Assessing the Demand for a Functional Food Product: Is There Cannibalization in the Orange Juice Category?

Yan Yuan, Oral Capps, Jr., and Rodolfo M. Nayga, Jr.

The demand for functional foods has increased notably in recent years due to growing consumer interest in diet and health issues. Currently, the food industry is introducing many types of new food products with functional attributes. Consequently, cannibalization is a critical issue for firms that offer multiple products within a certain product category. The identification and assessment of cannibalization are integral factors when making strategic decisions about new product introductions. Using scanner data from Information Resources, Inc. (IRI), pertaining to a particular functional food, namely a phytosterol-enriched product for orange juice, we find that no cannibalization effects exist with respect to its introduction. We also provide estimates of own-price and cross-price elasticities of the orange juice category using a synthetic demand system.

Key Words: functional foods, phytosterols, orange juice industry, cannibalization, synthetic demand system

Evidence exists in the literature that health-related concerns have an influence on decisions made by consumers to reduce the consumption of harmful ingredients (e.g., fats and salt) and to increase the consumption of beneficial food components into their diets (Brown and Schrader 1990, Capps and Schmitz 1991, Chang and Kinnucan 1991, Skaggs et al. 1987). According to Willett (2002), 60 percent of the risk of chronic diseases potentially is preventable with lifestyle modifications, including changes in diet. Consequently, functional foods have increased in popularity in recent years. Functional foods generally are defined as foods or food components that may provide a health benefit beyond basic nutrition. Functional foods are believed to offer consumers an increased ability to reduce the risk of certain diseases or health problems (Schmidt 2000). Research conducted by the International Food Information Council (IFIC) (2005) shows that consumer demand for functional foods has increased steadily since 1996, which makes the development of these types of products potentially profitable (Singletary and Morganosky 2004). It is no surprise that many food companies now are developing food products with functional or health-related attributes.

To successfully launch functional foods, it is essential to obtain information on how these food products are performing in the market. This information can be used as a guide in current marketing and product development programs. However, recent studies indicate that consumer research within the functional food sector still is in its infancy. Further research is recommended to understand consumer needs, attitudes, and perceptions more fully (Bogue and Ryan 2000, Childs and Poryzees 1998). The objectives of this study are twofold: (i) to assess the demand for a phytosterol-enriched product in the orange juice category, and (ii) to examine possible cannibalization effects of its introduction. The particular phytosterol-enriched product in question is Minute Maid Heart Wise.

Yan Yuan is Assistant Professor in the Research Institute of Economics and Management at Southwestern University of Finance and Economics in Chengdu, Sichuan, P.R. China. Oral Capps is Professor and Southwest Dairy Marketing Endowed Chair in the Department of Agricultural Economics at Texas A&M University in College Station, Texas. Rodolfo Nayga is Professor and Tyson Chair in Food Policy Economics in the Department of Agricultural Economics and Agribusiness at the University of Arkansas in Fayetteville, Arkansas.

The authors wish to acknowledge comments made by an anonymous reviewer in revising this manuscript. Finally, they wish to acknowledge financial support for this research from The Kellogg Company.

Agricultural and Resource Economics Review 38/2 (October 2009) 153–165

Phytosterol is a plant sterol or a plant stanol (in more condensed form) that is helpful in reducing blood cholesterol levels, one of the major risk factors of heart disease. Through clinical research, phytosterols also have been found to (i) reduce symptoms of an enlarged prostate, (ii) improve the control of blood sugar among people with diabetes, and (iii) reduce inflammation among patients with autoimmune diseases such as rheumatoid arthritis and lupus.

An Overview of Literature on Cannibalization

New product introduction always has been a popular strategy for firms seeking growth (Reddy, Holak, and Bhat 1994). In the United States, a record number (18,722) of new food and beverages were introduced in 2005 (Mancino, Kuchlera, and Leibtag 2008). Many of these new introductions are in the U.S. food sector, which is going through rapid transformations (Dhar and Foltz 2005). In particular, new food products with health attributes have risen in popularity because they are believed to offer consumers an increased ability to reduce the risk of certain diseases or health problems (Schmidt 1999).

Introducing new brands successfully is more difficult, particularly due to increases in advertising costs and due to competition within distribution channels and customer outlets. It is observed that consumers in general are committed to brands they trust (Holleran 2005, Mason and Milne 1994). Thus, firms have increased the use of line extensions to improve firm performance. Line extensions refer to the use of an established brand to offer a new product in the same class or category, but they differ from their parent brand in relatively minor ways. However, cannibalization is one of the critical issues that firms face when offering multiple products using line extensions (Reddy, Holak, and Bhat 1994).

Cannibalization has been defined in several ways. For example, Heskett (1976, p. 581) defined cannibalization as "the process by which a new product gains sales by diverting them from existing products," while Mason and Milne (1994, p. 163) characterized it as "the extent to which one product's customers are at the expense of other products offered by the same firm." Heskett's definition relates cannibalization to new product introductions and does not restrict it to products that are offered by the same firm. In our analysis, we adopt Heskett's definition of cannibalization, and we quantitatively measure the effects of cannibalization in the orange juice category through the use of unit diversion ratios or sales diversion ratios (Abere et al. 2002). Unit diversion ratios or sales diversion ratios have not previously been considered in the extant literature on cannibalization. They are used extensively in the literature on mergers and acquisitions.

Cannibalization studies are important to multiproduct firms in competitive industries because they provide insights into the benefits of offering product variety. In addition, the identification and assessment of cannibalization are integral factors for strategic decisions of new product introductions (Mason and Milne 1994). While previous research has generated substantial evidence and insights about the cost implications of product variety, empirical work on demand responses to variety and the extent of cannibalization within a product line is scant (Carpenter and Hanssens 1994, Hui 2004), and no standard measures of cannibalization have been proposed in the literature.

