestimated.

To control for price endogeneity, we used our media advertising data for each brand as well as Heckman (1978) and Hausman (1989) types of instrumental variables. However, since the instrumental variable method is rather complicated in a non-linear choice model, we opted for using the instruments in a control function approach (Petrin and Train, 2010). The approach decomposes the unobserved term $\grave{o}_{ij}$ into a general control function of μ_{ij} and an i.i.d. error $\tilde{o}_{ij}$. We first regressed the price variable on the observed explanatory variable and instruments. The residuals of this regression were used to calculate the control function. We then estimated the ASC logit model with the control function entering as an extra variable. For simplicity, we specified a linear function as our control function. The instrumental variables we used are cost shifters, including the prices of sugar, wheat, and advertising.[7]

4. Empirical Results

Table 3 reports the estimates for alternative-specific variables for the ASC logit model with endogeneity correction. The results of case-specific variables are reported in the Appendix. Column (1) 3 lists the estimates for the full sample. The coefficient of the interactions of FOP labeling and healthiness of the product is positive and statistically significant at the 10% level, indicating that that FOP labels increase the probability of households purchasing a healthier RTEC product when an FOP label is used. Alternatively, a less healthy RTEC is less likely to be purchased when that RTEC brand does not have a FOP label. The implication of Proposition 1 is confirmed by this finding. The estimates for price and TV advertising coefficients have the expected signs.

Column (2) and (3) report estimates for sub-samples 1 and 2, which are based on the volume of purchases. Estimates of price coefficients take negative signs for both sub-samples. The estimate for TV advertising coefficient is positive for sub-sample 1 but not statistically significant for sub-sample 2, suggesting that TV advertising tends to influence households that purchase less. The coefficient estimate for the healthiness dummy for sub-sample 2 is negative, indicating that households that purchase more are more likely to purchase a less healthy brand. FOP labels have no impact on households with fewer purchases, but have significant positive impact on households

[7]DMA level advertising expenditure per GRP of all cereal products.

with more purchases. We concluded that households with more purchases are more sensitive to decreases in information search costs in RTEC market.

5. Conclusions

How information search costs affect consumers' food choices is an important question in many contexts. In this paper, we first analyzed the relationship between health information search costs and consumers' food choices as well as the relationship between cost reduction and size of purchases and then tested two salient propositions with data from the RTEC market.

We took advantage of a natural experiment in which the two leading RTEC companies used front-of-package labeling in addition to back-of-package nutrition labeling, which presumably would lower the health information search cost. Our empirical analysis found that decreases in information search costs via more convenient front-of-package labeling increased the probability of consumers choosing a healthier RTEC brand, particularly for consumers who purchase larger volumes of RTEC. For consumers with smaller purchases, the front-of-package labeling system had no discernable impact on their choices. To the extent that households that purchase larger volumes of RTECs represent those who have children, FOP labeling or any other technology or any labeling format that lowers health search information costs would have a positive impact on improving human nutrition via healthier choices.

References

Berning, J. P., H. H. Chouinard, and J. J. McCluskey (2008). Consumer preferences for detailed versus summary formats of nutrition information on grocery store shelf labels. *Journal of Agricultural & Food Industrial Organization*, Vol. *6*(1), Article 6, 20 pages.

Cameron, A. C. and P.K. Trivedi (2010). Microeconometrics Using Stata. Rev. ed. College Station, TX: Stata Press.

Castetbon, K., J. L. Harris, and M. B. Schwartz (2011). Purchases of ready-to-eat cereals vary across US household sociodemographic categories according to nutritional value and advertising targets. *Public Health Nutrition*, Vol. 15(8): 1456.

Greene, W. H. (2011). Econometric Analysis. 7th ed. Upper Saddle River, NJ: Prentice Hall.

Grunert, K. G. and J. M. Wills (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health*, Vol. 15(5): 385-399.

Harris, J. L., M. B. Schwartz, K. D. Brownell, V. Sarda, M.E. Weinberg, S. Speers, and E. Bukofzer. (2009). Cereal FACTS: evaluating the nutrition quality and marketing of children's cereals. New Haven, CT: Rudd Center for Food Policy and Obesity, 2009.

Hausman, J. and D. Wise. (1978). A conditional probit model for qualitative choice: Discrete decisions recognizing interdependence and heterogeneous preferences, *Econometrica*, Vol. 48: 403–429.

