Consumer Willingness to Pay for Breads marketed as "Low-Carbohydrate"

William E. Nganje, Simeon Kaitibie, Cheryl J. Wachenheim and Gretchen Johnston

W.E. Nganje is an associate professor (william.nganje@ndsu.nodak.edu), S. Kaitibie is a research assistant professor (simeon.kaitibie@ndsu.nodak.edu), C. J. Wachenheim is an associate professor (cwachenh@ndsuext.nodak.edu) and G. Johnston is a graduate student, Department of Agribusiness and Applied Economics, North Dakota State University.

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2005.

Consumer Willingness to Pay for Breads marketed as "Low-Carbohydrate"

Abstract

Bread producers are taking advantage of healthy feeding habits by developing new "low carbohydrate" products to entice customers. These low carbohydrate breads are generally more expensive than conventional types. This study tests the hypothesis that consumers are willing to pay higher premium for "low carbohydrate" breads at various locations and markets. We use retail data in a hedonic pricing framework to estimate the premium paid for the "low carbohydrate" attribute of bread. Results show that the implicit price of the "low carbohydrate" attribute of bread ranges from about 0.06¢ to 1.1¢ per gram, reflecting the amount consumers are willing to pay above the price of conventional bread.

Key Words: low carbohydrate bread, hedonic price, willingness to pay

JEL Classifications: D12

Consumer Willingness to Pay for Breads marketed as "Low-Carbohydrate"

Introduction

Americans spend about $900 billion on food each year (USDA, 2003). A substantial portion of this expenditure is on food products containing concentrate sugars and refined starches. The resulting high carbohydrate intake is a major cause of obesity in the U.S., the second leading preventable cause of death in the United States (Mokdad, et al., 2004). Today, nearly two out of three adult Americans fall under the categories of overweight or obese (Philipson, et al., 2004). Obesity accounts for about $117 billion a year in direct and indirect economic costs, and its associated effects cause approximately 300,000 deaths each year (Mancino, Lin, and Ballenger, 2004).

There have been a number of high-profile public and private efforts to address this growing problem. Some initiatives include changes in the USDA food pyramid and increased adoption of low-carbohydrate diets. The food pyramid is under revision. Objectives include making consumers more aware and able to recognize the difference between types of carbohydrates so that they chose, for example, more unprocessed cereal grains and whole wheat bread instead of white bread to increase the fiber content of their diet (Dietary Guidelines Advisory Committee, 2004).

There are no existing regulations permitting the use of carbohydrate claims on foods governed by the FSIS because there is no legal definition of a "low (or reduced) carbohydrate diet." However, in a study that used USDA's Continuing Survey of Food Intakes by Individuals, Bowman and Spence (2002) used the term "low carbohydrate diets" to describe foods that provided no more than 45% of energy intake from carbohydrates. A "low carbohydrate diet" is naturally one that limits the intake of carbohydrates (Allan and Lutz, 2000). Proteins and fats

from plants and animals comprise a larger percentage of the diet. Although there is no official definition of the claim, firms are taking advantage of increased public awareness by developing new "low-carbohydrate" products to entice consumers. Consumers are also becoming aware of the effect of diet on their health and as a result, they are changing purchasing habits. The last decade has brought the potential weight-reduction benefits of low-carbohydrate diets to the public attention.

The bread market is particularly important as consumption of carbohydrates decreases and therefore development and marketing of a low-carbohydrate product will have particular appeal for this industry. Bread sales increased 18% between 1998 and 2003, when they reached 16 billion dollars (Mintel International Group Limited, 2004). The low carbohydrate food class grew from $10 million in 1997 to more than $1.4 billion in 2003, and this is expected to almost triple by the year 2006 (Nutrition Business Journal, 2004). Forty percent of adults in the U.S., an estimated 83.6 million people, report that they have reduced their carbohydrate intake (Mintel International Group Limited, 2004), and an estimated 6% to 7% of consumers were on a low-carbohydrate diet in 2004. There is therefore reason to believe that consumers value low-carbohydrate alternatives to traditionally-consumed products, although little work exists which quantifies this value.