To illustrate, Moorthy and Png (1992) demonstrated that cannibalization affected the optimal timing of new product introductions, but they did not provide measures to quantify its effects. Mason and Milne (1994) identified cannibalization in cigarette markets, and van Herdee, Leeflang, and Wittink (2004) studied the effects of promotion on new product introductions. Van Herdee and his coauthors considered cannibalization to be tantamount to a loss in net sales of existing products due to promotion of a new product within the same category. Lomax et al. (1997) examined three measures of cannibalization, namely, gain-loss analysis, duplication of purchase tables, and deviations from expected share movements. They centered attention on detergents in the United Kingdom and Germany using household data. More recently, Srinivasan, Ramakrishnan, and Grasman (2005a), focusing on the beverage industry, proposed the use of volume and market share changes after a new product is introduced to investigate the effects of cannibalization. Srinivasan, Ramakrishnan, and Grasman (2005b) incorporated models of cannibalization into demand forecasting.

Unit and Sales Diversion Ratios

Unit diversion ratios (u_{ji}) measure the change in quantity of product j due to a unit change in

quantity *i*. We wish to measure the extent to which quantities of other brands of orange juice have been affected by the introduction in late October 2003 of the phytosterol-enriched product Minute Maid Heart Wise. Abere et al. (2002) show that

$$u_{ji} = \frac{\varepsilon_{ji} q_j}{\varepsilon_{ii} q_i} = \frac{\Delta q_j}{\Delta q_i}, \tag{1}$$

where ε_{ji} is the uncompensated cross-price elasticity of product *j* with respect to product *i*, and ε_{ii} is the uncompensated own-price elasticity of product *i*. Product *i* in our analysis is Minute Maid Heart Wise. Unit diversion ratios are appropriate if products *j* and *i* are measured in the same units.

Sales diversion or dollar diversion ratios (d_{ij}) measure the change in sales of product *j* due to a unit change in sales of product *i*. As such, Abere et al. (2002) show that

$$d_{ji} = \frac{\varepsilon_{ji} p_j q_j}{\varepsilon_{ii} p_i q_i} = \frac{p_j \Delta q_j}{p_i \Delta q_i}. \tag{2}$$

The respective diversion ratios exhibited in equations (1) and (2) are functions of own- and cross-price elasticities. For substitute (complementary) products, the diversion ratios are negative (positive). The use of u_{ji} and d_{ji} allows the investigation of the extent to which units or sales of existing orange juice products are diverted (or diminished) because of the introduction of Minute Maid Heart Wise. In our analysis, we use a flexible demand system to estimate own-price and cross-price elasticities so as to compute the relevant unit and sales diversion ratios.

The remainder of the paper is organized as follows. The next section describes the data and descriptive statistics. The subsequent section deals with the methodology used to estimate the demand elasticities of the phytosterol-containing product and its counterparts. Then, the empirical results are discussed, and a summary of the findings and recommendations for further research are presented.

Data and Descriptive Statistics

Our data consist of weekly sales ($) and volume information (half gallons) for orange juice obtained from Information Resources, Inc. (IRI). Frozen orange juice is treated as a different product category and is excluded from the analysis. Consequently, our analysis concerns only ready-to-drink orange juice. The orange juice category contains 628 Universal Product Codes (UPCs) over the study period October 2003 to September 2005. This time period covers 98 weeks.

UPCs are aggregated with reference to brands in order to limit the number of products to consider. The various brands examined are (i) Minute Maid, (ii) Tropicana, (iii) Florida's Natural, (iv) Private Label Orange Juice, and (v) all other branded orange juice. Prices of these branded products are calculated by dividing sales figures by corresponding volume figures.

The principal product of interest is Minute Maid Heart Wise, which was introduced into the market in October 2003. Consequently, we separate Minute Maid Heart Wise from the other Minute Maid orange juice products. Thus, six different commodities (including Minute Maid Heart Wise and Other Minute Maid) of ready-to-drink orange juice are considered in this analysis. Given that Minute Maid Heart Wise was not available in the marketplace until October 2003, for consistency we analyze the descriptive statistics of the orange juice category over the 98 weeks from October 2003 to September 2005.

In Table 1, we present the descriptive statistics of ready-to-drink orange juice prices, sales, volumes, and market shares. As expected, Private Label orange juice has the lowest price on average, at $1.57 per half gallon. Tropicana is the most expensive orange juice product, at $2.65 per half gallon. Interestingly, the Minute Maid Heart Wise product, on average, is priced lower than other Minute Maid products, $2.37 versus $2.43 per half gallon. On average, Tropicana is the category leader in terms of average sales and volume. Other Minute Maid ranks second in terms of average sales, but ranks third behind Private Label products in terms of average volume. Minute Maid Heart Wise product sales and volume are the lowest among the various brands. In terms of market shares, Tropicana commands the highest market share at roughly 45 percent, followed by Minute Maid at about 17 percent. The average market share for Minute Maid Heart Wise over the study period is 0.86 percent. After January

Table 1. Descriptive Statistics of Orange Juice Prices ($/half gallon), Orange Juice Sales ($), Orange Juice Volume (half gallons), and Orange Juice Category Market Shares (%) over the Period October 2003 to September 2005