Heckman, J. (1978). Dummy endogenous variables in a simultaneous equation system. *Econometrica*, Vol. 46: 931–959.

Kiesel, K. and S.B. Villas-Boas. (2013). Can information costs affect consumer choice? Nutritional labels in a supermarket experiment. *International Journal of Industrial Organization*, Vol. 31(2): 153–163

Levy, A. S. and S. B. Fein. (1998). Consumers' ability to perform tasks using nutrition labels. *Journal of Nutrition Education*, 30(4), 210-217.

Nevo, A. (2001). Measuring market power in the ready-to-eat cereal industry. *Econometrica*, Vol. 69(2): 307-342.

Petrin, A. and K. Train. (2010). A control function approach to endogeneity in consumer choice models. *Journal of Marketing Research*, Vol. 47(1), 3-13.

Reedy, J. and S.M. Krebs-Smith. (2010). Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *Journal of the American Dietetic Association*, Vol. 110 (10): 1477–1484.

Silberberg, E. and W.C. Suen. (2001). *The structure of economics: A mathematical analysis*. New York: McGraw-Hill.

Todd, J. E. and J.N. Variyam. (2008). The decline in consumer use of food nutrition labels, 1995-2006. United States Department of Agriculture, Economic Research Service No. 56466.

Train, K. (2009). *Discrete choice methods with simulation*. Cambridge University Press, New York. .

Wansink, B., Sonka, S. T. and Hasler, C. M. (2004). Front-label health claims: When less is more. *Food Policy*, Vol. 29(6): 659-667.

Williams, P. (2005). Consumer understanding and use of health claims for foods. *Nutrition Reviews*, Vol. 63(7): 256-264.

Zhu, C. and R. Huang. (2014). Heterogeneity in consumer responses to front-of-package nutrition labels: Evidence from a natural experiment. Working Paper, Zwick Center for Food and Resource Policy, University of Connecticut.

Table 1. Summary Statistics of Top RTECs

Firm	Brand	Calories (/oz)	Sugar (g/oz)	Saturated Fat (g/oz)	Sodium (mg/oz)	Fiber (g/oz)	Market Share
Kellogg's	Frosted Flakes	103	11	0	129	1	3.03%
Kellogg's	Raisin Bran	90	8	0	162	3	2.01%
Kellogg's	Froot Loops	110	13	1	132	1	1.29%
Kellogg's	Rice Krispies	108	3	0	254	0	1.17%
Kellogg's	Special K Red Berries	103	9	0	199	1	1.24%
Kellogg's	Apple Jacks	109	12	0	124	0	0.97%
Kellogg's	Corn Pops	106	13	0	108	0	0.84%
Kellogg's	Smart Start	102	8	0	154	2	0.71%
General Mills	Cheerios	103	1	0	186	3	3.48%
General Mills	Cinnamon Toast Crunch	121	9	0	196	1	1.90%
General Mills	Lucky Charms	114	11	0	190	1	1.47%
General Mills	Cocoa Puffs	112	13	0	149	1	0.88%
General Mills	Reese's Puffs	121	11	0	187	1	0.70%
Quaker	Cap'n Crunch	113	12	1	209	1	0.67%
Quaker	Life Cinnamon	104	7	0	134	2	0.72%
Quaker	Cap'n Crunch Crunchberries	113	13	1	196	1	0.64%
Quaker	Cap'n Crunch Peanut Butter Crunch	116	9	1	208	1	0.40%
Post	Honey Bunches of Oats	112	6	0	140	2	3.39%
Post	Fruity Pebbles	112	12	1	164	3	0.70%
Post	Cocoa Pebbles	111	12	1	151	3	0.57%