Economic theory suggests that consumers will pay a premium for goods providing them additional utility. The demand for goods and services used for maintenance or improvement of one's health tend to increase as income increases (Grossman, 1972). According to the concept of full income (Becker, 1965), higher wages such as those evident in the US and the resultant inflated value of time may induce consumers to purchase goods and services that are more convenient, better prepared, or higher quality. Thus this study tests the hypothesis that

consumers are willing to pay higher premium for low carbohydrate breads at various locations and markets. The hedonic pricing is an appropriate method for such analysis, and it is based on the concept that the quality of a good is related to some measurable specification variables (Deaton and Muellbauer, 1980).

The main focus of this paper is to estimate how consumers evaluate tradeoffs among price, quantity, and quality dimensions when they make bread purchasing decisions. This study examines product attributes and store characteristics and their effects on prices of low carbohydrate bread and conventional bread. The specific objectives of this study are to: 1. Compare the markets for low-carbohydrate breads; 2. Determine the marginal impacts of major factors affecting price premiums associated with low carbohydrate breads; 3. Estimate consumer willingness to pay for low carbohydrate bread; and 4. Derive implications for short and long run demand trends.

Methods

A variety of methods to value non-marketed attributes are available to estimate consumer willingness to pay for products. Among them are choice experiments (Alpizar, Carlsson, and Martinsson, 2004), experimental auctions (Lusk, Feldkamp, and Schroeder, 2004), surveys, and hedonic pricing (Rosen, 1974). This study uses data collected from retail stores and develops a hedonic pricing model to analyze the price premium paid for low carbohydrate bread. The basic premise of the hedonic pricing method is that the price of a marketed good is related to its quality and quantity characteristics. Maguire, Owens and Simon (2004) used a hedonic pricing model to estimate price premiums for organic baby foods in several markets. An advantage of hedonic pricing methods is the ability to use over-the-counter data on quantity, prices and other store characteristics to estimate premiums for product quality characteristics.

Model

The hedonic pricing framework is used to estimate price for the low-carbohydrate characteristic of bread. Several studies have used the hedonic pricing approach to derive implicit prices for food quality and nutritive attributes (Brooker, Terry and Eastwood, 1986; Stiegert and Blanc, 1997; Salayo, Voon and Selvanathan, 1999). Following Rosen (1974), the statistical framework is a multiple regression model which assumes that consumers purchase one unit of a differentiated good such as a loaf of bread consisting of *n* component characteristics including low-carbohydrate, other nutritional characteristics, and store type and shelf allocation.

The market for bread is assumed to be competitive so that, for price-taking consumers, utility is maximized when the marginal rate of substitution between the low-carbohydrate characteristic and the composite good, bread, equals the marginal price of the characteristic. A quality attribute such as 'low carbohydrate' will be consumed up to the point where the consumer's marginal willingness to pay for the attribute equals its marginal price. On the supply side, markets are also assumed to be competitive so that firms are price-takers maximizing profit. The profit maximizing level of production occurs where the per-unit marginal cost of producing the low carbohydrate characteristic is equal to the marginal price of that characteristic. The aforementioned assumptions suggest that under optimal market conditions, the relative value consumers place on the component characteristic is equivalent to the per unit marginal cost of producing the characteristic. This enables this us to analyze price premiums of low carbohydrate bread based on posted or observed prices rather than actual market transactions. Rosen (1974), Samikwa, Brorsen and Sanders (1998), and Maguire, Owens and Simon (2004) explain how data on prices and characteristics can be used to estimate the marginal value of one characteristic, holding all others constant.

Using the hedonic pricing framework, over-the-counter data on prices, quantity and other store characteristics can be used to estimate values based on actual choices. The main objective of this study is to estimate price premiums for the low carbohydrate characteristic in bread. However, there are other very important food quality characteristics, and these were identified based on earlier works by Maguire, Owens and Simon (2004), Nayga (1998), and Kantor (1998). Table 1 provides a descriptive list of variables that were included in the design of the empirical model.