	ORANGE JUICE PRICES ($/HALF GALLON)				
BRAND	Mean	Std Dev	Min	Median	Max
Minute Maid Heart Wise	2.37	0.12	1.97	2.37	2.77
Other Minute Maid	2.43	0.09	2.16	2.42	2.69
Florida's Natural	2.29	0.10	1.95	2.29	2.46
Tropicana	2.65	0.14	2.34	2.65	2.94
Private Label	1.57	0.05	1.45	1.58	1.70
All other brands	2.24	0.09	1.92	2.23	2.46
	ORANGE JUICE SALES ($)				
BRAND	Mean	Std Dev	Min	Median	Max
Minute Maid Heart Wise	436,421	147,115	592	469,062	687,784
Other Minute Maid	8,365,562	898,891	6,877,139	8,186,538	10,701,132
Florida's Natural	4,852,704	724,936	3,506,228	4,785,681	7,295,869
Tropicana	22,475,210	2,345,265	18,641,582	21,903,951	30,567,230
Private Label	8,064,706	733,204	6,846,835	7,964,011	9,696,973
All other brands	6,998,584	636,886	5,675,239	6,938,784	9,138,556
	ORANGE JUICE VOLUMES (HALF GALLONS)				
BRAND	Mean	Std Dev	Min	Median	Max
Minute Maid Heart Wise	185,929	65,120	230	199,911	303,210
Other Minute Maid	3,455,836	430,031	2,754,054	3,375,164	4,759,817
Florida's Natural	2,131,354	388,016	1,459,709	2,107,575	3,4646,548
Tropicana	8,547,591	1,243,872	6.620,358	8,264,600	12,971,113
Private Label	5,123,841	472,259	4,370,939	5,044,412	6,639,226
All other brands	3,132,074	343,461	2,306,462	3,094,730	4,148,894
	ORANGE JUICE CATEGORY MARKET SHARES (%)				
BRAND	Mean	Std Dev	Min	Median	Max
Minute Maid Heart Wise	0.86	0.29	0.00[a]	0.92	1.29
Other Minute Maid	16.33	1.02	14.19	16.35	18.36
Florida's Natural	9.51	1.42	7.17	9.40	13.99
Tropicana	43.87	2.64	38.66	43.65	52.52
Private Label	15.75	0.76	14.03	15.82	17.57
All other brands	13.69	0.98	11.00	13.66	15.70

[a] Less than 0.01 percent.

2004, market shares of Minute Maid Heart Wise stabilized at approximately 0.96 percent.

In Figure 1 we present graphically the evolution of the market by shares over the study period. The market shares do indeed change, albeit not greatly, but recall that the change in market shares is not the metric associated with cannibalization.

Methodology

We employ a demand-system approach to derive the own-price, cross-price, and expenditure elasticities of orange juice products. Because of the use of unit and dollar diversion ratios, emphasis is placed on the use of cross-price elasticities of demand in considering cannibalization effects.

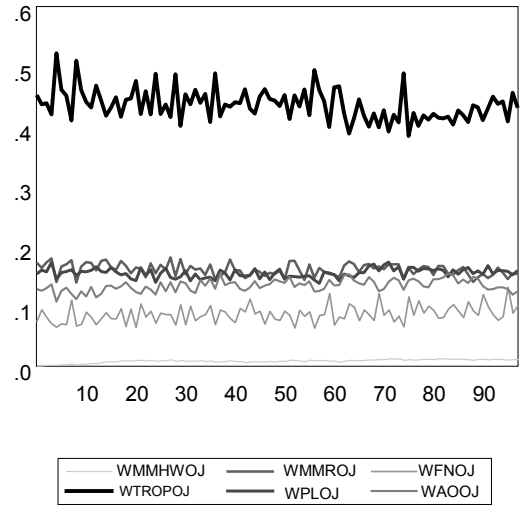

Figure 1. The Evolution of Weekly Market Shares of Various Brands of Orange Juice Over the Period October 2003 to September 2005

Notes: "WMMHWOJ" is market share of Minute Maid Heart Wise orange juice. "WMMROJ" is market share of regular Minute Maid orange juice. "WFNOJ" is market share of Florida's Natural orange juice. "WTROPOJ" is market share of Tropicana orange juice. "WPLOJ" is market share of Private Label orange juice. "WAOOJ" is market share of all remaining brands of orange juice.

The choice of the type of demand system potentially can have a notable effect on the estimation of elasticities. Several demand systems—including Barten's (1964) and Theil's (1965) Rotterdam model and its several variants, the Translog demand system (TLDS) of Christensen, Jorgenson, and Lau (1975), and Deaton and Muellbauer's (1980) Almost Ideal Demand System (AIDS)—have been used in the economics literature (e.g., Capps, Seo, and Nichols 1997, Nayga and Capps 1994, Seo and Capps 1997).

One of the compelling features of demand system models is that they maintain flexibility while simultaneously satisfying the adding-up, homogeneity, and symmetry restrictions in accordance with demand theory. However, there is little to guide a researcher when attempting to choose a particular functional form among the set of alternatives. Barten (1993) developed a synthetic system which nests four popular differential demand systems including the Rotterdam, LA/AIDS, CBS (Central Bureau of Statistics), and NBR (National Bureau Research). Maynard and Veeramani (2003) also show that synthetic models help avoid specification bias by allowing more generalized functional forms.

The Barten model is specified as follows:

$$(3)\quad w_i d\ln q_i = (b_i + \delta w_i) d\ln Q + \sum_j \left[c_{ij} - \gamma w_i (\delta_{ij} - w_j) \right] d\ln p_j,$$

where $\delta_{ij} = 1$ if $i = j$, and $\delta_{ij} = 0$ if $i \neq j$. $d\ln Q$ represents a Divisia Volume Index, w_i and q_i denote expenditure share and sales quantity of ith product, respectively, and p_j denotes the price of jth product. b_i, c_{ij}, δ, and γ are the parameters to be estimated in the demand system. When $\delta = \gamma = 0$, this specification statistically is equivalent to the Rotterdam model; when $\delta = \gamma = 1$, the specification is tantamount to LA/AIDS; when $\delta = 1$ and $\gamma = 0$, the Barten model is equivalent to the CBS model; and when $\delta = 0$ and $\gamma = 1$, the Barten model and the NBR model are indistinguishable. Theoretical demand restrictions are homogeneity, symmetry, and adding-up, which are given by

$$(4a)\quad \sum_j c_{ij} = 0 \text{ for all } i \text{ (homogeneity)},$$

$$(4b)\quad c_{ij} = c_{ji} \text{ for all } i \text{ and } j \text{ (symmetry)},$$

$$(4c)\quad \sum_i c_{ij} = 0 \text{ for all } j \text{ (adding-up), and}$$

$$(4d)\quad \sum_i b_i = 1 - \delta \text{ (adding-up)}.$$

To account for potential seasonality, we add dummy variables pertaining to calendar quarters to the demand system specification. To avoid the dummy variable trap, the reference quarter is the fourth quarter of the year.