Table 2. Summary Statistics for Explanatory Variables

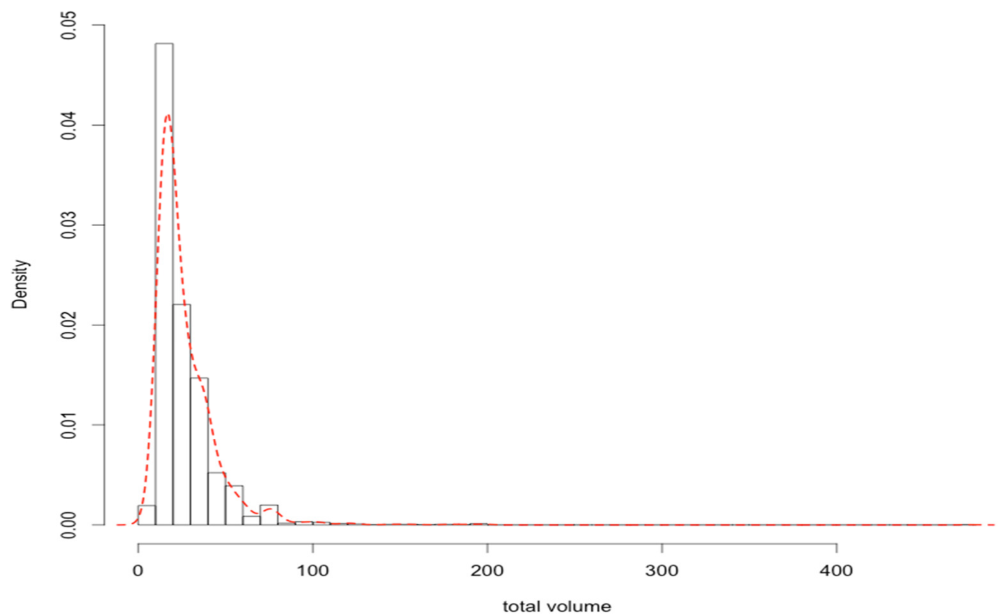
Variable	Variable Description	Mean	Std. Dev.	Min	Max
	Product Attributes				
Price	Price ($/ounce)	0.162	0.060	0.000	0.500
GRPgw	TV Advertising GRP	0.972	0.937	0.000	5.082
Healthy	Healthy (yes=1, no=0)	0.300	0.458	0.000	1.000
FOP x Healthy	FOP label*healthy	0.083	0.277	0.000	1.000
Sugar	Sugar content	0.965	0.331	0.100	1.300
Satfat	Saturated Fat	0.300	0.458	0.000	1.000
Sodium	Sodium content	1.686	0.357	1.080	2.540
Fiber	Fiber content	1.400	0.970	0.000	3.000
Last	Last purchase of the same product	0.042	0.201	0.000	1.000
	Demographic Variables				
HHsize	Household Size	3.485	1.528	1.000	9.000
HHedudum2	Household head has college degree or higher	0.328	0.470	0.000	1.000
HHedudum3	Household head has college degree or higher	0.439	0.496	0.000	1.000
HighIncDum	If average family annual income>60000=1; others=0	0.590	0.492	0.000	1.000
HHkid17	One child13-17=1; others=0.	0.359	0.480	0.000	1.000
HHkid12	Child younger than 12=1; others=0.	0.333	0.471	0.000	1.000

Table 3. Coefficient Estimates for Alternative Specification of the Conditional Logit Model

Variables	Estimates (Standard errors)		
	Full Sample (1)	Sub-sample 1 (2)	Sub-sample 2 (3)
price	-4.096***	-0.821***	-9.659***
	(0.098)	(0.140)	(0.147)
GRPgw	0.042***	0.074***	-0.019
	(0.011)	(0.010)	(0.018)
healthy	0.103	0.072	-0.236**
	(0.068)	(0.086)	(0.116)
FOP x Healthy	0.021*	-0.039	0.143***
	(0.011)	(0.029)	(0.035)
Last	2.210***	2.090***	2.418***
	(0.014)	(0.020)	(0.027)
sugar	-6.620***	-7.682***	-5.029***
	(0.414)	(0.362)	(0.663)
sugar2	3.490***	4.151***	2.233***
	(0.289)	(0.252)	(0.485)
satfat	-1.148***	-1.078***	-1.607***
	(0.121)	(0.136)	(0.234)
sodium	6.821***	6.544***	10.514***
	(0.906)	(1.247)	(1.972)
sodium2	-1.943***	-1.831***	-3.128***
	(0.259)	(0.353)	(0.567)
fiber	1.479***	1.582***	1.243***
	(0.142)	(0.135)	(0.270)
fiber2	-0.417***	-0.479***	-0.300***
	(0.034)	(0.031)	(0.062)
Quaker Co.	-1.081***	-1.228***	-1.155***
	(0.137)	(0.141)	(0.219)
General Mills Co.	0.149*	0.120	-0.103
	(0.079)	(0.082)	(0.113)
Post Co.	-0.753***	-0.696***	-0.874***
	(0.072)	(0.096)	(0.146)
Residual $\tilde{\delta}$	48.146***	37.841***	59.989***
	(0.428)	(0.613)	(0.863)
Case-specific Variables	Table A1	Table A	Table A3
Observations	828,480	520,560	307,920
Log likelihood	-98093.610	-63959.149	-31859.592

Note: Standard errors are from 200 bootstrapping. Sub-sample 1 indicates households that purchased 20 ounces of RTECs per week (50^{th} percentile) or less. Sub-sample 2 indicates those that purchased more than 20 ounces per week. The results for case-specific variables are presented in Appendix 2 due to space consideration.