Bread price was established in dollars per gram of product and a low carbohydrate dummy variable was included to identify all breads sold as low carbohydrate to be 1 and others as 0. The product characteristics include serving size, and product quantity per package, and quality attributes and nutritional characteristics such as total calories, total fat, protein content, carbohydrate content, sugar content and fiber content, all expressed in grams per serving. The study evaluates the importance of these other quality attributes or nutritional characteristics and estimates their price premiums. This is necessary because low carbohydrate claims are generally made in concert with other nutrition claims that contribute to high product quality. While the low carbohydrate claim is very important, consumer demand for more nutritious foods follows a holistic view of associated quality attributes. Data on store characteristics include store type, store location and amount of shelf space allocated to bread were used for the analysis. Accordingly, data for this study were collected from grocery stores, discount stores and other non-grocery stores for multiple varieties of low carbohydrate and conventional bread in the twin city metropolis of Fargo, North Dakota and Moorhead, Minnesota. This location was selected because of cost considerations. Additional data were collected from the Internet bread sales sites.

In the hedonic pricing framework, theory does not provide a basis for selecting any particular functional form. However, linear models have been used because the parameters are directly interpretable as implicit prices, and thus easier to explain (Samikwa, Brorsen and Sanders, 1998). Accordingly, a linear model is specified as follows:

$$(1)\quad PRICE_{ijk} = \alpha_0 + \alpha_1 \text{ SERVING SIZE} + \alpha_2 \text{ QUANTITY} + \alpha_3 \text{ TOTAL CALORIES} + \alpha_4 \text{ PROTEIN} + \alpha_5 \text{ CARBOHYDRATES} + \alpha_6 \text{ SUGAR} + \alpha_7 \text{ FIBER} + \alpha_8 \text{ TOTAL FAT} + \alpha_9 \text{ LOW CARBOHYDRATE} + \alpha_{10} \text{ SHELF SPACE} + \varepsilon_{ijk}.$$

The subscripts i, j, and k represent observations, store location and store type, respectively, and ε is the error term.

Descriptive Statistics of Data

Data were collected in July, 2004 in stores across Fargo, North Dakota and Moorhead, Minnesota. Internet sales were also included, and the internet prices included delivery costs. Internet sales were included because they are a growing market for low-carbohydrate food products. The internet data provide analysis for nationwide comparison to this regional market. The study used observations from grocery and discount stores that sold one or more low carbohydrate bread products. The data collection exercise was carried out during a period when sales promotions for bread were not indicated within the venues. Table 2 shows the breakdown of observations by store type and location.

There were 751 observations; 466 observations from Fargo stores, 215 from Moorhead stores and 70 from the Internet. Among them were 394 observations from Fargo grocery stores, 72 observations from other stores in Fargo, 172 observations from grocery stores in Moorhead, 43 observations from other stores in Moorhead, and 70 internet observations. Means and standard deviations of price, product characteristics, and shelf space allocation data are provided

overall and by store type and location in Table 3. As suggested by hedonic pricing theory, product price is measured as a continuous variable. Data show that average prices for low carbohydrate bread ranged from 0.4 cents per gram in Moorhead non-grocery stores to 1.6 cents per gram on Internet sites. The high internet price was statistically significant from store prices in Fargo-Moorhead, possibly due to the fact that it included delivery costs. For analytical purposes, a dummy variable was used to represent bread type (conventional versus low-carbohydrate). Approximately 150 of the 751 observations were observations of low-carbohydrate breads. Among the 150 low carbohydrate observations, there were 20 observations from non-grocery stores, 81 observations from grocery stores and 49 observations from the Internet. The estimation method makes no distinction between Fargo stores and Moorhead stores because the cost of movement between Fargo and Moorhead is assumed to be negligible.