Multicollinearity, degrees of freedom issues, and computational limitations necessitate aggregation across UPCs (Capps and Love 2002). Our demand system consists of six equations. In estimating the Barten synthetic demand system, one equation is dropped to avoid estimation problems due to the singularity of the variance-covariance matrix of disturbance terms. The "all other branded products" equation is chosen to be omit-

ted from the system; the parameter estimates associated with this omitted equation are recovered through the use of the aforementioned theoretical restrictions given by equations (4a) to (4d). The theoretical restrictions are imposed when estimating the system.

An Iterated Seemingly Unrelated Regression (ITSUR) technique is applied, taking into account the contemporaneous correlation of the disturbance terms among the equations. As well, we allow for the presence of first-order serial correlation [AR(1)] in the disturbance terms in each of the equations. This "mechanical" correction accounts for other systematic factors (e.g., advertising and promotion expenditures of the respective orange juice brands) that do not explicitly appear in the demand system due primarily to the lack of available data. These other systematic factors may affect the dependent variables in the system. Because of adding-up, a common AR(1) coefficient is estimated for the system of equations.

Empirical Results

The estimated coefficients, standard errors, p-values, and goodness-of-fit statistics associated with the estimation of the Barten demand models are presented in Tables 2a and 2b. The majority of the estimated coefficients in the demand system are not statistically different from zero. Not counting the coefficients associated with the quarterly dummy variables, only 10 of the 29 coefficients in the demand system are statistically significant at the 0.10 level. The goodness-of-fit statistics indicate that the individual equations of the demand system explain a notable amount of the variability in each of the dependent variables. The range of the goodness-of-fit statistics is from 0.6925 to 0.9664. Importantly, based on the estimates of δ and γ, the Barten model is statistically superior to the Rotterdam model, the LA/AIDS model, the CBS model, and the NBR model. As well, the joint test of the coefficients associated with the quarterly dummy variables indicates that seasonality is evident, but only for Minute Maid Heart Wise.

The uncompensated and compensated price elasticities together with expenditure elasticities are presented in Tables 3 and 4. Although a minority of the estimated coefficients in the demand system is statistically significant, 33 of the 42 elasticities exhibited in Table 3, and 30 of the 36 elasticities exhibited in Table 4, are statistically different from zero at the 0.10 level of significance. The price elasticities refer to the percentage change in volume sold due to a one percent change in price. That is, elasticities relate the sensitivity of consumers to price changes. We consider two types of cross-price elasticities: uncompensated and compensated. Uncompensated cross-price elasticity pertains to the sensitivity of volume sold of brand i to a change in price of brand j, holding total expenditure constant. The expression for the uncompensated elasticity of brand i with respect to the price of brand j is

$$\varepsilon_{ij} = \frac{[c_{ij} - \gamma w_i(\delta_{ij} - w_j)]}{w_i} - w_j n_i . \tag{5}$$

The compensated cross-price elasticity, ε_{ij}^{*}, relates the responsiveness of volume sold of brand i to a change in price of brand j, holding utility constant. The compensated elasticity for the ith product with respect to jth product price change is computed as

$$\varepsilon_{ij} = \frac{[c_{ij} - \gamma w_i(\delta_{ij} - w_j)]}{w_i} . \tag{6}$$

The notions of substitutability and complementarity among the products in our system are based on the compensated (Hicksian) cross-price elasticities. Substitutes in the Hicksian sense are evident for positive compensated cross-price elasticities, while complements in the Hicksian sense are evident for negative compensated cross-price elasticities.

We also calculate the expenditure elasticities, computed as

$$n_i = \frac{(b_i + \delta w_i)}{w_i} . \tag{7}$$

The respective own-price, cross-price, and expenditure elasticities are functions of estimated parameters and expenditure shares. We calculate the elasticities using sample means of the expenditure shares. As shown in Table 3, the uncom-

Table 2a. Parameter Estimates, Standard Errors, t-Statistics, and Goodness-of-Fit Statistics for the Synthetic Barten Model

	Durbin-Watson	R-Squared
Minute Maid Heart Wise equation	1.5484	0.8269
Other Minute Maid equation	2.3989	0.9048
Florida's Natural equation	2.5436	0.8639
Tropicana equation	2.4095	0.9664
Private Label equation	2.7065	0.6925
Omitted equation – all other brands	--	--
	Coefficient	**St. Error**	**p-value**
b_1	0.0022	0.0028	0.4275
c_{11}	0.0033	0.0027	0.2231
c_{12}	-0.0046	0.0023	0.0430
c_{13}	0.0010	0.0013	0.4416
c_{14}	0.0013	0.0016	0.4071
c_{15}	-0.0001	0.0019	0.9527
delta	0.7174	0.2948	0.0150
gamma	2.4035	0.3142	0.0000
b_2	-0.0136	0.0498	0.7851
c_{22}	0.0034	0.0443	0.9393
c_{23}	0.0206	0.0112	0.0659
c_{24}	-0.0016	0.0257	0.9513
c_{25}	-0.0102	0.0146	0.4873
b_3	0.0439	0.0384	0.2536
c_{33}	-0.1058	0.0339	0.0018
c_{34}	0.0562	0.0206	0.0065
c_{35}	0.0068	0.0144	0.6351
b_4	0.2063	0.1367	0.1314
c_{44}	-0.0136	0.0823	0.8690
c_{45}	-0.0470	0.0256	0.0660
b_5	0.0039	0.0496	0.9371
c_{55}	0.0980	0.0477	0.0403
rho	-0.4017	0.0476	0.0000