Figure 1: Distribution of Volume of Weekly Purchases



Appendix: Results for Case-Specific Variables

Table A1 Estimates of Full Sample for Case-specific Variables

Firms	Brands	Hhsize	HHedudum2	HHedudum3	HighinDum	HHkid17	HHkid12
General Mills	Cinnamon Toast Crunch	0.063***	0.194***	0.266***	0.063	0.176**	-0.034
		(0.020)	(0.067)	(0.081)	(0.050)	(0.069)	(0.055)
General Mills	Lucky Charms	0.019	-0.267***	-0.179***	0.372***	-0.052	0.002
		(0.019)	(0.071)	(0.069)	(0.056)	(0.073)	(0.073)
Kellogg's	Froot Loops	-0.053**	-0.097	0.197***	-0.094	0.058	0.350***
		(0.024)	(0.068)	(0.073)	(0.061)	(0.073)	(0.082)
Kellogg's	Rice Krispies	-0.106***	0.026	0.126*	0.240***	-0.050	-0.228***
		(0.024)	(0.064)	(0.068)	(0.073)	(0.073)	(0.070)
Kellogg's	Apple Jacks	-0.033	-0.207***	-0.338***	0.165**	0.210**	0.361***
		(0.032)	(0.071)	(0.087)	(0.078)	(0.082)	(0.080)
Kellogg's	Corn Pops	0.009	-0.161*	0.106	0.102	0.052	-0.214***
		(0.025)	(0.087)	(0.099)	(0.073)	(0.093)	(0.075)
General Mills	Cocoa Puffs	-0.167***	-0.448***	-0.283***	0.346***	0.179**	0.372***
		(0.023)	(0.081)	(0.085)	(0.068)	(0.091)	(0.077)
PepsiCo	Quaker Cap'n Crunch	0.010	-0.107	0.249***	0.294***	0.483***	0.012
		(0.019)	(0.098)	(0.083)	(0.075)	(0.081)	(0.091)
General Mills	Reese's Puffs	-0.071***	-0.537***	-0.095	0.025	0.335***	0.183**
		(0.025)	(0.092)	(0.085)	(0.062)	(0.077)	(0.091)
PepsiCo	Quaker Cap'n Crunch Crunchberries	-0.015	-0.552***	-0.212**	-0.025	0.722***	0.067
		(0.030)	(0.104)	(0.108)	(0.092)	(0.086)	(0.091)
General Mills	Cheerios	-0.168***	-0.078	0.332***	-0.054	-0.708***	-0.511***
		(0.016)	(0.065)	(0.062)	(0.042)	(0.064)	(0.053)
Post	Honey Bunches of Oats	-0.090***	-0.138**	0.314***	-0.090**	-0.167***	-0.283***
		(0.021)	(0.054)	(0.062)	(0.044)	(0.059)	(0.058)

Kellogg's	Raisin Bran	-0.152***	0.084	0.251***	0.067	-0.253***	-0.558***
		(0.025)	(0.079)	(0.070)	(0.063)	(0.060)	(0.073)
Kellogg's	Special K Red Berries	-0.250***	-0.118*	0.158**	0.371***	-0.403***	-0.789***
		(0.026)	(0.064)	(0.072)	(0.074)	(0.073)	(0.077)
PepsiCo	Quaker Life Cinnamon	-0.165***	-0.245***	0.064	-0.030	-0.068	0.112
		(0.031)	(0.089)	(0.091)	(0.062)	(0.070)	(0.084)
Kellogg's	Smart Start	-0.421***	-0.242***	0.011	0.575***	-0.463***	-0.429***
		(0.025)	(0.080)	(0.075)	(0.066)	(0.078)	(0.082)
Post	Fruity Pebbles	0.031	-0.337***	-0.540***	0.086	-0.075	0.206**
		(0.031)	(0.088)	(0.102)	(0.078)	(0.082)	(0.094)
Post	Cocoa Pebbles	0.061**	-0.668***	-0.170*	-0.017	0.412***	-0.246***
		(0.029)	(0.102)	(0.088)	(0.074)	(0.103)	(0.075)
PepsiCo	Quaker Cap'n Crunch PB Crunch	-0.039	0.052	0.406***	-0.320***	0.247***	0.502***
		(0.031)	(0.119)	(0.110)	(0.102)	(0.094)	(0.114)