For the composite dataset, the average serving size was about 31.8 grams, and the difference among store locations or store types was marginal. Average serving size for low carbohydrate breads was lower at 25 grams compared to 33.4 grams for conventional breads. The quantity of bread per package sold varied from 16.7 slices for Internet observations to 25.8 slices for Fargo non-grocery stores. Quantity was marginally higher for conventional breads at 19.8 slices compared to 18.8 slices for low carbohydrate breads. Amount of calories per serving size is 79.9, ranging from 70.3 calories for the Internet to 86.9 calories for Moorhead non-groceries. The amount of calories per serving for low carbohydrate bread is 52.2 while that for conventional bread is significantly higher at 86.8 calories per serving. Average protein content for all breads is 3.4 grams per serving, ranging from 3.2 grams for conventional breads to nearly 4 grams for low carbohydrate breads. There is no legal definition for the “low carbohydrate” attribute therefore this study evaluated the amount of carbohydrate per serving size for all breads.

Total amount of carbohydrates averaged at about 15.1 grams per serving, with a range of about 8.8 grams for low carbohydrate breads to nearly 16.7 grams for conventional breads. This difference is statistically significant therefore the low carbohydrate characterization is a reasonable one. The sugar content averaged 2.2 grams per serving for all breads. Low carbohydrate breads had low sugar content of 0.7 grams whereas the conventional breads had a sugar content of 2.6 grams. Other quality attributes such as fiber and total fat were also evaluated. Fiber content per serving is estimated at 2.7 grams and 1.7 grams for low carbohydrate breads and conventional breads, respectively. In addition, total fat content is estimated at 0.7 grams per serving and 1.1 grams per serving for low carbohydrate breads and conventional breads, respectively. What the descriptive statistics largely show is that the low carbohydrate attribution is appropriate, and that other quality attributes were incorporated in these low carbohydrate breads to make them high quality products.

Model Estimation

The choice of functional form in the hedonic pricing framework is not underscored by theory. According to Maguire, Owens and Simon (2004), characteristics can vary independently of each other, thus the linear hedonic price function is appropriate. The estimation process followed diagnostic tests for aggregation across store types, and for normality and homoscedasticity. The locations where the data were collected (i.e., Fargo and Moorhead) were not considered separately because it is assumed that costs of movement between Fargo and Moorhead are negligible. On the other hand, the venue in which bread was sold (i.e., grocery stores, non-grocery stores, and the Internet) were considered separately because they may represent different costs to consumers. Heterogeneity within the composite dataset might lead to inaccurate parameter estimates therefore an F-test was performed to determine whether separate models

were required. If homogeneity was confirmed, a single model would be identified and estimated for the complete dataset. The null hypothesis of homogeneity is rejected (F-value = 317.67; p = 0.0001), indicating that the overall dataset was heterogeneous, and this heterogeneity was also defined by store type. Hence, the results are therefore reported for the composite dataset and by store type.

One important assumption of the classical linear regression model is that the variances of the disturbances or error terms are constant (homoscedastic). If homoscedasticity is rejected the ordinary least squares (OLS) estimator is no longer efficient. White's test was used to test for heteroscedasticity. An advantage of White's test is that it makes no assumptions about the form of the heteroscedasticity. White's test statistic is asymptotically distributed as a χ^2 with degrees of freedom equal to the number of slope coefficients. Heteroscedasticity is confirmed in the composite dataset (χ^2 = 475.7; p = 0.0001) as well in separate datasets for grocery stores (χ^2 = 161.0; p = 0.0001), non-grocery stores (χ^2 = 101.9; p = 0.0001) and Internet (χ^2 = 67.74; p = 0.0094).