Notes:

1. SHAZAM 10.0 is used to estimate the Barten (1993) model.
2. Rho refers to the autocorrelation coefficient in the disturbance terms [AR(1) process].
3. The estimated coefficients b_i's and c_{ij}'s correspond to equation (3). Subscript 1 represents Minute Maid Heart Wise, 2 refers to Other Minute Maid, 3 represents Florida's Natural, 4 denotes Tropicana, 5 denotes Private Label, and 6 refers to all other brands. For example, c_{12} refers to the price effect of Other Minute Maid on the volume of Minute Maid Heart Wise. We recover the coefficients associated with all other brands (c_{16}, c_{26} , c_{36}, c_{46}, c_{56}, c_{66}, and b_6) from the theoretical restrictions.

	Coefficient	St. Error	p-value
$c_{16} = -c_{11} - c_{12} - c_{13} - c_{14} - c_{15}$	-0.0008	0.0016	0.5900
$c_{26} = -c_{12} - c_{22} - c_{23} - c_{24} - c_{25}$	-0.0076	0.0130	0.5611
$c_{36} = -c_{13} - c_{23} - c_{33} - c_{34} - c_{35}$	0.0211	0.0124	0.0877
$c_{46} = -c_{14} - c_{24} - c_{34} - c_{44} - c_{45}$	0.0046	0.0228	0.8397
$c_{56} = -c_{15} - c_{25} - c_{35} - c_{45} - c_{55}$	-0.0475	0.0153	0.0019
$c_{66} = -c_{16} - c_{26} - c_{36} - c_{46} - c_{56}$	0.0302	0.0411	0.04630
$b_6 = 1 - b_1 - b_2 - b_3 - b_4 - b_5 - \delta$	0.0127	0.0434	0.7692

4.

	χ^2_2	p-value
Test of H_0: delta = 0 and gamma = 0 (Rotterdam model)	58.95	0.0000
Test of H_0: delta = 1 and gamma = 1 (LA/AIDS model)	24.25	0.0000
Test of H_0: delta = 1 and gamma = 0 (CBS model)	66.63	0.0000
Test of H_0: delta = 0 and gamma = 1 (NBR model)	21.97	0.0000

Table 2b. Parameter Estimates Associated with the Quarterly Dummy Variables Pertaining to Seasonality

Brand	Coefficient	St. Error	T-stat
Minute Maid Heart Wise			
Q1	0.00042	0.00010	4.35
Q2	-0.00019	0.00009	-1.00
Q3	0.00002	0.00010	0.17
Other Minute Maid			
Q1	-0.00080	0.00089	-0.89
Q2	-0.00093	0.00093	-1.00
Q3	0.00004	0.00098	0.04
Florida's Natural			
Q1	0.00177	0.00146	1.21
Q2	0.00028	0.00145	0.19
Q3	0.00197	0.00161	1.22
Tropicana			
Q1	-0.00052	0.00207	-0.25
Q2	0.00050	0.00203	0.25
Q3	-0.00223	0.00222	-1.00
Private Label			
Q1	-0.00060	0.00101	-0.60
Q2	-0.00051	0.00098	-0.52
Q3	0.00094	0.00108	0.87

Note: Joint test on all coefficients associated with seasonality; $\chi^2_{15} = 41.22$, p-value 0.0003.

pensated own-price elasticities range from -1.52 (Private Label) to -3.40 (Florida's Natural). Thus, all own-price elasticities are in the elastic range, suggesting that consumers are quite sensitive to price changes of orange juice. The own-price elasticity for the phytosterol brand (Minute Maid Heart Wise) is -2.01, slightly lower than the own-price elasticity of other Minute Maid brands (-2.12).

Expenditure elasticities, which refer to the percentage change in volume sold due to a one percent change in total expenditure in the orange juice category, vary from 0.74 (Private Label) to 1.20 (Florida's Natural and Tropicana). When total expenditure in the orange juice category rises, Florida's Natural and Tropicana benefit the most, while Private Label products and other Minute Maid brands benefit the least in terms of percentage change of volume.

As exhibited in Table 4, the dominance of positive compensated cross-price elasticities indicates that the products in question are substitutes. The competition among national brands is stronger than the competition between national brands and private label items. The major competitors to the phytosterol-enriched orange juice are Tropicana and Florida's Natural. In all cases, Tropicana is the major competitor to the brands in the orange juice category. The magnitude of the compensated cross-price elasticities of Minute Maid Heart Wise suggests that the phytosterol product is not a prominent competitor to existing brands in the orange juice category. Based on the estimated cross-price elasticities, both uncompensated and compensated, price changes of Minute Maid Heart Wise orange juice do not statistically affect the demand for other Minute Maid orange juice products, and vice versa. Purchasers of Minute Maid Heart Wise perhaps view this product differently from other non-phytosterol-enriched orange juice products due to its health attribute (i.e., phytosterol).