Table A2 Estimates of Sub-sample 1 for Case-specific Variables

		Hhsize	HHedudum2	HHedudum3	HighinDum	HHkid17	HHkid12
General Mills	Cinnamon Toast Crunch	0.060***	0.091	0.157*	0.002	0.116*	0.032
		(0.023)	(0.093)	(0.091)	(0.076)	(0.065)	(0.080)
General Mills	Lucky Charms	0.051*	-0.374***	-0.326***	0.370***	-0.008	0.019
		(0.028)	(0.086)	(0.082)	(0.069)	(0.083)	(0.101)
Kellogg's	Froot Loops	-0.067**	-0.115	0.141	-0.059	0.054	0.464***
		(0.027)	(0.091)	(0.100)	(0.077)	(0.086)	(0.072)
Kellogg's	Rice Krispies	-0.094***	-0.126	-0.031	0.225***	-0.023	-0.230**
		(0.033)	(0.085)	(0.098)	(0.074)	(0.070)	(0.090)
Kellogg's	Apple Jacks	0.010	-0.145	-0.356***	0.138	0.137*	0.391***
		(0.030)	(0.091)	(0.099)	(0.086)	(0.074)	(0.092)
Kellogg's	Corn Pops	0.063**	-0.210**	-0.006	0.106	0.013	-0.172*
		(0.029)	(0.094)	(0.101)	(0.092)	(0.084)	(0.091)
General Mills	Cocoa Puffs	-0.134***	-0.450***	-0.305***	0.318***	0.119	0.379***
		(0.032)	(0.077)	(0.083)	(0.081)	(0.082)	(0.095)
PepsiCo	Quaker Cap'n Crunch	0.002	-0.301***	0.064	0.371***	0.436***	-0.007
		(0.032)	(0.109)	(0.104)	(0.110)	(0.103)	(0.109)
General Mills	Reese's Puffs	-0.045	-0.613***	-0.126	0.097	0.299***	0.126
		(0.034)	(0.103)	(0.113)	(0.070)	(0.089)	(0.100)
PepsiCo	Quaker Cap'n Crunch Crunchberries	-0.027	-0.814***	-0.343***	-0.059	0.645***	0.157*
		(0.036)	(0.117)	(0.098)	(0.110)	(0.109)	(0.087)
General Mills	Cheerios	-0.129***	-0.257***	0.050	-0.115**	-0.661***	-0.591***

		(0.024)	(0.068)	(0.079)	(0.054)	(0.078)	(0.065)
Post	Honey Bunches of Oats	-0.103***	-0.316***	0.078	-0.055	-0.054	-0.316***
		(0.026)	(0.059)	(0.070)	(0.060)	(0.079)	(0.080)
Kellogg's	Raisin Bran	-0.226***	0.003	0.182	0.494***	-0.025	-0.451***
		(0.037)	(0.090)	(0.112)	(0.087)	(0.096)	(0.106)
Kellogg's	Special K Red Berries	-0.234***	-0.447***	-0.297***	0.512***	-0.399***	-0.607***
		(0.035)	(0.071)	(0.092)	(0.076)	(0.085)	(0.094)
PepsiCo	Quaker Life Cinnamon	-0.126***	-0.290***	0.036	0.003	-0.002	-0.070
		(0.035)	(0.106)	(0.110)	(0.078)	(0.103)	(0.091)
Kellogg's	Smart Start	-0.486***	-0.354***	-0.140	0.793***	-0.200*	-0.345***
		(0.030)	(0.095)	(0.092)	(0.068)	(0.120)	(0.122)
Post	Fruity Pebbles	0.042	-0.333***	-0.497***	0.076	-0.077	0.274***
		(0.034)	(0.119)	(0.119)	(0.097)	(0.107)	(0.096)
Post	Cocoa Pebbles	0.051	-0.817***	-0.276***	0.070	0.538***	-0.097
		(0.032)	(0.128)	(0.102)	(0.098)	(0.109)	(0.101)
PepsiCo	Quaker Cap'n Crunch PB Crunch	-0.110**	0.064	0.510***	-0.258**	0.385***	0.493***
		(0.046)	(0.133)	(0.151)	(0.118)	(0.121)	(0.132)