As an assumption of the classical linear regression model, normality was also tested. Results from the Kolmogorov-Smirnov test reject the assumption of error term normality in the composite dataset (K-S statistic = 0.171; p = 0.01), grocery stores data set (K-S statistic = 0.113; p = 0.01), non-grocery stores dataset (K-S statistic = 0.096; p = 0.01) and Internet dataset (K-S statistic = 0.138; p = 0.01). Under these circumstances (heteroscedasticity and non-normality), the OLS estimator would no longer be best linear unbiased, and therefore it is inappropriate. The MLE approach will provide consistent and robust parameter estimates; under assumptions of normality MLE is also asymptotically normal.

Model Results

Table 4 shows MLE parameter estimates for the composite dataset and by store type. The low-carbohydrate variable is statistically significant at 1% for all estimated models, indicating its importance as a quality attribute to bread pricing and consumer demand. The positive sign indicates a price premium for the low-carbohydrate quality attribute in breads, and this is consistent with expectations. Serving size and quantity per serving are highly significant variables and they have a negative effect on pricing in all models except for non-grocery stores. This follows descriptive statistics results which show that low carbohydrate breads usually have lower serving sizes and quantities per serving than conventional breads. The amount of calories per serving is highly significant and varies positively with bread price for the composite model and the grocery stores model. This is contrary to expectations since high product quality suggests low calorie content in most food products. The result probably derives from the high amount of calories in conventional bread. Protein was not statistically significant in any of the store models, indicating that consumers do not select bread type based on protein content.

Separate from the low carbohydrate variable which merely captures the low carbohydrate attribution in stores, a separate variable was included in the model to capture the effect of the amount of carbohydrate in the bread product on product pricing. This carbohydrate variable is highly significant and negative for the composite model as well as for grocery stores, yet it is positive and significant quantity for the Internet model. The results show that high amounts of carbohydrate do not generate a price premium, at least in grocery stores. On the other hand sugar content is significant, yet positive, for grocery stores and non-grocery stores. This suggests that pricing is still being positively influenced by sugar content. The data suggest that on average, there is very low sugar content in low carbohydrate breads such that the positive

effect is not yet alarming. Sugar was not statistically significant for the aggregate model. High fiber content is seen as an important quality attribute in breads marketed as low carbohydrate breads. This variable is significant and positive in the grocery store model, suggesting that a price premium exists for high fiber content. In the grocery store model alone, total fat is expectedly negative, and statistically significant. In the grocery store model, there is no price premium for high content of total fat, nor does the amount of space allocated to the bread product generate a price premium. Each product is given a certain amount of shelf space; for example, discount brands sell at a lower price and have more shelf space, where as name brand breads have less shelf space with fewer loaves at a higher price.

The lack of statistical significance among variables in the non-grocery model and the Internet model may be due to data defects such as a relatively small sample size which leads to a lack of variability. For the purpose of this study, the effectiveness of the grocery store model in evaluating the impact of certain quality attributes is sufficient to capture associated price premiums.

Implicit Price of Low-Carbohydrate and Other Quality Attributes in Low Carbohydrate Bread

Quality attributes with negative signs are those attributes for which the consumer is not willing to pay a price premium. For example, the grocery store consumer is not willing to pay for serving size, quantity, or shelf space, nor is she willing to pay for high amounts of carbohydrate and total fat. On the other hand, some consumers (grocery store model) are willing to pay for the low carbohydrate product attribute, as well as for high fiber content.

Results show significant and positive parameter estimates for the low carbohydrate variable across store types. Based on hedonic pricing theory, the results suggest that consumers are willing to pay a premium for low carbohydrate bread over the conventional type. The implicit

price of the product attribute can be obtained by calculating the marginal effects of each attribute. For example, from Table 5, it is shown that consumers are willing to pay a premium for low carbohydrate bread ranging from about 0.06¢ per gram in grocery stores, to 1.1¢ per gram for bread available on the Internet, above the price of conventional bread. This converts into an average price (across all store types) of nearly $2.74 per loaf of bread (assuming a loaf of bread weighs 600 grams). The high average price premium is consistent with higher prices for low-carbohydrate bread at grocery stores. The average implicit price of fiber is calculated at $0.07 per loaf of bread.