Table 3. Uncompensated Own-Price and Cross-Price Elasticities and Expenditure Elasticities Associated with the Orange Juice Brands

	Minute Maid Heart Wise	Other Minute Maid	Florida's Natural	Tropicana	Private Label	All other brands	Expen-diture	Market shares
Minute Maid Heart Wise	-2.0091[a]	-0.3060	0.2477	0.7827	0.2119	0.0969	0.9758	0.86%
	(0.0000)[b]	(0.2652)	(0.0967)	(0.0000)	(0.3224)	(0.5892)	(0.000)	
Other Minute Maid	-0.0146	-2.1212	0.2784	0.6936	0.1902	0.1730	0.8006	16.32%
	(0.3127)	(0.0000)	(0.0000)	(0.0000)	(0.0191)	(0.0136)	(0.000)	
Florida's Natural	0.0207	0.4162	-3.3995	1.1287	0.2649	0.3901	1.1790	9.51%
	(0.1198)	(0.0004)	(0.0000)	(0.0000)	(0.0860)	(0.0021)	(0.000)	
Tropicana	0.0135	0.1949	0.2438	-1.9010	0.0843	0.1770	1.1876	43.87%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0125)	(0.0000)	(0.000)	
Private Label	0.0136	0.2067	0.2014	0.4301	-1.5197	-0.0742	0.7423	15.75%
	(0.2322)	(0.0127)	(0.0216)	(0.0000)	(0.0000)	(0.4083)	(0.000)	
All other brands	0.0075	0.2047	0.3059	0.7325	-0.0962	-1.9650	0.8105	13.69%
	(0.5057)	(0.0169)	(0.0005)	(0.0000)	(0.3645)	(0.0000)	(0.000)	

[a] All elasticities are computed using the sample means of the data.
[b] The figures in parentheses are the corresponding p-values.

Table 4. Compensated Own-Price and Cross-Price Elasticities Associated with the Orange Juice Brands

	Minute Maid Heart Wise	Other Minute Maid	Florida's Natural	Tropicana	Private Label	All Other Brands
Minute Maid Heart Wise	-2.0007[a] (0.0000)[b]	-0.1467 (0.5940)	0.3405 (0.0177)	1.2108 (0.0000)	0.3656 (0.0783)	0.2304 (0.1919)
Other Minute Maid	-0.0077 (0.5940)	-1.9905 (0.0000)	0.3545 (0.0000)	1.04448 (0.0000)	0.3163 (0.0000)	0.2826 (0.0000)
Florida's Natural	0.0308 (0.0177)	0.6087 (0.0000)	-3.2874 (0.0000)	1.6459 (0.0000)	0.4506 (0.0013)	0.5514 (0.0000)
Tropicana	0.0237 (0.0000)	0.3888 (0.0000)	0.3567 (0.0000)	-1.38 (0.0000)	0.2713 (0.0000)	0.3395 (0.0000)
Private Label	0.0200 (0.0783)	0.3279 (0.0000)	0.2720 (0.0013)	0.7557 (0.0000)	-1.4028 (0.0000)	0.0274 (0.7550)
All Other Brands	0.0145 (0.1919)	0.3370 (0.0000)	0.3830 (0.0000)	1.0881 (0.0000)	0.0315 (0.7550)	-1.8540 (0.0000)

[a] All elasticities are computed using the sample means of the data.
[b] The figures in parentheses are the corresponding p-values.

Use of Diversion Ratios to Identify Cannibalization Effects

We argue that the primary reason behind the introduction of Minute Maid Heart Wise orange juice is simply the addition of a health attribute, namely phytosterol, designed to reduce cholesterol levels. In this context, then, consumers see this "new" product potentially as a healthy alternative to other existing brands of orange juice, including the other Minute Maid brands, the Tropicana brands, the Florida's Natural brands, and the private label brands. Consumers, in our view, see the "new" product potentially as a better one relative to the current products in the marketplace.

The key questions then are the following: (i) What happens to quantities purchased or sales in the orange juice category due to the introduction of the healthy alternative? Specifically, do sales or quantities purchased for the entire category rise because of this introduction? (ii) What happens to the quantities purchased or sales of Minute Maid because of the introduction of Minute Maid Heart Wise? and (iii) What happens to the quantities purchased or sales of other brands in the category due to the introduction of Minute Maid Heart Wise? The cannibalization issue, narrowly defined, revolves around question (ii). If cannibalization exists, then quantities purchased or sales of regular Minute Maid orange juice are diminished, while quantities purchased or sales of Minute Maid Heart Wise are increased. But ramifications exist due to the introduction of Minute Maid Heart Wise for the orange juice category. Hence we also are interested in addressing questions (i) and (iii). In addressing these issues, we employ the unit diversion ratios and the sales diversion ratios.

The respective unit and dollar diversion ratios associated with our analysis are exhibited in Table 5. Simply put, cannibalization is not just a measure of substitution effects holding prices constant. Prices are permitted to vary, and indeed must vary, in order to glean the appropriate own-price and cross-price elasticities.

The diversion ratios are negative for all orange juice brands except for other Minute Maid brands. Therefore, the introduction of Minute Maid Heart Wise diverts volume and sales away from competing brands and directs volume and sales toward other Minute Maid brands. In particular, with the introduction of a unit (half gallon) of Minute Maid Heart Wise, volumes of Tropicana, Private Label, Florida's Natural, and all other brands were reduced by 0.31, 0.19, 0.12, and 0.06 half gallons, respectively. On average, the introduction of Minute Maid Heart Wise increased the volume of other Minute Maid orange juice by 25,113 half gallons on a weekly basis, but reduced the volume of Tropicana by 57,435 half gallons, the volume of Private Label orange juice by 34,684 half gallons, the volume of Florida's Natural by 21,960 half gallons, and the volume of

Table 5. Unit Division Ratios and Dollars Diversion Ratios Associated with the Introduction of Minute Maid Heart Wise

	Unit Diversion Ratios [a]	Volume Generated with the Introduction of Minute Maid Heart Wise [b]	Dollar Diversion Ratios [a]	Sales Generated with the Introduction of Minute Maid Heart Wise [c]
Minute Maid Heart Wise	1	185,929	1	$436,421
Other Minute Maid	0.1351	25,113 (0.73%)[d]	0.1392	$60,792 (0.73%)[d]
Florida's Natural	-0.1181	-21,960 (-1.03%)	-0.1146	-$49,998 (-1.03%)
Tropicana	-0.3089	-57,435 (-0.67%)	-0.3460	-$151,021 (-0.67%)
Private Label	-0.1865	-34,684 (-0.68%)	-0.1251	-$54,592 (-0.68%)
All Other Brands	-0.0629	-11,692 (-0.37%)	-0.0599	-$26,126 (-0.37%)
Sum	0.4587	85,271	0.4936	$215,476