Table A3 Estimates of Sub-sample 2 for Case-specific Variables

		Hhsize	HHedudum2	HHedudum3	HighinDum	HHkid17	HHkid12
General Mills	Cinnamon Toast Crunch	0.051*	0.369***	0.424***	0.133	0.232**	-0.109
		(0.030)	(0.124)	(0.084)	(0.085)	(0.099)	(0.094)
General Mills	Lucky Charms	-0.049	-0.105	0.100	0.357***	-0.144	-0.018
		(0.033)	(0.125)	(0.128)	(0.130)	(0.130)	(0.123)
Kellogg's	Froot Loops	0.058	-0.188	0.330**	-0.259**	0.174	-0.119
		(0.048)	(0.186)	(0.160)	(0.121)	(0.156)	(0.153)
Kellogg's	Rice Krispies	-0.066	0.456**	0.648***	0.378***	-0.207	-0.334**
		(0.045)	(0.198)	(0.158)	(0.138)	(0.162)	(0.162)
Kellogg's	Apple Jacks	-0.106**	-0.598***	-0.368**	0.141	0.504***	0.202
		(0.050)	(0.162)	(0.150)	(0.131)	(0.138)	(0.139)
Kellogg's	Corn Pops	-0.140**	-0.077	0.597***	0.044	0.302**	-0.458**
		(0.056)	(0.210)	(0.212)	(0.178)	(0.150)	(0.212)
General Mills	Cocoa Puffs	-0.240***	-0.552***	-0.302**	0.410***	0.346**	0.347***
		(0.038)	(0.166)	(0.149)	(0.103)	(0.141)	(0.135)
PepsiCo	Quaker Cap'n Crunch	0.051	0.331	0.705***	0.128	0.561***	0.008
		(0.045)	(0.253)	(0.219)	(0.147)	(0.171)	(0.158)
General Mills	Reese's Puffs	-0.127***	-0.448***	-0.059	-0.125	0.423***	0.278**
		(0.036)	(0.145)	(0.109)	(0.114)	(0.113)	(0.131)
PepsiCo	Quaker Cap'n Crunch Crunchberries	0.015	-0.044	0.047	0.077	0.938***	-0.187
		(0.041)	(0.180)	(0.158)	(0.174)	(0.176)	(0.137)
General Mills	Cheerios	-0.236***	0.251**	0.801***	0.015	-0.791***	-0.400***
		(0.029)	(0.127)	(0.094)	(0.088)	(0.086)	(0.084)

Post	Honey Bunches of Oats	-0.114***	0.088	0.595***	-0.159*	-0.291***	-0.230***
		(0.030)	(0.114)	(0.101)	(0.085)	(0.079)	(0.082)
Kellogg's	Raisin Bran	-0.154***	0.170*	0.353***	-0.267***	-0.398***	-0.601***
		(0.041)	(0.092)	(0.103)	(0.087)	(0.105)	(0.110)
Kellogg's	Special K Red Berries	-0.270***	0.789***	1.223***	0.076	-0.422***	-1.263***
		(0.041)	(0.144)	(0.126)	(0.111)	(0.103)	(0.172)
PepsiCo	Quaker Life Cinnamon	-0.246***	-0.199	0.091	-0.099	-0.185	0.436***
		(0.057)	(0.131)	(0.122)	(0.112)	(0.138)	(0.129)
Kellogg's	Smart Start	-0.399***	-0.128	0.206*	0.244**	-0.829***	-0.454***
		(0.036)	(0.124)	(0.115)	(0.111)	(0.137)	(0.130)
Post	Fruity Pebbles	0.022	-0.364**	-0.649***	0.084	-0.070	0.057
		(0.043)	(0.163)	(0.158)	(0.126)	(0.161)	(0.140)
Post	Cocoa Pebbles	0.076**	-0.429***	0.037	-0.172	0.214	-0.530***
		(0.038)	(0.164)	(0.136)	(0.121)	(0.138)	(0.146)
PepsiCo	Quaker Cap'n Crunch PB Crunch	0.083	-0.061	0.145	-0.396**	0.008	0.583***
		(0.058)	(0.188)	(0.217)	(0.171)	(0.185)	(0.198)