Summary and Conclusions

Interest in low-carbohydrate foods is showing up in many product categories tracked by ACNielsen . Data from ACNielsen suggests that more than 17 percent of US households have someone in their household who is currently on a low-carbohydrate diet; in addition, nearly 19.2 percent of households reported that at least one household member was once on such a diet. (ACNielsen, 2004). This study uses store data in a hedonic pricing framework to determine the value consumers place on the low carbohydrate attribute in breads. Results show that consumers are generally willing to pay from 36¢ to $6.90 per loaf of bread more for the low carbohydrate bread as compared to conventional breads. This premium may not only reflect the value for those specifically following a low-carbohydrate diet. Individuals could also value the lower carbohydrate attribute for other health reasons. Results also suggest that consumers are willing to pay a premium for high fiber content at a value of 7¢ per loaf of bread. Other variables such as serving size, quantity, carbohydrate content, and total fat appropriately command no price premium from bread consumers at grocery stores.

This study leads to several hypotheses that warrant further study. For example, should an FDA-approved "low-carbohydrate" label be forthcoming, how will that change the value of low-carbohydrate foods, and the marketing of such? The sample of stores was relatively limited, and the study concentrated in one regional market, hence this study could be considered a case study. A larger study may be necessary, especially one with more heterogeneous store types and populations of shoppers, and different low-carbohydrate products in several markets around the US. Such a study would provide additional information to firms who are, or are considering developing and marketing low-carbohydrate breads, and other products.

References

ACNielsen. "ACNielsen Quantifies Impact Of Low Carb Diets." ACNielsen News Release, 2004. Available at http://www.acnielsen.com/news/american/us/2004/20040209.htm

Allan, C., and W. Lutz. *Life Without Bread: How a Low-Carbohydrate Diet Can Save Your Life*. New Canaan, CT.: Keats Publishing. 2000.

Alpizar, F., F. Carlsson, and P. Martinsson. "Using Choice Experiments for Non-Market Valuation." Staff Working Paper, Goteborg University, Department of Economics, Series Paper 52, (June 2001) 3.

Becker, G.S. "A Theory of the Allocation of Time." *The Economic Journal* 75(September 1965):493-517.

Bowman, S.A., and J.T. Spence. "A Comparison of Low-Carbohydrate *vs.* High-Carbohydrate Diets: Energy Restriction, Nutrient Quality and Correlation to Body Mass Index." *Journal of the American College of Nutrition*, 21, 3(2002):268-274.

Brooker, J.R., D.E. Terry, and D.B. Eastwood. "Hedonic Pricing of Food Items Based on Nutritive Attributes." *Journal of Food Distribution Research* 17(February, 1986):61-68.

Deaton, A., and J. Muellbauer. *Economics and Consumer Behavior*. Cambridge: Cambridge University Press, 1980.

Dietary Guidelines Advisory Committee. "*2005 Report of the Dietary Guidelines Advisory Committee*." United States Department of Agriculture. (2004). Available on the World Wide Web: http://www.health.gov/dietaryguidelines/dga2005/.

Grossman, M. On the Concept of Health Capital and the Demand for Health." *The Journal of Political Economy* 80(March-April 1972):223-225.

Kantor, L.S. "A Dietary Assessment of the US Food Supply: Comparing Per Capita Consumption with Food Guide Pyramid Serving Recommendations." USDA, ERS, AER-722. December 1998.

Lusk, J.L., T. Feldkamp, and T.C. Schroeder. "Experimental Auction Procedure: Impact on Valuation of Quality Differentiated Goods." *American Journal of Agricultural Economics* 86(May 2004):389-405.

Maguire, K.B., N. Owens, and N.B. Simon. "The Price Premium for Organic Baby food: A Hedonic Analysis." *Journal of Agricultural and Resource Economics*. 29(2004): 132-149.

Mancino, L., B-H. Lin, and N. Ballenger. "The Role of Economics in Eating Choices and Weight Outcomes." United States Department of Agriculture, Economic Research Service, Agricultural Information Bulletin Number 791. September, 2004.