[a] Based on sample means of the data as well as the uncompensated elasticities exhibited in Table 3.
[b] Units of half gallons; the units in this column are arrived at by the product of the unit diversion ratios and the sample mean of the Minute Maid Heart Wise volume from Table 1.
[c] The sales figures in this column are arrived at by the product of the dollar diversion ratios and the sample mean of the Minute Maid Heart Wise sales from Table 1.
[d] The gain or loss in quantities purchased or sales on a percent basis associated with the introduction of Minute Maid Heart Wise.

all other brands of orange juice by 11,692 half gallons on a weekly basis. The introduction of Minute Maid Heart Wise thus had the overall effect of increasing the volume of orange juice sold by 85,271 half gallons per week. The new product volume gains of Minute Maid Heart Wise and of other Minute Maid brands overshadowed the volume reduction of competing orange juice brands.

Sales associated with Tropicana, Private Label, Florida's Natural, and all other brands were diminished by 35 cents, 13 cents, 11 cents, and 6 cents, respectively, for every dollar in sales of Minute Maid Heart Wise. As exhibited in Table 5, sales of other Minute Maid products were increased by $60,792 per week with the introduction of Minute Maid Heart Wise. But sales of Tropicana, Florida's Natural, Private Label, and all other brands of orange juice were diminished by $151,021, $49,998, $54,592, and $26,126, respectively, on a per week basis. For the orange juice category as a whole, sales increased by $215,476 per week with the introduction of Minute Maid Heart Wise.

To put these calculations into perspective, we report on a percent basis the gain or loss in quantities purchased and the gain or loss in sales associated with the introduction of Minute Maid Heart Wise relative to average weekly volumes and sales. On a percent basis, the loss for Florida's Natural came to roughly one percent of average weekly volume and sales; the loss in Tropicana and Private Label volumes and sales came to roughly two-thirds of one percent of average weekly volume and sales. In the case of all other brands, the loss amounted to just under four-tenths of one percent of average weekly volume and sales. The gain in volume and in sales attributed to other Minute Maid brands amounted to slightly less than three-fourths of one percent of average weekly volume and sales.

Bottom line, the introduction of the phytosterol-enriched orange juice product manufactured by Minute Maid did not cannibalize sales or volumes of existing Minute Maid orange juice products. Sales and volumes of competing brands, however, were diminished. But sales and volumes of the entire orange juice category were enhanced by the introduction of Minute Maid Heart Wise.

Concluding Remarks

Food companies often try to differentiate their products by introducing additional product features or attributes that are health-related (e.g., functional foods). While one stream of general marketing research (Carpenter and Glazer 1994, Meyers-Levy and Tybout 1989, Nowlis and Simonson 1996) has shown that adding attributes to a product generally improves product evaluation

and performance, another set of research indicates that adding attributes may not always improve product evaluation (Broniarczyk and Gershoff 1997, Brown and Carpenter 2000, Nowlis and Simonson 1996). Although these studies provide considerable information on the effects of new attributes, little is known about the effects of health-related or functional attributes on food product demand. In addition, line extensions are more widely used due to the increasing advertising costs and competition in distribution channels to introduce new brands. Consequently, cannibalization has been considered one of the critical issues for firms that offer multiple products (Reddy, Holak, and Bhat 1994).

Using weekly scanner data from October 2003 to September 2005 and a synthetic demand system developed by Barten (1993), we estimated own-price elasticities for phytosterol-enriched brands and non-phytosterol brands to address consumer sensitivity to price changes. We also estimated cross-price elasticities of phytosterol-enriched food products relative to other products within the category to assess the degree of substitutability among the products.

Our results suggest that consumers view the phytosterol-enriched orange juice product differently from conventional products. This claim is substantiated by rather strong substitutability among the conventional orange juice products and weak substitutability between phytosterol and conventional orange juice products. Furthermore, based on diversion ratios, our findings indicate that there are no cannibalization effects between Minute Maid Heart Wise and other Minute Maid orange juice brands. As well, volumes and sales of the entire orange juice category are increased because of the introduction of Minute Maid Heart Wise.

Our study also provides a framework to study cannibalization effects using diversion ratios based on own-price and cross-price elasticities from a flexible demand system. Firms now have more access to scanner data than ever before. Hence, they can replicate the analysis developed here, using their own data, to evaluate cannibalization effects in their product lines.

References

Abere, A., O. Capps, Jr., S. Church, and H.A. Love. 2002. "Mergers and Market Power: Estimating the Effect on Market Power of the Proposed Acquisition by the Coca-Cola Company of Cadbury Schweppes' Carbonated Soft Drinks in Canada." In D.J. Slottje, ed., *Measuring Market Power*. Amsterdam, London, and New York: Elsevier Science, North-Holland.

Barten, A.P. 1964. "Consumer Demand Functions Under Conditions of Almost Additive Preferences." *Econometrica* 32(1/2): 1–38.

____. 1993. "Consumer Allocation Models: Choice of Functional Form." *Empirical Economics* 18(1): 129–158.

Bogue, J., and M. Ryan. 2000. "Market-Oriented New Product Development: Functional Foods and the Irish Consumer." Agribusiness Discussion Paper No. 27, Department of Food Economics, National University of Ireland.

Broniarczyk, S.M., and A.D. Gershoff. 1997. "Meaningless Differentiation Revisited." *Advances in Consumer Research* 24(1): 223–228.

Brown, C.L., and G.S. Carpenter. 2000. "Why Is the Trivial Important? A Reasons-Based Account for the Effects of Trivial Attributes on Choice." *Journal of Consumer Research* 26(4): 372–385.

Brown, D.J., and L.F. Schrader. 1990. "Cholesterol Information and Shell Egg Consumption." *American Journal of Agricultural Economics* 72(3): 548–555.