Mintel International Group Limited. "The Bread Market - US 2004." Report/Study Product Ref 26023, Published Feb 4, 2004.

Mokdad, A.H., Marks, J.S., Stroup, D.F., and J. L. Gerberding. "Actual Causes of Death in the United States, 2000." JAMA. 291(2004):1238-1245.

Nayga Jr., R.M., "Consumer Characteristics Associated with Low-Fat, Low-Cholesterol Foods," *International Food and Agribusiness Management Review*, 1,1(1998):41-49.

Nutrition Business Journal. "Sports Nutrition & Weight Loss Report 2004." Nutrition Business Journal**,** San Diego, CA. 2004.

Philipson, T., Dai, C., Helmchen, L., and J. Variyam. "The Economics of Obesity: A Report on the Workshop Held at USDA's Economic Research Service." E-FAN No. 04004, USDA/ERS, 45 pp, May 2004. Available on the World Wide Web at http://www.ers.usda.gov/publications/efan04004/

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82 1 (Jan-Feb 1974): 34-55.

Salayo, N.D., T.J.P. Voon, and S. Selvanathan. "Implicit Prices of Prawn and Shrimp Attributes in the Philippine Domestic Market." *Marine Resource Economics* 14(1999):65-78.

Samikwa, D.D., B.W. Brorsen, and L.D. Sanders. "Hedonic Prices of Malawi Burley Tobacco." *International Food and Agribusiness Management Review* 1,1(1998):107-117.

Stiegert, K., and J-P. Blanc. "Japanese Demand for Wheat Protein Quantity and Quality." *Journal of Agricultural and Resource Economics* 22,1(1997):104-119.

United States Department of Agriculture, Economic Research Service, The Economics of Food, Farming, Natural Resources and Rural America. 1869-2003. Data available at http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/Data/table1.htm

Table 1. Description of Model Variables

Variable	Description
Price and Low-Carbohydrate	
Price	$ per gram
Low Carbohydrate	1 if low carbohydrate product, = 0 otherwise
Product Characteristics	
Serving Size	Grams per serving
Quantity	Number of slices per package
The following product characteristic variables are all per serving:	
Calories, Total Fat, Saturated Fat, Calories from Fat, Protein, Carbohydrates, Sugar, Fiber	
Store Characteristics	
Grocery	1 if sold in grocery, 2 non-grocery
Shelf Space	Feet
Location	1 if sold in ND, 2 MN, 3 Internet.

Table 2. Sources and Number of Observations for Survey Data

	Distribution by Location				
Store type	Moorhead	Obs	Fargo	Obs	Internet
Grocery store	4	172	10	394	
Other stores	4	43	6	72	
Number of Observations		215		466	70

Note: 'Other stores' include discount stores and convenience stores. Fargo and Moorhead columns contain the number of stores in each location. Data were collected in July of 2004.