Capps, Jr., O., and H.A. Love. 2002. "Econometric Considerations in the Use of Electronic Scanner Data to Conduct Consumer Demand Analysis." *American Journal of Agricultural Economics* 84(3): 807–816.

Capps, O., and J.D. Schmitz. 1991. "A Recognition of Health and Nutrition Factors in Food Demand Analysis." *Western Journal of Agricultural Economics* 16(1): 21–35.

Capps, O., S.C. Seo, and J.P. Nichols. 1997. "On the Estimation of Advertising Effects for Branded Products: An Application to Spaghetti Sauces." *Journal of Agricultural and Applied Economics* 29(2): 291–302.

Carpenter, G.S., and R. Glazer. 1994. "Meaningful Brands from Meaningless Differentiation: The Dependence on Irrelevant Attributes." *Journal of Marketing Research* 31(3): 339–350.

Carpenter, G.S., and D.M. Hanssens. 1994. "Market Expansion, Cannibalization, and International Airline Pricing Strategy." *International Journal of Forecasting* 10(2): 313–326.

Chang, H.-S., and H.W. Kinnucan. 1991. "Advertising, Information, and Product Quality: The Case of Butter." *American Journal of Agricultural Economics* 73(4): 1195–1203.

Childs, N.M., and G.H. Poryzees. 1998. "Foods That Help Prevent Disease: Consumer Attitudes and Public Policy Implications." *British Food Journal* 100(9): 419–426.

Christensen, L.R., D.W. Jorgenson, and L.J. Lau. 1975. "Transcendental Logarithmic Utility Functions." *American Economic Review* 65(3): 367–383.

Deaton, A., and J. Muellbauer. 1980. "An Almost Ideal Demand System." *American Economic Review* 70(3): 312–326.

Dhar, T., and J.D. Foltz. 2005. "Milk by Any Other Name ... Consumer Benefits from Labeled Milk." *American Journal of Agricultural Economics* 87(1): 214–228.

Heskett, J. 1976. *Marketing*. New York: Macmillan.

Holleran, J. 2005. "Big Brands: Benefits Spur New Product Trial." *Stagnito's New Products Magazine* (January 1). Available online at http://www.allbusiness.com/marketing-advertising/342694-1.html.

Hui, K.L. 2004. "Product Variety under Brand Influence: An Empirical Investigation of Personal Computer Demand." *Management Science* 50(5): 686–700.

International Food Information Council. 2005. "2005 Consumer Attitudes toward Functional Foods/Foods for Health." International Food Information Council, Washington, D.C. Available at http://www.ific.org.

Lomax, W., K. Hammond, R. East, and M. Clemente. 1997. "The Measurement of Cannibalization." *Journal of Product and Brand Management* 6(1): 27–39.

Mancino, L., F. Kuchlera, and E. Leibtag. 2008. "Getting Consumers to Eat More Whole Grains: The Role of Policy, Information, and Food Manufacturers." *Food Policy* 33(6): 489–496.

Mason, C.H., and G.R. Milne. 1994. "An Approach for Identifying Cannibalization within Product Line Extensions and Multi-Brand Strategies." *Journal of Business Research* 31(2/3): 163–170.

Maynard, L.J., and V.N. Veeramani. 2003. "Price Sensitivities for U.S. Frozen Dairy Products." *Journal of Agricultural and Applied Economics* 35(3): 599–609.

Meyers-Levy, J., and A.M. Tybout. 1989. "Schema Congruity as a Basis for Product Evaluation." *Journal of Consumer Research* 16(1): 39–54.

Moorthy, K.S., and I.P.L. Png. 1992. "Market Segmentation, Cannibalization, and the Timing of Product Introductions." *Management Science* 38(3): 345–359.

Nayga, R.M., and O. Capps. 1994. "Tests of Weak Separability in Disaggregated Meat Products." *American Journal of Agricultural Economics* 76(4): 800–808.

Nowlis, S.M., and I. Simonson. 1996. "The Effect of New Product Features on Brand Choice." *Journal of Marketing Research* 33(1): 36–46.

Reddy, S.K., S.L. Holak, and S. Bhat. 1994. "To Extend or Not to Extend: Success Determinants of Line Extensions." *Journal of Marketing Research* 31(2): 243–262.

Schmidt, D.B. 1999. "Message Understood?" *Functional Foods* 2: 24–26.

____. 2000. "Consumer Response to Functional Foods in the 21st Century." *AgBioForum* 3(1): 14–19.

Seo, S.C., and O. Capps. 1997. "Regional Variability of Price and Expenditure Elasticities: The Case of Spaghetti Sauces." *Agribusiness: An International Journal* 13(6): 659–672.

Singletary, K.W., and M.A. Morganosky. 2004. "Functional Foods: Consumer Issues and Future Challenges." *Journal of Food Distribution Research* 35(1): 1–5.

Skaggs, R., D. Menkhaus, S. Torok, and R. Field. 1987. "Test Marketing of Branded, Low Fat, Fresh Beef." *Agribusiness: An International Journal* 3(3): 257–272.

Srinivasan, S.R., S. Ramakrishnan, and S.E. Grasman. 2005a. "Identifying the Effects of Cannibalization on the Product Portfolio." *Marketing Intelligence and Planning* 23(4): 359–371.

____. 2005b. "Incorporating Cannibalization Models into Demand Forecasting." *Marketing Intelligence and Planning* 23(5): 470–485.

Theil, H. 1965. "The Information Approach to Demand Analysis." *Econometrica* 33(1): 67–87.

van Herdee, H.J., P.S.H. Leeflang, and D.R. Wittink. 2004. "Decomposing the Sales Promotion Bump with Store Data." *Marketing Science* 23(3): 317–334.

Willett, W. 2002. "Balancing Life-Style and Genomics Research for Disease Prevention." *Science* 296(5568): 695–698.