Table 3. Means and Standard Deviations for Survey Data

		Moorhead		Fargo		Internet
Variable	All Data	Grocery	Non-Grocery	Grocery	Non-Grocery	
			Price (cents/gram)			
Price	0.516	0.435	0.357	0.454	0.389	1.287
	(0.367)	(0.191)	(0.094)	(0.194)	(0.119)	(0.683)
Price (conventional bread)	0.406	0.404	0.344	0.413	0.372	0.502
	(0.138)	(0.141)	(0.091)	(0.129)	(0.122)	(0.264)
Price (low carbohydrate)	0.954	0.637	0.440	0.688	0.458	1.624
	(0.600)	(0.319)	(0.077)	(0.310)	(0.083)	(0.506)
			Product characteristics			
Serving size	31.752	32.224	32.767	32.134	28.625	31.029
	(7.654)	(6.681)	(7.160)	(6.827)	(8.059)	(12.238)
Quantity	19.602	19.198	20.279	19.094	25.764	16.700
	(5.663)	(4.177)	(3.142)	(4.327)	(11.269)	(3.428)
Calories	79.905	80.756	86.977	79.543	85.000	70.271
	(22.211)	(19.271)	(21.716)	(19.768)	(23.957)	(34.408)
Protein	3.421	3.247	3.372	3.211	3.403	5.080
	(1.404)	(0.996)	(1.064)	(0.956)	(1.009)	(2.983)
Carbohydrates	15.134	15.478	16.767	15.261	16.500	11.234
	(4.585)	(3.749)	(3.999)	(3.771)	(4.783)	(7.742)
Sugar	2.184	2.229	2.395	2.272	2.639	0.979
	(1.677)	(1.111)	(1.067)	(1.836)	(1.859)	(1.509)
Fiber	1.872	1.791	1.814	1.766	1.972	2.601
	(1.142)	(0.957)	(1.052)	(0.981)	(1.074)	(1.984)
Total fat	1.019	1.026	1.139	0.999	1.028	1.035
	(0.500)	(0.409)	(0.467)	(0.418)	(0.697)	(0.817)
			Store characteristics			
Shelf space	2.811	3.086	3.032	3.102	3.164	na
	(3.925)	(4.948)	(3.179)	(3.811)	(2.971)	na
Observations	751	172	43	394	72	70

Note that “na” implies not applicable.

Table 4. Parameter Estimates using Maximum Likelihood Estimator

Variables	All observations	Grocery stores	Non-grocery stores	Internet
Intercept	1.4574**	1.9039**	0.2097	2.4157**
	(0.0848)	(0.0436)	(0.1085)	(0.4430)
Low carbohydrate	0.1833**	0.0603**	0.1613**	1.1499**
	(0.0330)	(0.0149)	(0.0384)	(0.2291)
Serving size	-0.0219**	-0.0191**	-0.0012	-0.0529**
	(0.0019)	(0.0009)	(0.0023)	(0.0096)
Quantity	-0.0256**	-0.0419**	0.0005	-0.0678**
	(0.0021)	(0.0011)	(0.0020)	(0.0142)
Calories	0.0049**	0.0030**	0.0003	-0.0004
	(0.0016)	(0.0008)	(0.0017)	(0.0061)
Protein	0.0720**	-0.0110	0.0050	0.0344
	(0.0096)	(0.0067)	(0.0142)	(0.0310)
Carbohydrate	-0.0302**	-0.0144**	0.0001	0.0595*
	(0.0069)	(0.0034)	(0.0083)	(0.0276)
Sugar	0.0108	0.0098**	0.0269**	0.0532
	(0.0061)	(0.0025)	(0.0096)	(0.0447)
Fiber	0.0307**	0.0118*	0.0195	-0.0123
	(0.0099)	(0.0057)	(0.0123)	(0.0288)
Total fat	-0.0131	-0.0532**	0.0265	0.0067
	(0.0247)	(0.0134)	(0.0241)	(0.0765)
Shelf space	-0.0102**	-0.0058**	-0.0048	na
	(0.0022)	(0.0009)	(0.0031)	
Observations	751	566	115	70
-2 Res Log likelihood	-23.1	-1084.3	-153.0	81.4

Note that **, and * imply statistical significance at 1% and 5%, respectively. Numbers in parentheses are standard errors, and 'na' implies not applicable.

Table 5: Implicit Price of the Low Carbohydrate and other Quality Attributes

Quality attribute	Implicit price*				
	Grocery stores (cents/gram)	Non-grocery stores (cents/gram)	Internet (cents/gram)	Mean price (cents/gram)	Mean price ($/loaf)**
Low carbohydrate	0.0603	0.1613	1.1499	0.4572	2.74
Calories	0.003			0.0030	0.02
Carbohydrate			0.0595	0.0595	0.36
Sugar	0.0098	0.0269		0.0184	0.11
Fiber	0.0118			0.0118	0.07

* Only significant positive variables are considered.
** Assumes a loaf of bread weighs 600 grams (obtained from observed data).